CASE NOT YET SCHEDULED FOR ORAL ARGUMENT

CASE NO. 11-1483
Consolidated with Case No. 15-1027

UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

INDEPENDENT PILOTS ASSOCIATION,
Petitioner,

v.

FEDERAL AVIATION ADMINISTRATION,
Respondent.

JOINT APPENDIX TO REPLY BRIEF OF PETITIONER INDEPENDENT PILOTS ASSOCIATION

VOLUME I of V
PAGES 1-787

Review of the FAA Rule, Flightcrew Member Duty and Rest Requirements,
Docket No. the FAA-2009-1093; Amdt. Nos. 117-1, 119-16, 121-357
issued on December 21, 2011.

W. Eric Pilsk
epilsk@kaplankirsch.com
KAPLAN, KIRSCH & ROCKWELL, LLP
1001 Connecticut Avenue, NW
Washington, D.C. 20036
Telephone: (202) 955-5600
Facsimile: (202) 955-5616

Counsel to Independent Pilots Association

William C. Trent,
General Counsel
INDEPENDENT PILOTS
ASSOCIATION
3607 Fern Valley Road
Louisville, KY 40219
(502) 967-0341 ext. 2205
(502) 753-3252 (fax)
btrent@ipapilot.org

JOINT APPENDIX
TABLE OF CONTENTS

VOLUME I of V

JOINT APPENDIX
TABLE OF CONTENTS

VOLUME II of V

JOINT APPENDIX
TABLE OF CONTENTS

VOLUME III of V

JOINT APPENDIX
TABLE OF CONTENTS

VOLUME IV of V

JOINT APPENDIX
TABLE OF CONTENTS

VOLUME V of V

TAB 1

FEDERAL REGISTER

Vol. 77 Wednesday,
No. 2 January 4, 2012

Part II

Department of Transportation

Federal Aviation Administration

14 CFR Parts 117, 119, and 121
Flightcrew Member Duty and Rest Requirements; Final Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 117, 119, and 121

[Docket No. FAA–2009–1093; Amdt. Nos. 117–1, 119–16, 121–357]

RIN 2120–AJ58

Flightcrew Member Duty and Rest Requirements

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This rule amends the FAA's existing flight, duty and rest regulations applicable to certificate holders and their flightcrew members operating under the domestic, flag, and supplemental operations rules. The rule recognizes the universality of factors that lead to fatigue in most individuals and regulates these factors to ensure that flightcrew members in passenger operations do not accumulate dangerous amounts of fatigue. Fatigue threatens aviation safety because it increases the risk of pilot error that could lead to an accident. This risk is heightened in passenger operations because of the additional number of potentially impacted individuals. The new requirements eliminate the current distinctions between domestic, flag and supplemental passenger operations. The rule provides different requirements based on the time of day, whether an individual is acclimated to a new time zone, and the likelihood of being able to sleep under different circumstances.

DATES: Effective January 14, 2014.

ADDRESSES: For information on where to obtain copies of rulemaking documents and other information related to this final rule, see "How To Obtain Additional Information" in the **SUPPLEMENTARY INFORMATION** section of this document.

FOR FURTHER INFORMATION CONTACT: For technical issues: Dale E. Roberts, Air Transportation Division (AFS–200), Flight Standards Service, Federal Aviation Administration, 800 Independence Avenue SW., Washington, DC 20591; telephone (202) 267–5749; email: *dale.e.roberts@faa.gov.* For legal issues: Rebecca MacPherson, Office of the Chief Counsel, Regulations Division (AGC–200), 800 Independence Avenue SW., Washington, DC 20591; telephone (202) 267–3073; email: *rebecca.macpherson@faa.gov.*

SUPPLEMENTARY INFORMATION:

Authority for This Rulemaking

The FAA's authority to issue rules on aviation safety is found in Title 49 of the United States Code. This rulemaking is promulgated under the authority described in 49 U.S.C. 44701(a)(5), which requires the Administrator to promulgate regulations and minimum safety standards for other practices, methods, and procedures necessary for safety in air commerce and national security. This rulemaking is also promulgated under the authority described in 49 U.S.C. 44701(a)(4), which requires the Administrator to promulgate regulations in the interest of safety for the maximum hours or periods of service of airmen and other employees of air carriers.

Table of Contents

I. Overview of Final Rule

The FAA is issuing this final rule to address the risk that fatigue poses to passenger operations conducted under 14 CFR part 121. Part 121 applies to the majority of flights flown by the American public. As such, changes to the existing flight, duty and rest rules in part 121 will directly affect the flying public. This rule applies to all part 121 passenger operations, including traditional scheduled service and large charter operations. The FAA has removed the existing distinctions between domestic, supplemental and flag passenger operations because the factors leading to fatigue are universal and addressing the risk to the flying public should be consistent across the different types of operations.

This final rule addresses fatigue risk in several ways. The underlying philosophy of the rule is that no single element of the rule mitigates the risk of fatigue to an acceptable level; rather, the FAA has adopted a system approach, whereby both the carrier and the pilot accept responsibility for mitigating fatigue. The carrier provides an environment that permits sufficient sleep and recovery periods, and the crewmembers take advantage of that environment. Both parties must meet their respective responsibilities in order to adequately protect the flying public.

The final rule recognizes the natural circadian rhythms experienced by most people that causes them to be naturally more tired at night than during the day. Under the final rule, flightcrew members will be able to work longer hours during the day than during the night. Significant changes in time zones, a situation unique to aviation, are accounted for to reduce the risk to the flying public posed by "jetlag".

The FAA has decided against adopting various provisions proposed in the NPRM. The final rule does not apply to all-cargo operations, although those carriers have the ability to fly under the new rules if they so choose. The proposal that carriers meet certain schedule reliability requirements has been dropped, as has the proposed requirement that carriers evaluate flightcrew members for fatigue. The FAA has determined that these provisions were either overly costly or impractical to implement.

1. Fitness for Duty

This rule places a joint responsibility on the certificate holder and each flightcrew member. In order for the flightcrew member to report for an FDP properly rested, the certificate holder must provide the flightcrew member with a meaningful rest opportunity that will allow the flightcrew member to get the proper amount of sleep. Likewise, the flightcrew member bears the responsibility of actually sleeping during the rest opportunity provided by the certificate holder instead of using that time to do other things. The consequence of a flightcrew member reporting for duty without being properly rested is that he or she is prohibited from beginning or continuing an FDP until he or she is properly rested.

2. Fatigue Education and Training

Part 121 air carriers are currently statutorily-required to annually provide, as part of their Fatigue Risk Management Plan, fatigue-related education and training to increase the trainees' awareness of: (1) Fatigue; (2) ''the effects of fatigue on pilots;'' and (3) ''fatigue countermeasures.'' Today's rule adopts the same standard of training as required by the statute. In addition, today's rule adopts a mandatory update of the carriers' education and training program every two years, as part of the update to their FRMP. Both of these regulatory provisions merely place the existing statutory requirements in the new flight and duty regulations for the ease and convenience of the regulated parties and the FAA.

3. Fatigue Risk Management System

The FAA proposed a Fatigue Risk Management System (FRMS) as an alternative regulatory approach to provide a means of monitoring and mitigating fatigue. Under an FRMS, a certificate holder develops processes that manage and mitigate fatigue and meet an equivalent level of safety. The FAA is adopting that proposal largely as proposed. The FAA has also decided to extend the voluntary FRMS program to all-cargo operations, which are not required to operate under part 117. Under the FRMS provisions that this rule adds to subparts Q, R, and S of part 121, an all-cargo operator that does not wish to operate under part 117 can nevertheless utilize an FRMS as long as it has the pertinent FAA approval.

4. Unaugmented Operations

One of the regulatory concepts that this rule introduces is the restriction on flightcrew members' maximum Flight Duty Period (FDP). In creating a maximum FDP limit, the FAA attempted to address three concerns. First, flightcrew members' circadian rhythms needed to be addressed because studies have shown that flightcrew members who fly during their window of circadian low (WOCL) can experience severe performance degradation. Second, the amount of time spent at work needed to be taken into consideration because longer shifts increase fatigue. Third, the number of flight segments in a duty period needed to be taken into account because flying more segments requires more takeoffs and landings, which are both the most task-intensive and the most safety-critical stages of flight. To address these concerns, the FAA is adopting as part of the regulatory text a table limiting maximum FDP based on the time of day and the number of segments flown during the FDP period. Under today's rule an FDP begins when a flightcrew member is required to report for duty that includes a flight and ends when the aircraft is parked after the last flight and there is no plan for further aircraft movement by the same flightcrew member. The maximum FDP limit is reduced during nighttime hours to account for being awake during the WOCL; when an FDP period consists of multiple flight segments in order to account for the additional time on task; and if a flightcrew member is unacclimated to account for the fact that the unacclimated flightcrew member's circadian rhythm is not in sync with the theater in which he or she is operating. Actual time at the controls (flight time) is limited to 8 or 9 hours, depending on the time of day that the FDP commences.

5. Augmented Operations

In order to accommodate common operational practices, the final rule allows longer duty periods in instances where the carrier provides additional crew and adequate on-board rest facilities. The extended FDPs are laid out in a table and provide maximum credit when an operator employs a 4-man crew and provides the highest quality on-board rest facility.

6. Extensions of Flight Duty Periods

This rule sets forth the limits on the number of FDPs that may be extended; implements reporting requirements for affected FDPs; and distinguishes extended FDPs due to unforeseen operational circumstances that occur prior to takeoff from those unforeseen operational circumstances that arise after takeoff. The FAA agrees that an extension must be based on exceeding the maximum FDP permitted in the regulatory tables rather than on the times that the air carrier had originally intended for an FDP, which may be considerably less than the tables allow. It is unreasonable to limit extensions on FDPs that are less than what the certificate holder can legally schedule. In addition, there is a 30-minute buffer attached to each FDP to provide certificate holders with the flexibility to deal with delays that are minimal.

7. Split Duty

Split duty rest breaks provide carriers with nighttime operations with additional flexibility. Typically split duty rest would benefit carriers who conduct late night and early morning operations where the flightcrew members would typically be afforded some opportunity to sleep, but would not receive a legal rest period. Under today's rule split duty rest must be at least 3 hours long and must be scheduled in advance. The actual split duty rest breaks may not be shorter than the scheduled split duty rest breaks. The rationale for this is that flightcrew members must, at the beginning of their FDP, evaluate their ability to safely complete their entire assigned FDP. In order to do so, they must not only know the length of the FDP, but any scheduled split duty rest breaks that they will receive during the FDP.

8. Consecutive Night Operations

In formulating this rule, the FAA was particularly concerned about cumulative fatigue caused by repeatedly flying at night. Modeling shows substantially deteriorating performance after the third consecutive nighttime FDP for flightcrew members who worked nightshifts during their WOCL and obtained sleep during the day. However, if a sleep opportunity is provided during each nighttime FDP, that sleep opportunity may sustain flightcrew member performance for five consecutive nights. Based on modeling results, the FAA has determined that a 2-hour nighttime sleep opportunity each night improves pilot performance sufficient to allow up to 5 nights of consecutive nighttime operations.

9. Reserve

The FAA has decided to rely on the expertise represented in the ARC to address the issue of reserve duty. The adopted regulatory provisions addressing reserve and unaugmented operations provide that the total number of hours a flightcrew member may spend in a flight duty period and reserve availability period may not exceed 16 hours or the maximum applicable flight duty period table plus four hours, whichever is less. This will allow most FDPs to be accommodated by a flightcrew member on short-call reserve. This rule adopts the proposal that limits the short-call reserve availability period, in which the flightcrew member is not called to report to work, to 14 hours.

10. Cumulative Limits

The FAA is adopting cumulative limits for FDP and flight-time limits. The FAA has decided to retain both of these cumulative limits because (1) the FDP limits restrict the amount of cumulative fatigue that a flightcrew member accumulates before and during flights; and (2) the flight-time limits allow the FAA to provide air carriers with more scheduling flexibility by setting higher cumulative FDP limits in this rule. This additional scheduling flexibility justifies the added restrictions on cumulative flight time, which can easily be tracked by scheduling programs currently in use throughout the industry. The FAA has decided to eliminate the cumulative duty-period limits, which should greatly simplify compliance with this section.

11. Rest

Carriers will be required to provide their crew with a 10-hour rest opportunity prior to commencing a duty period that includes flying. While the 10-hour rest period may include the amount of time it takes to get to or from a flightcrew member's house or hotel room, the actual amount of time required for a sleep opportunity may not be reduced below 8 hours. In addition, the length of continuous time off during a 7-day period has been extended from 24 hours under the existing rules to 30 hours. Additional time off is required for individuals whose internal clock may be off because of flipping back and forth between different time zones.

12. Emergency and Government Sponsored Operations

This rulemaking also addresses operations that require flying into or out of hostile areas, and politically sensitive, remote areas that do not have rest facilities. These operations range from an emergency situation to moving armed troops for the U.S. military, conducting humanitarian relief, repatriation, Air Mobility Command (AMC), and State Department missions. The applicability provision of this section now specifically articulates the two categories of operations that are affected. This section applies to operations conducted pursuant to contracts with the U.S. Government department and agencies. This section also applies to operations conducted pursuant to a deviation issued by the Administrator under § 119.57 that authorizes an air carrier to deviate from the requirements of parts 121 and 135 to perform emergency operations. This authority is issued on a case-by-case basis during an emergency situation as determined by the Administrator. The FAA concludes that these two categories are the only types of operations that warrant separate consideration because of the unique operating circumstances that otherwise limit a certificate holder's flexibility to deal with unusual circumstances.

Costs and Benefits

We have analyzed the benefits and the costs associated with the requirements contained in this final rule. We provide a range of estimates for our quantitative benefits. Our base case estimate is $376 million ($247 million present value at 7% and $311 million at 3%) and our high case estimate is $716 million ($470 million present value at 7% and $593 million at 3%). The FAA believes there are also not-quantified benefits to the rule that, when added to the base case estimate, make the rule cost beneficial. The total estimated cost of the final rule is $390 million ($297 million present value at 7% and $338 million at 3%).

SUMMARY OVER A 10 YEAR PERIOD

Total quantified benefits			
Estimate	Nominal (millions)	PV at 7% (millions)	PV at 3% (millions)
Base	$376	$247	$311
High	716	470	593
Total quantified costs			
Component	Nominal (millions)	PV at 7% (millions)	PV at 3% (millions)
Flight Operations	$236	$157	$191
Rest Facilities	138	129	134
Training	16	11	13
Total	390	297	338

The FAA has made significant changes to the final rule since the NPRM. The training requirement has been substantially reduced because the FAA has determined that pilots are already receiving the requisite training as part of the statutorily required Fatigue Risk Management Plans. The FAA also has removed all-cargo operations from the applicability section of the new part 117 because their compliance costs significantly exceed the quantified societal benefits.[1] All-cargo carriers may choose to comply with the new part 117 but are not required to do so. Since the carrier would decide voluntarily to comply with the new requirements, those costs are not attributed to the costs of this rule. The costs associated with the rest facilities occur in the two years after the rule is published. The other costs of the rule and the benefits are then estimated over the next ten years.

II. Background

On September 14, 2010, the FAA published a Flightcrew Member Duty and Rest Requirements notice of proposed rulemaking (NPRM) setting out proposed flight, duty, and rest regulations intended to limit flightcrew member fatigue in part 121 operations. These proposed regulations applied to all operations conducted pursuant to part 121, and the regulations would

[1] The projected cost for all-cargo operations is $306 million ($214 million present value at 7% and $252 million at 3%). The projected benefit of avoiding one fatal all-cargo accident ranges between $20.35 million and $32.55 million, depending on the number of crewmembers on board the aircraft.

have imposed, among other things, the following limits/requirements: (1) A requirement that a flightcrew member must notify the certificate holder (air carrier) when he or she is not fit for duty and that a certificate holder must also independently evaluate its flightcrew members for fitness for duty; (2) a limit on daily flight duty period (FDP) and flight-time hours that varies depending on the time of day that the FDP begins; (3) cumulative limits on FDPs, flight times, and duty periods; (4) a schedule reliability requirement, which stated that a certificate holder's scheduled FDPs must be at least 95% consistent with actual FDPs; (5) a requirement that a flightcrew member be provided with at least 9 consecutive hours of rest between FDPs, as measured from the time the flightcrew member reaches a suitable accommodation; and (6) credit for employing fatigue-mitigating measures such as split-duty rest and augmentation.

The FAA received over 8,000 comments in response to the NPRM. In response to the comments, the FAA has made a number of changes to the regulatory provisions proposed in the NPRM. These changes include the following:

- The mandatory provisions of the NPRM do not apply to all-cargo operations. Instead, this rule permits all-cargo operations to voluntarily opt into the new flight, duty, and rest limitations imposed by this rule.
- Certificate holders are no longer required to independently verify whether flightcrew members are fit for duty.
- Most of the daily FDP limits have been increased to provide certificate holders with more scheduling flexibility. One of the daily flight-time limits has been decreased to address safety considerations.
- The cumulative duty-period limit has been removed from this rule.
- The schedule-reliability requirement has been largely removed from the final rule. The remaining parts of the schedule-reliability process have been changed to only apply to instances in which a flightcrew member exceeds the FDP and/or flight-time limits imposed by this rule.
- The flightcrew member must now be provided with 10 hours of rest between FDP periods, but that rest is measured from the time that the flightcrew member is released from duty. The rest must provide for an 8-hour sleep opportunity.
- The amount of credit provided for split-duty rest and augmentation has been increased, and changes to the final rule make these credits easier to obtain.

The changes listed above are just some of the amendments that were made to the NPRM in response to the comments. The Discussion of Public Comments and Final Rule section of this preamble contains a discussion of the changes that were made to the NPRM in response to issues raised by the commenters.

A. Statement of the Problem

Fatigue is characterized by a general lack of alertness and degradation in mental and physical performance. Fatigue manifests in the aviation context not only when pilots fall asleep in the cockpit in flight, but perhaps more importantly, when they are insufficiently alert during take-off and landing. Reported fatigue-related events have included procedural errors, unstable approaches, lining up with the wrong runway, and landing without clearances.

There are three types of fatigue: Transient, cumulative, and circadian. Transient fatigue is acute fatigue brought on by extreme sleep restriction or extended hours awake within 1 or 2 days. Cumulative fatigue is fatigue brought on by repeated mild sleep restriction or extended hours awake across a series of days. Circadian fatigue refers to the reduced performance during nighttime hours, particularly during an individual's WOCL (typically between 2 a.m. and 6 a.m.).

Common symptoms of fatigue include:

- Measurable reduction in speed and accuracy of performance,
- Lapses of attention and vigilance,
- Delayed reactions,
- Impaired logical reasoning and decision-making, including a reduced ability to assess risk or appreciate consequences of actions,
- Reduced situational awareness, and
- Low motivation to perform optional activities.

A variety of factors contribute to whether an individual experiences fatigue as well as the severity of that fatigue. The major factors affecting fatigue include:

- *Time of day.* Fatigue is, in part, a function of circadian rhythms. All other factors being equal, fatigue is most likely, and, when present, most severe, between the hours of 2 a.m. and 6 a.m.
- *Amount of recent sleep.* If a person has had significantly less than 8 hours of sleep in the past 24 hours, he or she is more likely to be fatigued.
- *Time awake.* A person who has been continually awake for a long period of time since his or her last major sleep period is more likely to be fatigued.
- *Cumulative sleep debt.* For the average person, cumulative sleep debt is the difference between the amount of sleep a person has received over the past several days, and the amount of sleep he or she would have received with 8 hours of sleep a night.
- *Time on task.* The longer a person has continuously been doing a job without a break, the more likely he or she is to be fatigued.
- *Individual variation.* Individuals respond to fatigue factors differently and may become fatigued at different times, and to different degrees of severity, under the same circumstances.

Scientific research and experimentation have consistently demonstrated that adequate sleep sustains performance. For most people, 8 hours of sleep in each 24-hour period sustains performance indefinitely. Sleep opportunities during the WOCL are preferable because sleep that occurs during the WOCL provides the most recuperative value. Within limits, shortened periods of nighttime sleep may be nearly as beneficial as a consolidated sleep period when augmented by additional sleep periods, such as naps before evening departures, during flights with augmented flightcrews, and during layovers. Sleep should not be fragmented with interruptions. In addition, environmental conditions, such as temperature, noise, and turbulence, impact how beneficial sleep is and how performance is restored.

When a person has accumulated a sleep debt, recovery sleep is necessary to fully restore the person's ''sleep reservoir.'' Recovery sleep should include at least one physiological night, that is, one sleep period during nighttime hours in the time zone in which the individual is acclimated. The average person requires in excess of 9 hours of sleep a night to recover from a sleep debt. [2]

Several aviation-specific work schedule factors [3] can affect sleep and subsequent alertness. These include early start times, extended work periods, insufficient time off between work periods, insufficient recovery time off between consecutive work periods, amount of work time within a shift or duty period, number of consecutive work periods, night work through one's window of circadian low, daytime sleep

[2] Recovery sleep does not require additional sleep equal to the cumulative sleep debt; that is, an 8-hour sleep debt does not require 8 additional hours of sleep.

[3] Rosekind MR. *Managing work schedules: an alertness and safety perspective.* In: Kryger MH, Roth T, Dement WC, editors. *Principles and Practice of Sleep Medicine;* 2005:682.

periods, and day-to-night or night-to-day transitions.

The FAA believes that its current regulations do not adequately address the risk of fatigue. The impact of this risk is greater in passenger operations due to the number of persons placed at risk. Presently, flightcrew members are effectively allowed to work up to 16 hours a day (regardless of the time of day), with all of that time spent on tasks directly related to aircraft operations. The regulatory requirement for 9 hours of rest is regularly reduced, with flightcrew members spending rest time traveling to or from hotels and being provided with little to no time to decompress. Additionally, certificate holders regularly exceed the allowable duty periods by conducting flights under part 91 instead of part 121, where the applicable flight, duty and rest requirements are housed. As the National Transportation Safety Board repeatedly notes, the FAA's regulations do not account for the impact of circadian rhythms on alertness. The entire set of regulations is overly complicated, with a different set of regulations for domestic operations, flag operations, and supplemental operations. In addition, these regulations do not consider other factors that can lead to varying degrees of fatigue. Instead, each set of operational rules (*i.e.* those applicable to domestic, flag, or supplemental operations) sets forth a singular approach toward addressing fatigue, regardless of the operational circumstances that may be more or less fatiguing.[4]

B. National Transportation Safety Board (NTSB) Recommendations

The NTSB has long been concerned about the effects of fatigue in the aviation industry. The first aviation safety recommendations, issued in 1972, involved human fatigue, and aviation safety investigations continue to identify serious concerns about the effects of fatigue, sleep, and circadian rhythm disruption. Currently, the NTSB's list of Most Wanted Transportation Safety Improvements includes safety recommendations regarding pilot fatigue. These recommendations are based on two accident investigations and an NTSB safety study on commuter airline safety.[5]

In February 2006 the NTSB issued safety recommendations after a BAE–J3201 operated under part 121 by Corporate Airlines struck trees on final approach and crashed short of the runway at Kirksville Regional Airport, Kirksville, Missouri. The captain, first officer, and 11 of the 13 passengers died. The NTSB determined the probable cause of the October 19, 2004 accident was the pilots' failure to follow established procedures and properly conduct a non-precision instrument approach at night in instrument meteorological conditions. The NTSB concluded that fatigue likely contributed to the pilots' performance and decision-making ability. This conclusion was based on the less than optimal overnight rest time available to the pilots, the early report time for duty, the number of flight legs, and the demanding conditions encountered during the long duty day.

As a result of the accident, the NTSB issued the following safety recommendations related to flight and duty time limitations: (1) Modify and simplify the flightcrew hours-of-service regulations to consider factors such as length of duty day, starting time, workload, and other factors shown by recent research, scientific evidence, and current industry experience to affect crew alertness (recommendation No. A–06–10); and (2) require all part 121 and part 135 certificate holders to incorporate fatigue-related information similar to the information being developed by the DOT Operator Fatigue Management Program into initial and recurrent pilot training programs. The recommendation notes that this training should address the detrimental effects of fatigue and include strategies for avoiding fatigue and countering its effects (recommendation No. A–06–10).

The NTSB's list of Most Wanted Transportation Safety Improvements also includes a safety recommendation on pilot fatigue and ferry flights conducted under 14 CFR part 91. Three flightcrew members died after a Douglas DC–8–63 operated by Air Transport International was destroyed by ground impact and fire during an attempted three-engine takeoff at Kansas City International Airport in Kansas City, Missouri. The NTSB noted that the flightcrew conducted the flight as a maintenance ferry flight under part 91 after a shortened rest break following a demanding round trip flight to Europe that crossed multiple time zones. The NTSB further noted that the international flight, conducted under part 121, involved multiple legs flown at night following daytime rest periods that caused the flightcrew to experience circadian rhythm disruption. In addition, the NTSB found the captain's last rest period before the accident was repeatedly interrupted by the certificate holder.

In issuing its 1995 recommendations, the NTSB stated that the flight time limits and rest requirements under part 121 that applied to the flightcrew before the ferry flight did not apply to the ferry flight operated under part 91. As a result, the regulations permitted a substantially reduced flightcrew rest period for the nonrevenue ferry flight. As a result of the investigation, the NTSB reiterated earlier recommendations to (1) finalize the review of current flight and duty time limitations to ensure the limitations consider research findings in fatigue and sleep issues and (2) prohibit certificate holders from assigning a flightcrew to flights conducted under part 91 unless the flightcrew met the flight and duty time limits under part 121 or other applicable regulations (recommendation No. A–95–113).

In addition to recommending a comprehensive approach to fatigue with flight duty limits based on fatigue research, circadian rhythms, and sleep and rest requirements, the NTSB has also stated that a Fatigue Risk Management System (FRMS) may hold promise as an approach to dealing with fatigue in the aviation environment. However, the NTSB noted that it considers fatigue management plans to be a complement to, not a substitute for, regulations to address fatigue.

C. Flight and Duty Time Limitations and Rest Requirements Aviation Rulemaking Committee

As part of this rulemaking action, the FAA chartered an aviation rulemaking committee (ARC) on June 24, 2009. The FAA brought together pilots, airlines, and scientific experts to collaborate and develop options for an FAA-proposed rulemaking to help mitigate pilot fatigue. The ARC provided a forum for the U.S. aviation community to discuss current approaches to mitigate fatigue found in international standards (*e.g.,* the International Civil Aviation Organization (ICAO) standard, the United Kingdom Civil Aviation Publication (CAP) 371, and the European Aviation Safety Agency

[4] While several of the commenters have claimed that the NPRM proposed a ''one-size-fits-all'' regulatory structure, the FAA believes this suggestion is misleading. In the NPRM, and in the final rule with regard to passenger-carrying operations, the FAA has eliminated distinctions between domestic, flag, and supplemental operations, but in all of these operations, the rule imposes differing requirements based on the operating environment.

[5] On February 2, 2010, the NTSB released a press release summarizing the results of its investigation into the Colgan Air crash of February 12, 2009, which resulted in the death of 50 people. The NTSB did not state that fatigue was causal factor to the crash; however, it did recommend that the FAA take steps to address pilot fatigue.

Notice of Proposed Amendment). The ARC provided its report, a copy of which is in this rulemaking docket, to the agency on September 9, 2009.

D. Congressional Mandate

On August 1, 2010, the President signed the Airline Safety and Federal Aviation Administration Extension Act of 2010 (Pub. L. 111–216). Section 212 of Public Law 111–216 required ''the FAA Administrator to issue regulations to limit the number of flight and duty time hours allowed for pilots to address pilot fatigue.'' This section, in subsection 212(a)(3), set a deadline of 180 days for the FAA to publish an NPRM and 1 year for the FAA to issue a final rule.

E. Notice of Proposed Rulemaking

On September 14, 2010, the FAA published in the **Federal Register** the Flightcrew Member Duty and Rest Requirements NPRM.[6] The NPRM proposed to amend the FAA's existing flight, duty, and rest regulations applicable to certificate holders and their flightcrew members. The proposal recognized the factors that lead to fatigue in most individuals, and it proposed to regulate these factors to ensure that flightcrew members do not accumulate dangerous amounts of fatigue. Because the proposed rule addressed fatigue factors that apply universally, the proposed requirements eliminated the existing distinctions between domestic, flag and supplemental operations. The proposal also provided different requirements based on the time of day, whether an individual is acclimated to a new time zone, and the likelihood of being able to sleep under different circumstances.

The NPRM provided for a 60-day comment period, which ended on November 15, 2010. Following publication of the NPRM, the FAA received a number of requests to extend the comment period and to clarify various sections of the preamble, regulatory text, and the Regulatory Impact Analysis (RIA). In response, the agency published two actions in the **Federal Register**.

The first action was a ''Notice of procedures for submission of clarifying questions.'' [7] Persons asking for clarifications were advised to file their questions to the rulemaking docket by October 15, 2010. The FAA said it would respond by October 22, 2010. On October 22, 2010, the agency filed two response documents to the rulemaking docket: ''Response to Clarifying Questions to the RIA'' and ''Response to Clarifying Questions to the NPRM.''

The second action was a ''Response to requests for a comment period extension.'' [8] The FAA provided notice that the comment period would not be extended. The agency's rationale for this decision is outlined in the October 15, 2010 action.

The FAA received more than 8,000 comment submissions, containing multiple comments on various sections of the preamble and the rule. Many comment submissions also included specific recommendations for changes and clarifications.

III. Discussion of Public Comments and Final Rule

A. Applicability

In the NPRM, the FAA stated that fatigue factors are ''universal.'' [9] The FAA noted that sleep science, while still evolving, was clear in several important respects:

> Most people need eight hours of sleep to function effectively, most people find it more difficult to sleep during the day than during the night, resulting in greater fatigue if working at night; the longer one has been awake and the longer one spends on task, the greater the likelihood of fatigue; and fatigue leads to an increased risk of making a mistake.

Id. In light of its determination concerning the universal applicability of factors underlying fatigue, the FAA proposed a single set of flight, duty, and rest regulations that would regulate these factors. The proposed regulations would have been applicable to all part 121 domestic, flag, and supplemental operations. The proposed regulations would also have applied to all part 91 flights conducted by part 121 certificate holders, including flights, such as ferry flights, that have historically been conducted under part 91. The NPRM also stated that ''the part 135 community should expect to see an NPRM addressing its operations that looks very similar to, if not exactly like, the final rule the agency anticipates issuing as part of its rulemaking initiative.'' *Id.* The comments received in response to the proposed applicability of this rule and the corresponding FAA responses are included below.

The National Air Carrier Association (NACA) and a number of air carriers operating non-scheduled flights objected to the proposed rule applying to supplemental operations. These industry commenters stated that non-scheduled operations require additional scheduling flexibility because they are fundamentally different from scheduled operations. The industry commenters stated that, unlike scheduled operations, non-scheduled operations provide on-demand operations on behalf of private and government consumers on a timetable that is determined by the consumer. According to the industry commenters, non-scheduled carriers do not have regularly-set schedules that they know months in advance, but are instead called to fly with little advance notice, making it more difficult to plan flightcrew member flight times and rest periods. The industry commenters emphasized that this difficulty is exacerbated by the fact that non-scheduled operations' flight times (especially departure times) are controlled largely by the consumer and not the air carrier.

The non-scheduled industry commenters also asserted that non-scheduled carriers serve remote, sometimes hostile locations, with no established crew bases. Thus, they do not have the same extensive infrastructure that scheduled operations have access to and must deadhead flightcrew members into remote locations in order to be able to swap out flightcrew members during an operation. These commenters emphasized that the certificate holders running non-scheduled operations are largely small businesses that will have difficulty adjusting to the burdens imposed by this rule.

Based on the differences between non-scheduled and scheduled operations, the industry commenters stated that a ''one-size-fits-all'' approach does not work for non-scheduled operations. The industry commenters stated that the existing regulations governing supplemental operations have existed for over 60 years, and that changing these regulations will adversely affect air security and national defense missions conducted through the use of non-scheduled operations. The commenters emphasized that the existing supplemental flight, duty, and rest regulations ensure aviation safety by containing additional rest requirements that are not a part of this rule. In conclusion, the industry commenters suggested that the FAA either: (1) Retain the existing flight, duty, and rest regulations governing supplemental operations, and/or (2) adopt the alternative proposal put forward by the industry commenters.

In addition to the concerns expressed by non-scheduled air carriers, the Cargo Airline Association (CAA) and a number of air carriers operating all-cargo flights have also objected to the

[6] 75 FR 55852; September 14, 2010.

[7] 75 FR 62486; October 12, 2010.

[8] 75 FR 63424; October 15, 2010.

[9] 75 FR 55852, 55857 (Sep. 14, 2010).

proposed rule applying to supplemental operations. These industry commenters asserted that, while a passenger-operation accident can result in numerous fatalities, an all-cargo accident would consist primarily of property damage.

The commenters also stated that the cargo industry is composed of both scheduled and on-demand operators, and that it specializes in express delivery services. To effectuate these express delivery services, some all-cargo carriers do not maintain U.S. domicile bases and regularly operate long-haul flights and point-to-point operations outside the United States, traveling across multiple time zones at all hours of the day and night. The industry commenters also stated that all-cargo carriers regularly operate around the world in all directions with extended overseas routings, not with quick overnight turns at foreign destinations. This results in a lower aircraft utilization rate than domestic passenger operations. According to the industry commenters, these types of nighttime and around-the-world operations are the norm for all-cargo carriers.

The all-cargo industry commenters added that, similar to non-scheduled operations, some all-cargo operations also fly to remote, undeveloped, and sometimes hostile locations. According to the industry commenters, these types of operations are driven by the same considerations as similar non-scheduled operations: (1) The schedule is determined primarily by the customer, and (2) there is a lack of infrastructure, which necessitates deadheading in flightcrew members. The industry commenters emphasized that many all-cargo carriers currently provide their flightcrew members with split duty rest while cargo is being sorted at sorting facilities, and that the carriers have invested millions of dollars in high-quality rest facilities. The industry commenters also stated that flightcrew members working in all-cargo operations fly fewer total hours than their passenger-transporting counterparts. The industry commenters concluded by asking the FAA to either: (1) Retain the existing flight, duty, and rest regulations that govern supplemental operations, or (2) adopt the alternative proposal that they have included in their comments.

Conversely, a number of labor groups submitted comments approving of a single flight, duty, and rest standard. These groups stated that they were ''pleased that the FAA has acknowledged the current science and recognizes that pilot fatigue does not differ whether the pilot is operating domestically, internationally or in supplemental operations.'' The NTSB also expressed support for a single flight, duty, and rest standard, commending the proposed rule for recognizing that ''human fatigue factors are the same across [domestic, flag, and supplemental] operations and science cannot support the notion of allowing longer duty hours for certain subgroups.'' Numerous individual commenters have also stated that the existing 16-hour duty periods utilized by supplemental operations result in an unsafe amount of fatigue.

In addition to the concerns expressed by the preceding comments, United Air Lines (United) objected to the applicability of this rule to flightcrew members who conduct only part 91 operations on behalf of part 121 certificate holders. United stated that the original reason for the applicability of this rule to part 91 operations on behalf of part 121 certificate holders was to ensure that flightcrew members operating under part 121 did not use part 91 to avoid their flight, duty, and rest requirements under part 121. Because flightcrew members who only conduct part 91 operations cannot conduct part 121 flights, United argued that these flightcrew members should not be subject to this rule.

The FAA also received a number of other questions and concerns about the applicability of this rule. The NetJets Association of Shared Aircraft Pilots (NJASAP) asked how this rule would apply to certificate holders who operate under several different parts of the regulation (*e.g.,* Part 121, Part 135, Subpart 91K). The Regional Airline Association (RAA) asked the FAA to amend this section in order to clarify that this rule applies to ''operations directed by the certificate holder under part 91 of this chapter.'' In addition, a number of part 135 certificate holders objected to having their operations included in the proposed flight, duty, and rest requirements. These commenters asserted that part 135 operations are fundamentally different from part 121 operations, and thus, these operations should not be subject to the same requirements.

In response to concerns expressed by part 135 certificate holders, the FAA emphasizes that this rule does not apply to part 135 operations. If, in the future, the FAA initiates a rulemaking to change the existing part 135 flight, duty, and rest regulations, the FAA will solicit comments from the affected stakeholders and respond to part-135-specific concerns at that time.

Turning to concerns expressed by United, this rule applies to some part 91 operations because many flightcrew members involved in part 121 operations have routinely used part 91 as a way of exceeding the limits imposed by the part 121 flight, duty, and rest requirements. However, the FAA agrees with United that there is no reason to require flightcrew members who do not fly any part 121 operations to comply with part 121 flight, duty, and rest requirements. Accordingly, the FAA has amended this rule so that it applies to flightcrew members operating under part 91 only if at least one their flight segments is operated under part 117. Flightcrew members operating under part 91 and who do not have any flight segments subject to part 117 (*e.g.* pilots flying only part 91 operations) are not subject to the provisions of this rule.

Turning to concerns expressed by air carriers conducting all-cargo operations, as discussed in the regulatory evaluation, the FAA has determined that this rule would create far smaller benefits for all-cargo operations than it does for passenger operations. Consequently, the FAA is unable to justify imposing the cost of this rule on all-cargo operations. The FAA notes that in the past it has excluded all-cargo operations from certain mandatory requirements due to the different cost-benefit comparison that applies to all-cargo operations. For example, in 2007, the FAA excluded all-cargo operations of airplanes with more than two engines from many of the requirements of the extended range operations (ETOPS) rule because the cost of these provisions for all-cargo operations relative to the potential societal benefit was simply too high.[10]

Based on the cost-benefit analysis of this rule and its past precedent, the FAA has amended this rule to make compliance with part 117 voluntary for all-cargo operations and to allow those operations to continue operating under the existing part 121 flight, duty, and rest regulations if they choose to do so. As such, this rule now allows all-cargo operations to voluntarily determine, as part of their collective bargaining and business decisions, whether they wish to operate under part 117.

In order to prevent manipulation of this voluntary provision, certificate holders who wish to operate their all-cargo operations under part 117 cannot pick and choose specific flights to operate under this rule. Instead, the certificate holders can only elect to operate under part 117: (1) All of their all-cargo operations conducted under contract to a U.S. government agency; and (2) all of their all-cargo operations

[10] 72 FR 1808, 1816 (2007).

not conducted under contract to a U.S. Government agency.

Turning to the objections expressed by non-scheduled passenger operations, the FAA notes that existing regulations set out different flight, duty, and rest standards for part 121 domestic, flag, and supplemental operations. Under these regulations, supplemental operations consist of non-scheduled, all-cargo, and public-charter flights. The existing regulations provide supplemental operations with significant scheduling flexibility because they allow air carriers conducting supplemental operations to schedule unaugmented flightcrew members for 16-hour FDPs [11] and augmented flightcrew members for 30-hour FDPs [12] regardless of the time of day.[13]

The FAA acknowledges that this rule will significantly impact supplemental passenger operations because it reduces the existing 16- and 30-hour across-the-board limits. This section discusses these reductions and why they are justified in light of the flexibility concerns of non-scheduled passenger operations. The other changes made by this rule that affect supplemental operations are discussed in the other parts of this preamble.

The FAA has decided to impose the same FDP limits on supplemental passenger operations as other part 121 operations because it has determined that the 16-hour unaugmented FDP and the 30-hour augmented FDP permitted by existing supplemental flight, duty, and rest regulations are almost always unsafe for passenger operations.[14] As discussed in other parts of this preamble, a series of studies analyzing the national accident rate as a function of the amount of hours worked have shown that after a person works for about eight or nine hours, the risk of an accident increases exponentially for each additional hour worked.[15] According to these studies, the risk of an accident in the 12th hour of a work shift is ''more than double'' the risk of an accident in the 8th hour of a work shift.[16] Based on this exponential increase in the accident rate, the FAA has determined that the risk of an accident in the 16th hour of an unaugmented FDP rises to unacceptable levels for passenger operations, especially for shifts that take place during the WOCL. The FAA has also determined, based on the above data, that a 30-hour FDP likewise poses an unacceptably high risk of an accident for passenger operations even with the fatigue-mitigation benefits provided by augmentation.

In determining that a 16-hour unaugmented and a 30-hour augmented FDP is unsafe for passenger operations, the FAA has also taken into account the fact that aviation-specific data shows that FDPs of this length significantly increase the risk of an accident. A study published in 2003 analyzed the accident rate of pilots as a function of the amount of time that the pilots spent on duty.[17] The study found that:

> [T]he proportion of accidents associated with pilots having longer duty periods is higher than the proportion of longer duty periods for all pilots. For 10–12 hours of duty time, the proportion of accident pilots with this length of duty period is 1.7 times as large as for all pilots. For pilots with 13 or more hours of duty, the proportion of accident pilot duty periods is over five and a half times as high.[18]

Because studies examining the national accident rate and aviation-specific accidents have both shown that working over 13 hours significantly increases the risk of an accident, the FAA has decided to disallow the 16-hour unaugmented and 30-hour augmented FDPs currently permitted in supplemental passenger operations by subjecting supplemental passenger operations to the same FDP limits as other part 121 passenger operations. The effect that other provisions of this rule will have on supplemental passenger operations and the reasons why the FAA has chosen to adopt these provisions are discussed in the corresponding portions of this preamble.

The FAA understands that including supplemental passenger operations in this rule will take away a portion of the scheduling flexibility currently enjoyed by non-scheduled passenger operations. However, this rule contains a number of provisions that ease the burden of current rules on non-scheduled operations in a way that does not decrease safety.

The most significant way in which this rule eases the burden of existing rules on supplemental passenger operations is the elimination of compensatory rest requirements. Under the existing rules, a pilot who flies an aircraft for over 8 hours in a supplemental operation must receive a compensatory rest period that is 16 hours or longer (depending on whether the flight was augmented) at the conclusion of his or her duty day. This compensatory rest requirement imposed a significant burden on supplemental passenger operations because pilots had to be provided with at least 16 hours of rest simply for flying for 9 hours. In addition, the FAA found that by focusing on flight time and not on FDP, the existing supplemental flight, duty, and rest regulations led to counterintuitive results in which long 16- and 30-hour FDPs were permitted with only a 9-hour required rest period, but a 9-hour flight time with a relatively-short FDP resulted in a 16- to 18-hour required rest period.

In order to address the concerns discussed in the preceding paragraph and because there was an absence of scientific data showing that rest periods providing for more than 8 hours of sleep were always necessary to combat transient fatigue, this rule eliminates the existing compensatory rest requirements for supplemental passenger operations. The removal of this additional rest requirement will allow certificate holders conducting non-scheduled passenger operations to fly augmented international operations, including those that are under contract with the United States Government, without having to provide flightcrew members with an additional 6 hours of rest at the end of the operation. In addition, to ensure that certificate holders

[11] 14 CFR 121.505(b). The existing regulations do not regulate FDPs, but instead, regulate the length of duty time. The FAA believes that duty time, as used in the existing regulations, is roughly equivalent to the concept of an FDP because flightcrew members typically begin and end their duty periods at about the same times as an FDP, as defined by this rule, would begin and end.

[12] 14 CFR 121.523(c).

[13] An unaugmented flight contains the minimum number of flightcrew members necessary to safely pilot an aircraft. An augmented flight contains additional flightcrew members and at least one onboard rest facility, which allows flightcrew members to work in shifts and sleep during the flight.

[14] The FAA notes that this rule technically allows an unaugmented flightcrew member to work on a 16-hour FDP if a 14-hour FDP is extended through the use of a 2-hour FDP extension. However, a 14-hour unaugmented FDP is only permitted during periods of peak circadian alertness, and the 2-hour FDP extension is subject to additional safeguards. A 30-hour FDP is never permitted, although a carrier could potentially develop an FRMS that allowed a 30-hour FDP in augmented operations.

[15] *See* Simon Folkard & Philip Tucker, *Shift work, safety and productivity,* Occupational Medicine, Feb. 1, 2003, at 98 (analyzing three studies that reported a trend in risk over successive hours on duty).

[16] *Id.* The FAA notes that the Federal Motor Carrier Safety Administration, another DOT agency, has examined studies comparing crash risk to hours worked in certain truck operations. Similar to the Folkard & Tucker study, these studies found a steady rise in crash risk with additional work hours; however, they did not show an increase as rapid as the results reported by Folkard and Tucker. (*See,* for example, Blanco, M., Hanowski, R., Olson, R., Morgan, J., Soccolich, S., Wu, S.C., and Guo, F., ''The Impact of Driving, Non-Driving Work, and Rest Breaks on Driving Performance in Commercial Motor vehicle Operations,'' FMCSA, April 2011).

[17] Jeffrey H. Goode, *Are pilots at risk of accidents due to fatigue?,* Journal of Safety Research 34 (2003) 309–13.

[18] *Id.* at 311.

conducting supplemental operations are able to provide critical services in support of government operations, this rule also contains an Emergency and Government Sponsored Operations section that allows operations performed in accordance with a government contract to exceed this rule's flight, duty, and rest limits in certain situations.

Another example of a provision in this rule that benefits supplemental passenger operations is the increase of the flight-time limits for augmented and unaugmented flights. This increase will allow certificate holders conducting supplemental operations to schedule unaugmented flightcrew members for 9 hours of flight time during peak circadian times after providing them with only 10 hours of rest. The existing regulations would require certificate holders conducting supplemental operations to provide their flightcrew members with 18 hours of rest after an operation involving 9 hours of unaugmented flight time.

In addition to including provisions that ease the burden of the maximum-FDP-limit reduction on supplemental operations, the FAA has also made adjustments to this rulemaking in response to concerns raised by air carriers (certificate holders) conducting non-scheduled passenger operations. Thus, the FAA has: (1) Increased the unaugmented and augmented FDP limits in Tables B and C, (2) increased the amount of the split-duty credit and made that credit easier to obtain, and (3) largely eliminated the scheduling reliability requirements that were proposed in the NPRM. All of these adjustments were made, at least in part, in response to the concerns raised by certificate holders conducting non-scheduled operations, and they should significantly ease the burden of this rule on these types of operations. In making these adjustments, the FAA has, where possible, incorporated into this rule portions of the alternative proposal put forward by the industry commenters who conduct non-scheduled passenger operations.

While air-carrier business models for passenger operations may differ, the factors that give rise to unsafe levels of fatigue are the same for each flightcrew member involved in these operations. A flightcrew member working a 16 or 30-hour FDP as part of a supplemental passenger operation will not be less tired simply because he or she is working in a supplemental type of operation instead of a domestic type operation. To account for this fact and ensure that fatigue is limited to safe levels, the FAA has decided to set a single flight, duty, and rest standard for all part 121 certificate holders conducting passenger operations. The FAA is sympathetic to the fact that supplemental passenger operations require additional flexibility that is not required by other business models and as a result, may bear a disproportionate cost of this rule. To ameliorate the cost of this rulemaking on supplemental operations, this rule contains supplemental-friendly provisions and adjustments that do not have an adverse effect on safety. However, the flexibility and cost-savings required by supplemental passenger operations can no longer be used to justify 16 and 30-hour FDPs for these operations because scientific studies have shown that FDPs of this length significantly increase the risk of an aviation accident that could injure passengers onboard an aircraft.

In response to NJASAP's question, the FAA notes that this rule applies to all part 121 certificate holder passenger operations and all part 121 and part 91 operations where an FDP includes at least one flight segment conducted under part 117. Thus, if a flightcrew member flies one or more segments of an FDP in passenger-carrying operations, but also flies a part 91 positioning flight as part of that FDP, the part 91 flight would have to be conducted under part 117. Parts 135 and 91K have their own set of flight, duty, and rest requirements that will continue to apply to those operations.

B. Definitions

The NPRM included definitions specific to this part. The definitions adopted in this rule are in addition to those in §§ 1.1 and 110.2. In the event that terms conflict, the definitions in part 117 control for purposes of the flight and duty regulations adopted in this rule. The section below provides a discussion of the specific definitions used in the final rule.

1. Acclimated

The FAA proposed to define ''acclimated'' as a condition in which a flightcrew member has been in a theater for 72 hours or has been given at least 36 consecutive hours free from duty.

The Airline Pilots Association (ALPA), the Allied Pilots Association (APA), the Coalition of Airline Pilots Associations (CAPA), and the Independent Pilots Association (IPA) stated that acclimated should mean a condition in which a flightcrew member has been in a new theater for the first 72 hours since arriving and has been given at least 36 consecutive hours free from duty during the 72 hour period. Also, the Flight Time Aviation Regulation Committee and Flightcrew Representatives (representing labor) (Flight Time ARC) supported the suggested, revised definition. These commenters noted that according to established science, three consecutive local nights' rest is required to become acclimated. They also noted that Cap 371 provides for three consecutive local nights rest to become acclimated.

NACA, North American Airlines (NAA), World Airways, and Atlas Air Worldwide Holdings, Inc. (Atlas) contended that the proposed definition should be revised to allow 30 consecutive hours free from duty instead of 36 hours.

NACA and NAA said that it is important in regulations controlling both schedules and operations that the extended rest periods be consistent across domestic and international operations. NACA, NAA, and World Airways said that the FAA's proposed acclimation time should be changed to reflect the agency's proposed 168-hour look-back rest period of 30 hours. (See § 117.25(b)). These commenters believed that 30 hours is appropriate because any further time to acclimate may preclude flightcrew members from returning to their home base as flightcrew members, which becomes important in commercial operations where flight hours are guaranteed.

World Airways said that its recommendation of 30 hours free from duty is within the range the ARC discussed as sufficient for acclimation to occur. Atlas said that there is no scientific justification for selecting 36 as the minimum number of consecutive hours. Atlas further commented that subsequent to publication of the NPRM, the FAA clarified its definition of acclimated, stating that the computation is based on actual, not scheduled, operations. Atlas believed that this clarification needs to be incorporated into the definition as follows: ''Time in theater begins upon block in at an airport more than four time zones from the previous acclimated location.''

In response to the above comments, the FAA is not persuaded by the argument that acclimation only can occur when the flightcrew member is in a new theater for 72 hours and has been given 36 consecutive hours free from duty during that period. The Flight Time ARC did receive information from the sleep specialists that an individual attempting to acclimate to a new time zone will adjust his or her clock approximately one hour per day for each hour of time zone difference. 75 FR 55852, 55861 (Sep. 14, 2010). The ARC, however, concluded that, based on its collective experience, acclimation can occur more quickly if the flightcrew member manages the sleep opportunity appropriately. The ARC also concluded that a flightcrew member can become acclimated by either receiving three consecutive physiological nights' rest or a layover rest period of 30 to 36 consecutive hours. The ARC universally rejected the premise that, because the United Kingdom is 5 time zones away from the eastern coast of the United States, it would take between five and nine days to acclimate to a European time zone. The commenters did not present new information that was not considered during the ARC. There is no compelling information or argument that refutes the body of experience represented in the ARC and the FAA declines to amend this definition as suggested.

The FAA also declines to accept the suggestion that a 30 hour rest period is adequate to acclimate compared to the 36 hour period proposed in the NPRM. The ARC recommended a 30 to 36 hour layover rest period. The FAA decided to propose the 36-hour rest period because it provides for one physiological night's rest and then opportunity for a shorter rest period. The agency finds that the more conservative approach is appropriate to provide the more meaningful opportunity for rest.

United Parcel Service Co. (UPS) commented that administrative duties should be exempted or removed from the scope of flight duty when determining flightcrew member acclimation. UPS further commented that if flightcrew members revised company manuals or navigation charts during a duty free period (layover) or prior to report time, it is possible that the flightcrew members would not satisfy the definition of being acclimated or could drive different FDP limits based on when they claim their duties started.

In response to UPS' concern, to acclimate a flightcrew member under this rule, the certificate holder must provide the required rest and cannot assign any duties during the rest period. Similarly, it is the flightcrew member's responsibility to take advantage of the period and rest accordingly. If a flightcrew member independently decides to perform administrative type duties during this time period, as described by the commenter, the flightcrew member is considered acclimated regardless of whether he or she actually rested during this time period.

2. Acclimated Local Time

While the FAA did not propose this term, ALPA, CAPA, Flight Time ARC, and the Southwest Airlines Pilots Association (SWAPA) suggested including this term. They suggested that acclimated local time means the local time at the location where the pilot last had greater than 36 hours free from duty in the first 72 hours in theater. IPA recommended the same definition, except it replaced the term ''pilot'' with ''flightcrew member.'' In support of their recommendation, ALPA, CAPA, and Flight Time ARC said this new definition would provide an unambiguous time for applying the definition of ''nighttime duty period'' and for entering the FDP and flight time limit tables. They further said that the wording in the NPRM concerning acclimated or home base time left many questions of interpretation. For example, a USA-based pilot who acclimates in Europe and then subsequently flies to Japan would, under the current NPRM wording, enter the tables at home-base time instead of Europe time. The commenters also stated that the exact location of acclimation must be known to determine future loss of acclimation. Under their proposal, the commenters contended that both the tables and the definition of nighttime flight duty period would use the new term, ''acclimated local time.''

The FAA has accommodated these concerns by changing the heading of Tables A, B, and C to reflect acclimated time. In addition, the FAA clarifies that a flightcrew member is considered acclimated based on which rest he or she was given first. If the flightcrew member completes 36 consecutive hours of rest prior to being in theater for 72 hours, then the flightcrew member is acclimated at the time that the 36-hour period ends and he or she is acclimated at the location that the rest occurred.

3. Airport/Standby Reserve

According to the proposed definition, ''Airport/standby reserve'' means a defined duty period during which a flightcrew member is required by a certificate holder to be at, or in close proximity to, an airport for a possible assignment.

UPS said that the FAA's definition of airport/standby reserve is too vague and is open to interpretation. It recommended revising the definition to mean an assignment that requires a flightcrew member to be in a position to begin preflight activities following notification of an assignment without requiring additional travel time to arrive for the operation.

NACA and NAA did not believe that the definition is necessary because airport/standby reserve is an assignment within an FDP. If the term is adopted, NACA and NAA recommended that the term be defined as a duty period during which a flightcrew member is required by a certificate holder to be at, or in close proximity to, an airport for a possible assignment, and to show at the departure gate or aircraft within one hour.

Atlas contended that the FAA did not clarify the relationship of airport/standby reserve and short-call reserve in its clarification document published after the NPRM. This commenter noted that according to the FAA's clarification, airport/standby reserve and short-call reserve are mutually exclusive. Atlas said that the distinction was explained as whether or not the flightcrew member is ''at the airport or in close proximity to the airport.'' If at or in close proximity to the airport, a flightcrew member is deemed to be on airport/standby reserve, this suggests that a flightcrew member on short-call reserve in a hotel room near an airport could be deemed to be on airport/standby reserve. Atlas believed the distinction is important because it determines if the reserve is counted as part of the FDP. Atlas argued that airport/standby reserve means a defined duty period at an on-airport facility to which a flightcrew member has been required to report by a certificate holder immediately following assignment (usually within one hour) and at which no rest facilities are available or no rest is scheduled.

The FAA agrees that the proposed terminology could be confusing and has modified the term to mean a duty period during which a flightcrew member is required by a certificate holder to be at an airport for possible assignment.

4. Augmented Flightcrew

The NPRM defined ''augmented flightcrew'' as a flightcrew that has more than the minimum number of flightcrew members required by the airplane type certificate to operate the aircraft to allow a flightcrew member to be replaced by another qualified flightcrew member for in-flight rest.

A number of industry commenters objected to the fact that the proposed augmented flightcrew definition did not allow a flight engineer to augment a pilot. These commenters stated that adding a flight engineer to a flightcrew has a number of safety benefits. The commenters added that their inability to augment with a flight engineer would result in three-seat aircraft being retired prematurely, which would raise the costs of this rule.

This rule does not allow augmentation with a flight engineer for safety reasons. As discussed more fully in other parts of this preamble, an augmented flight provides fatigue-mitigation benefits because it contains more than the minimum number of pilots, and the additional pilots allow the flightcrew to obtain in-flight rest by working in shifts and replacing each other at the aircraft controls. However, a flight engineer is not qualified to manipulate the flight controls and pilot an aircraft and is generally prohibited from occupying a pilot duty station. Because a flight engineer who is not qualified as a pilot cannot occupy a pilot duty station, an engineer cannot replace a pilot at the aircraft controls. As such, this rule does not allow a pilot to be augmented with a flight engineer.

With regard to three-seat aircraft, even though this rule does not give augmentation credit for a flight engineer to augment a pilot, it does not prohibit flight engineers from working on three-seat aircraft. All this rule states is that, without additional pilots, a flightcrew that has a flight engineer would not be considered augmented. Because a flight engineer could still work on a three-seat aircraft under the terms of this rule, the FAA does not believe that the above limitation on augmentation would lead to the premature retirement of three-seat aircraft.

5. Calendar Day

The NPRM proposed that a ''calendar day'' means a 24-hour period from 0000 through 2359.

Alaska Airlines said that while the FAA contends in its clarifying document that the calendar day for the flightcrew member's home base should be sufficient, calendar day as defined in the NPRM does not provide this clarification. Alaska Airlines instead recommended that a calendar day means a 24-hour period from 0000 through 2359 local time at the flightcrew member's home base.

Boeing Commercial Airplanes (Boeing) suggested a similar definition to address frequent transitions between time zones. Boeing further stated that rules such as the ones proposed in the NPRM are implemented in computerized optimization systems for crew scheduling, and as a result, ambiguities in the rules can lead to different interpretations.

The FAA has amended this term to include reference to Coordinated Universal Time or local time. This is consistent with the definition of calendar day in section 121.467(a) (Flight attendant duty period limitations and rest requirements: Domestic, flag, and supplemental operations).

6. Consecutive Night Duty Period

The FAA did not propose a definition for this term; ALPA, CAPA, SWAPA, Flight Time ARC, and Federal Express Air Line Pilots Association, International (FedEx ALPA) said that the proposed § 117.27 limits consecutive nighttime flight duty periods to three periods. To avoid confusion in applying § 117.27, the commenters believed that the term ''consecutive night duty period'' should be defined. They recommended that consecutive night duty period mean two or more night flight duty periods that are not separated by at least a part § 117.25 rest between the duty periods that encompasses a physiological night's sleep (1 a.m. to 7 a.m. at home base or acclimated local time). IPA suggested the adoption of a similar definition.

The FAA declines defining the term consecutive night flight duty period and instead includes a provision in § 117.27 to address the commenters' concerns. Section 117.27 now specifies that the consecutive-night provisions apply to consecutive flight duty periods that infringe on the WOCL. The WOCL is defined later in this section.

7. Deadhead Transportation

As proposed, ''deadhead transportation'' means transportation of a flightcrew member as a passenger, by air or surface transportation, as required by a certificate holder, excluding transportation to or from a suitable accommodation.

Air Transport Association of America, Inc. (ATA) suggested removing the word ''passenger'' from the definition because the FAA should not assume that deadhead transportation should be limited to flightcrew members characterized as passengers when not all carriers carry passengers. Similarly, UPS commented that the proposed definition fails to address deadhead transportation on aircraft not configured for passenger operations (*i.e.*, all-cargo aircraft). UPS suggested that the FAA revise the definition as follows: ''Deadhead transportation means transportation of a flightcrew member as a passenger, non-assigned flight deck occupant, or other additional flightcrew member by air or surface transportation, as required by the certificate holder, excluding transportation to or from a suitable accommodation.''

The FAA agrees with the above commenters and has modified the term to apply to the transportation of a flightcrew member as a passenger or a non-operating flightcrew member. The FAA has also added two clarifying statements to the definition. The first is that all time spent in deadhead transportation is duty and is not rest. This provision was copied from proposed § 117.29 Deadhead transportation. Secondly, the FAA includes in this definition that deadhead transportation is not considered a segment for purposes of determining the maximum flight duty period in Table B.

8. Duty

The NPRM defines ''duty'' to mean any task, other than long-call reserve, that a flightcrew member performs on behalf of the certificate holder, including but not limited to airport/standby reserve, short-call reserve, flight duty, pre-and post-flight duties, administrative work, training, deadhead transportation, aircraft positioning on the ground, aircraft loading, and aircraft servicing.

Industry commenters largely rejected the proposition that short-call reserve be considered duty. They argued that this classification is inappropriate and unrelated to effective fatigue mitigation. They also stated that the only requirement or company task a pilot has on short call reserve is to be available to be contacted. Otherwise, the pilot is free to do what he or she wants and plans the day to take advantage of rest opportunities or any other activities as he or she desires, just as a lineholder would. Industry also largely objected to the classification of short-call reserve as duty. ALPA, CAPA, FedEx ALPA, SWAPA and APA all commented favorably on short call reserve being considered duty.

As stated in the NPRM, the FAA's rationale for this proposal was that while on short-call reserve, the flightcrew member can expect that he or she will not receive an opportunity to rest prior to commencing an FDP. Additionally, the flightcrew member is required to limit his or her action sufficiently so that he or she can report to the duty station within a fairly short timeframe. The FAA believed that this time should be accounted for under the cumulative limitations and therefore proposed that short-call reserve be considered duty.

However, the commenters argued that a flightcrew member on short-call reserve has the same predictable rest and sleep opportunities as a regularly-scheduled lineholder and that being on reserve cannot entail significant workload and thereby be fatiguing. The FAA accepts that while reserve cannot be categorized as ''rest'' it does not necessarily fit squarely with being considered duty either. As the commenters correctly pointed out, time spent on short-call reserve is simply not as fatiguing as time spent on an FDP. Therefore, this rule no longer includes short-call reserve as duty.

ATA, NACA, UPS, United, Continental Airlines, Inc. (Continental), Alaska Airlines, NAA, Delta Air Lines (Delta), and World Airways stated that the proposed definition of duty is too broad, operationally unworkable, and not clear regarding accountability. They objected to the inclusion of the terms ''any task,'' ''on behalf of the certificate holder,'' and ''administrative work'' in the definition. ATA provided the example of a professional pilot who routinely performs tasks such as refreshing outdated publications, watching videos for recurrent training, and reading and responding to emails. Because a flightcrew member can perform these tasks at a time and place of his or her choosing, the commenters argued that a certificate holder has no way of knowing or controlling the pertinent flightcrew member conduct.

ATA asserted that the inclusion of administrative but not labor-related work in the definition does not make sense because no material distinction exists between administrative tasks performed on behalf of management and similar tasks performed on behalf of labor.

Alaska Airlines said that the FAA in its clarifying document noted that the term ''administrative work'' is readily understandable; however, the commenter noted that the term's role in fatigue and in the context of the regulation is vague. The commenter believed that the term needs further clarification and should only include work associated with flight operations.

Continental and United said that the definition of duty considers administrative work in the same way that it assesses flight duty. They contend that this is inappropriate when applied to the cumulative duty restrictions discussed in proposed § 117.23.

Alaska Airlines suggested that the FAA make clear in the final rule that duty only includes activities that the carrier can directly control. ATA recommended clarifying the definition by replacing the phrase ''on behalf of the certificate holder'' with ''directed by a certificate holder on company property.'' NACA, UPS, Delta, and World Airways suggested revising the definition of duty to mean ''any task, other than long-call and short-call reserve, that is directed by the certificate holder * * *'' NAA believed the term ''on behalf of the certificate holder'' should be replaced with ''is assigned by the certificate holder.''

UPS contended that the FAA must address the issue of management pilot duty and suggested that management pilot duty include all time spent during company business-related meetings and other business-related activity conducted on company property. UPS argued that if this is not addressed, management pilots will effectively become non-flying pilots.

NACA, World Airways, and NAA recommend deleting the term ''administrative work'' because it is too vague and inclusive of issues that have nothing to do with direction by the certificate holder or FDP fatigue mitigation. Continental and United recommended that the FAA remove administrative activity from the definition and add a provision to the regulation that applies administrative duty to specific FDPs. ATA and Delta request that if the term is kept in the definition, the FAA should clarify that the definition treats management and labor-related administrative work in the same way.

In response to the above comments, the definition of duty has been further modified by replacing ''on behalf'' of the certificate holder with ''as required'' by the certificate holder. This addresses the certificate holders' concern that the administrative work accomplished by the flightcrew member is work that he or she is required to do, and appropriately included as duty. Lastly, the FAA agrees that performance of administrative management work is not distinguishable from any other type of administrative work, and therefore administrative management work is included in the term ''administrative work'' under this definition.

9. Duty Period

As proposed, ''duty period'' means a period that begins when a certificate holder requires a flightcrew member to report for duty and ends when that crew member is free from all duties.

UPS said that defining the end of the duty period as ''* * * free from all duties'' is too ambiguous and uncertain since a certificate holder cannot control voluntary duties that a flightcrew member may decide to accomplish at the end of his or her FDP. UPS suggested that the definition be changed so that the end of the duty period occurs when the flightcrew member is ''* * * released from all company directed duties.'' In light of the changes that have been made to this rule, the FAA has determined that it is no longer necessary to define this term, and therefore the proposed definition is withdrawn.

10. Early Start Duty

The NPRM did not propose a definition for this term, however, APA recommended including the term, which would mean an FDP that commences in the period 0500 to 0659 home base time or where acclimated. The FAA does not agree that adopting this term is necessary or useful.

11. Fatigue

Fatigue as proposed means physiological state of reduced mental or physical performance capability resulting from lack of sleep or increased physical activity that can reduce a flightcrew member's alertness and ability to safely operate an aircraft or perform safety-related duties.

ATA commented that the proposed definition of fatigue is inconsistent with ICAO's proposed definition. ATA noted that ICAO proposes to define fatigue as ''a physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness, circadian phase, or workload (mental and/or physical activity) that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety related duties.'' ATA recommended adopting the ICAO definition because it captures the fatigue-inducing effects of the interaction of sleep loss, circadian phase, and workload, and provides a scientific basis for fatigue risk management.

In response to ATA's comments, the FAA notes that ICAO has not finalized its definition of fatigue, and the proposed definition may be subject to change. At this point, it is not prudent for the FAA to include a term that ultimately may be changed or not even adopted. Therefore, the FAA is adopting the definition of fatigue that was proposed.

12. Fit for Duty

As proposed, the definition of ''fit for duty'' means physiologically and mentally prepared and capable of performing assigned duties in flight with the highest degree of safety.

UPS commented that including ''* * * duties in flight with the highest degree of safety'' in the definition of ''fit for duty'' is not practical and too subjective. UPS further stated that it is unrealistic for any human to be at their ''highest'' level of performance during every possible FDP and suggests replacing ''* * * highest degree of safety'' with ''* * * capable of performing duties that assure flight safety.''

The FAA does not agree with UPS because every flightcrew member on every flight should be prepared and capable of performing the assigned duties at the highest degree of safety. Accordingly, the FAA has adopted the proposed definition in the final rule.

13. Flight Duty Period

The NPRM defines ''flight duty period'' to mean a period that begins when a flightcrew member is required to report for duty with the intention of conducting a flight, a series of flights, or positioning or ferrying flights, and ends when the aircraft is parked after the last flight and there is no intention for further aircraft movement by the same flightcrew member. A flight duty period would include deadhead transportation before a flight segment without an intervening required rest period, training conducted in an aircraft, flight simulator or flight training device, and airport/standby reserve.

ATA, UPS, World Airways, NAA, NACA, Delta, and Alaska Airlines objected to including all flight training in a flight simulator or training device in the definition of FDP. ATA, Delta, and Alaska Airlines commented that there is no scientific basis for such inclusion, and all seven commenters said there is no inherent safety basis for this decision. Alaska Airlines and Delta added that with simulator time included in the FDP, pursuant to section 117.27, flightcrew members would be unable to participate in simulator training on more than three consecutive nights. ATA further commented that there is no basis for including travel to a training site in the FDP unless the travel occurs before flight time.

ATA, Delta, and Alaska Airlines recommended that the FAA revise the proposed definition to state that only training and flight simulator time conducted before a flight without an intervening rest period is counted as part of the FDP. UPS said that it supports counting time spent in a simulator or flight training device as part of an FDP only if this time immediately precedes flight duty without an intervening rest period. UPS believed that there is an unintended consequence of treating simulator and flight training device training as part of an FDP, regardless of when the training occurs. That is, the practice of providing additional training to a flightcrew member who requests that training will be discontinued; thereby, affecting flight safety.

NACA, NAA and World Airways commented that an FDP ''must involve a flight, or at a minimum, movement of an aircraft where the public is at risk where an aircraft accident potential immediately exists.'' They suggested revising the proposed definition to add the following phrases: ''but not limited to'' and ''whenever these duties are performed in conjunction with duties involving flight without an intervening rest period.'' This would result in a definition that reads: ''* * * A flight duty period includes, but is not limited to, deadhead transportation * * * and airport/standby reserve whenever these duties are performed in conjunction with duties involving flight without an intervening rest period.''

The FAA clarifies that an FDP begins when the flightcrew member reports for duty and will include the duties performed by the flightcrew member on behalf of the certificate holder that occur before a flight segment or between flight segments without a required intervening rest period. The FDP ends when the aircraft is parked after the last flight and there is no intention for further aircraft movement by the same flightcrew member. Included in the FDP are any of the following actions if they occur before a flight segment or between flight segments without an intervening rest period: deadhead transportation, training conducted in an aircraft or flight simulator, and airport/standby reserve. Time spent in a flight training device that takes place after the aircraft has been parked after the last flight has been eliminated from this definition. For purposes of calculating the pertinent part 121 flight, duty, and rest limits, the FAA considers time spent on an FDP to be duty.

14. Flight Time

The NPRM did not propose a definition for this term; however, APA, ALPA, CAPA, FedEx ALPA, SWAPA, and Flight Time ARC recommended adding a definition for flight time to begin when the aircraft first moves with the intention of flight. These commenters argued that this term in § 1.1 is defined as the moment the aircraft first moves under its own power. However, the pilot in command (PIC) and required flight deck flightcrew members are always responsible and must perform their duties when the aircraft is moved by a tug or sits on a hardstand and that time should count, according to the commenters, as flight time if the movement is with the intention for flight. They also state that this definition would be consistent with Annex II, Subpart Q to the Commission of the European Communities Regulation No. 3922/91, as Amended (EU OPS subpart Q) which defines flight time as the time between an airplane first moving from its parking place for the purpose of taking off until it comes to rest on the designated parking position and all engines or propellers are stopped.

IPA suggested that the proposed definition be revised as follows: ''Flight time means when the aircraft first moves with the intention of flight until it comes to rest on the designated parking position.''

The FAA declines the commenters' recommendations. Numerous other regulations are based on the definition of flight time that is set out in § 1.1. Changing this term solely in the context of the flight and duty regulations would make this rule more complicated than necessary and create confusion between this rule and other regulations.

15. Late Finish Duty

The NPRM did not propose a definition for this term; however, APA said a definition of ''late finish duty'' is needed to provide for fatigue mitigation caused by consecutive early starts and late finishes. APA suggested that the term be defined as an FDP that ends during the period of 0000–0159, home base time or where acclimated. The FAA does not find that it is necessary or useful to adopt this term.

16. Night and Nighttime

The FAA did not propose definitions for either of these terms; however, NACA and NAA said that the FAA's intent for using the term ''night'' in the NPRM should be defined. If it is not defined, the commenters said that the FAA should always use the term ''physiological night'' in all text in the preamble and in the final rule. They recommended defining night to mean ''the period between 0100 and 0700 at the flightcrew member's designated home base or acclimated location.'' The commenters noted that this would make the term compatible with the definition of ''physiological night's rest.''

Atlas said that the final rule should contain a definition of the terms ''night'' and ''nighttime,'' so as to make the meanings comparable to references in proposed § 117.27, as well as to the definition of ''physiological night's rest.'' It noted that while ''physiological night's rest'' refers to the hours of 0100 and 0700, the term ''nighttime'' referenced in proposed § 117.27 is interpreted to refer to operations that commence between 2200 and 0500, according to page 22 of the FAA's clarification document. Both definitions, the commenter said, differ from the definition of ''night'' in 14 CFR. § 1.1, which is the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the American Air Almanac, converted to local time.

The FAA declines to adopt these terms. The FAA uses the word ''physiological night's rest'' when it is appropriate. In addition, please refer to the FAA's response to the term ''Consecutive Night Duty Period.''

17. Nighttime Flight Duty Period

The FAA did not propose a definition for this term; however, APA, ALPA, CAPA, FedEx ALPA, SWAPA, and Flight Time ARC said that to avoid confusion when conducting consecutive nighttime operations under § 117.27, the FAA should define ''nighttime flight duty.'' They suggested that this term be defined to mean a duty period during which any part of the duty period falls within the home base or acclimated local time period of 0200 to 0459.

IPA suggested a definition of ''nighttime flight duty'' as follows: ''a duty period during which any part of the duty period falls within the home base or acclimated local time period of 0200 to 0459.''

Please see response to ''6. Consecutive Night Duty Period.'' The FAA does not find it necessary to define the term as suggested.

18. Nighttime Operations

ATA said that the FAA should add a new definition of nighttime operations for purposes of part 117 to be consistent with the agency's document that responds to clarifying questions to the NPRM. The commenter believed that the definition should include operations that commence between 10 p.m. and 5 a.m. The FAA has clarified the pertinent provisions of section 117.27, and as such, it finds that a separate definition for nighttime operations is unnecessary.

19. Report Time

The NPRM defined ''report time'' as the time that the certificate holder requires a flightcrew member to report for a duty period. The FAA did not receive any comments with regard to this definition, and as such, this rule adopts the proposed definition.

20. Reserve Availability Period

The NPRM defined ''reserve availability period'' to mean a duty period during which a certificate holder requires a reserve flightcrew member on short call reserve to be available to receive an assignment for a flight duty period.

NACA objected to the premise that short call reserve is duty. It noted that ARC discussions were clear that short call reserve, which is a period of time when the only responsibility the crew member has is to answer the phone, is not a fatiguing event, and thus, it should not constitute duty for cumulative-duty purposes. NACA suggested revising the proposed definition so that it reads ''reserve availability period means a period of time during which a certificate holder requires a reserve flightcrew member on short call reserve to be available to receive an assignment for a flight duty period.''

As discussed in other portions of this preamble, cumulative-duty-period limits have been removed from this rule. This removal addresses the concern expressed in NACA's comment as short-call reserve is no longer subject to the cumulative-duty-period limits.

21. Reserve Duty Period

The NPRM defined ''reserve duty period'' as the time, applicable only to short call reserve, from the beginning of the reserve availability period to the end of an assigned flight duty period. In light of the changes that were made to the reserve status section, this definition is no longer necessary, and it has been removed from the final rule.

22. Reserve Flightcrew Member

The NPRM defined ''reserve flightcrew member'' as a flightcrew member who a certificate holder requires to be available to receive an assignment for duty. The FAA did not receive any comments with regard to this definition, and as such, this rule adopts the proposed definition.

23. Rest Facility

The NPRM defines ''rest facility'' as a bunk, seat, room or other accommodation that provides a flightcrew member with a sleep opportunity. In determining what constitutes each specific type of rest facility, the FAA took note of a comprehensive evaluation of available onboard rest facilities, which was conducted by the Dutch government in 2007. Simons M, Spencer M., *Extension of Flying Duty Period By In-Flight Relief.* Report TNO–DV2007C362. TNO, Soesterberg, Netherlands, 2007 (TNO Report). The TNO Report was created in order to provide science-based advice on the maximum permissible extension of the FDP related to the quality of the available onboard rest facility and the augmentation of the flightcrew with one or two pilots.

As defined in the NPRM, ''Class 1 rest facility'' means a bunk or other surface that allows for a flat sleeping position and is located separate from both the flight deck and passenger cabin in an area that is temperature-controlled, allows the flightcrew member to control light, and provides isolation from noise and disturbance. ''Class 2 rest facility'' means a seat in an aircraft cabin that allows for a flat or near flat sleeping position; is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation; and is reasonably free from disturbance by passengers or flightcrew members. ''Class 3 rest facility'' means a seat in an aircraft cabin or flight deck that reclines at least 40 degrees and provides leg and foot support.

ATA stated that the proposed rule was overly restrictive with respect to the facilities it deemed sufficient for conferring credit for in-flight rest on augmented flights. ATA, NACA, and UPS criticized the proposal for over-relying on the TNO Report. ATA and UPS emphasized that the TNO Report is only a single study that has not been adopted by any regulatory body. NACA asserted that ''the TNO report is more than 10 years old and was proposed by a limited number of scientists and based upon limited studies.'' NACA added that ''[i]n the ARC discussions, Dr. Hursh stated that his [SAFTE/FAST] models value sleep on a bunk at approximately 66 to 80 percent of normal sleep.'' APA stated that the TNO Report has not been validated in the aviation context.

ATA stated that the proposed rule's adoption of the TNO report would have substantial adverse impacts on U.S. carriers because it would deviate from the less-restrictive criteria for rest facilities that the FAA set out in Advisory Circular (AC) 121–31. This is because, ATA asserted, many air carriers have invested a substantial amount of money developing rest facilities that comply with the guidelines set out in AC 121–31, and these facilities would not satisfy the more stringent criteria for rest facilities set out in the TNO Report. ATA noted that although it supports the concept of credit for in-flight rest, it does not support rest facility criteria derived from the TNO Report. It further noted that ''the FAA should continue to accept AC 121–31 standards for all aircraft built prior to the imposition of the new rule, the use of current business class seats as Class 2 facilities and for credit being afforded to all-cargo aircraft that provide a 'horizontal sleep opportunity' to flightcrew members. Rest facilities in use today built to AC 121–31 standards are operationally validated as a means of fatigue mitigation that FAA has accepted and there is no evidence that such facilities should not be used in the future.'' To minimize costs, ATA recommended that ''[a]t a minimum, the guidance in AC 121–31 should remain in effect for all aircraft built prior to the implementation date of the NPRM and a significant period allowed for newer aircraft to conform to any new standards.''

UPS added that most air-cargo carriers would be unable to install rest facilities needed for the augmentation credit because air-cargo aircraft do not have passenger cabins. UPS asserted that it would be unable to install the rest facilities required by this rule in approximately 18% of its total fleet.

The existing advisory circular that provides guidance for onboard rest facilities (AC 121–31) was written in 1994 based on the science that existed at that time. The TNO Report, on the other hand, was written in 2007, and it provides the most comprehensive evaluation available to date of onboard rest facilities. This report may not yet have been adopted by other regulatory bodies because it is only four years old, and significant regulatory changes usually take place over a longer period of time. When drafting this rule, the FAA found the TNO Report to be more persuasive than AC 121–31 because the TNO Report performed a comprehensive evaluation of rest facilities, and because it was based on more recent scientific data than AC 121–31.

The FAA understands that the TNO Report provides more conservative conclusions than the pertinent SAFTE/FAST data concerning onboard rest facilities. However, in response to comments discussed above, the FAA has increased the augmented FDP limits in Table C. This increase should more accurately reflect the results of the SAFTE/FAST modeling for augmented operations.

The FAA has considered the fact that basing the definition of rest facilities on the TNO Report may pose hardships for air carriers who currently rely on AC 121–31 for guidance about onboard rest facilities. To mitigate this hardship, as well as for a number of other considerations, the FAA has decided to make the effective date of this rule two years from publication. This two-year window will provide air carriers with time to phase out their current onboard rest facilities and install/upgrade onboard rest facilities that comply with the provisions of this rule.

APA, FedEx ALPA, SWAPA, CAPA, and Flight Time ARC said that the definition of ''rest facility'' should include the following clarification: ''A rest facility on an aircraft shall only be used for in-flight rest opportunities.'' The commenters said this statement will eliminate any temptation to have crews obtaining their part § 117.25 or part § 117.17 rest on the aircraft when it is on the ramp. Several of these commenters noted that a bunk or seat on an aircraft is not a suitable rest facility on the ground. APA further recommended that the FAA separate the definitions of an ''in-flight, onboard rest facility'' and a ''ground-based rest facility'' and clearly differentiate between a ground-based rest facility and a suitable accommodation.

The FAA agrees with the above commenters that rest in a rest facility should take place while an aircraft is in-flight. That is why the augmented FDP section, section 117.17, to which the rest-facilities definition applies, mandates that the required minimum augmentation rest take place in-flight. Because section 117.17 already requires that the minimum augmentation rest take place in-flight, there is no need to further amend the pertinent regulatory text.

Turning to APA's request for clarification concerning the distinction between onboard and ground-based rest facilities, the FAA notes that a rest facility is a facility that is installed in an aircraft. A suitable accommodation, on the other hand, is a ground-based facility. The FAA has amended the pertinent definitions to clarify this distinction between a suitable accommodation and a rest facility.

APA also stated that detailed minimum standards should be spelled out in regulatory requirements. At a minimum, the language in the Class 1 facility definition should be improved to indicate that other surfaces that allow for a flat sleeping position should be suitably padded and reasonably comfortable and suitable for sleeping. APA noted that the ARC's discussions described ground-based facilities primarily as bunkrooms and the like used by cargo carriers to provide rest during a package sort operation. APA urged the FAA to adopt the detailed recommendations regarding onboard rest facility requirements set out in the appendix included in its comment submission. APA added that it remains concerned that if such specifications are left to Advisory Circulars, and if important details are not followed, in-flight rest could be seriously compromised. Additionally, it noted that several studies have commented on sleep problems caused by low humidity or an improper temperature, but the FAA did not mention these factors nor list any requirement for them. APA suggested that a Class 1 rest facility should account for low humidity and improper temperatures.

Delta expressed concern with the following description of a Class 2 facility that, it said, is contained both in the preface and in Advisory Circular 121–31A: A Class 2 rest facility is ''a seat in an aircraft cabin that allows for a flat or near flat sleeping position (around 80 degrees from the seat's vertical centerline).'' Delta said that many U.S. carriers currently providing on board rest facilities on routes for which Class 2 seats would be used are using a passenger business class type seat, some of which have been slightly modified or enhanced. The commenter further noted that these types of facilities have been in use for many years mostly on flights governed by 14 CFR 121.483. According to Delta, the ARC discussed this issue and acknowledged that these existing seats have worked very well. Delta asserted that most of these seats do not recline to the 80 degree range nor is it known yet if it is feasible to modify them for this capability. Delta believed that business class type seats currently being used are more than adequate to allow for in-flight rest.

UPS and NACA said that the definition of a Class 2 rest facility fails to address rest facilities on aircraft configured without a passenger cabin (*i.e.,* all-cargo aircraft). UPS suggested that the definition should read: ''In an aircraft configured with a passenger cabin, Class 2 rest facility means a seat that allows for a flat or near flat sleeping position and is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation, and is reasonably free from disturbance by passengers or in-flight flightcrew members. In an aircraft not configured with a passenger cabin, Class 2 rest facility means a seat that allows for a flat or near flat sleeping position.''

In response to these comments, the FAA notes that, as discussed above, the specific requirements for rest facilities were derived from the TNO Report, which analyzed how much rest would be obtained from each rest facility that complied with those requirements. Because various air carriers currently utilize different types of rest facilities, the FAA has determined that adding to the TNO Report's minimum rest-facility requirements would require more air carriers to replace their existing rest facilities without a demonstrated safety benefit to justify this cost. Accordingly, the FAA declines to add additional requirements to the rest-facility requirements set out in the NPRM.

The FAA has also decided not to expand the definition of a Class 2 rest facility beyond the recommendations of the TNO Report. The FAA is open to the possibility of expanding the definition of a Class 2 rest facility if additional data is provided as part of an FRMS, and if expanding this definition would not adversely affect safety. In response to UPS and NACA's concerns, the FAA has changed the phrase ''passenger cabin'' to ''aircraft cabin'' in the rest-facility definition in order to include rest facilities on aircraft without a passenger cabin.

A number of industry groups and air carriers also objected to the fact that the NPRM did not consider economy-class seats to be a rest facility. These commenters stated that, in their operational experience, economy-class seats provided flightcrew members with significant amounts of restful sleep. The commenters cited a number of studies that, they claimed, indicate that an economy-class seat can provide restful sleep.

The decision to not consider an economy-class seat to be a rest facility was based on the TNO Report, which determined that ''the probability of obtaining recuperative sleep in such a seat would be minimal.'' [19] The TNO Report's determination was based on the following considerations: (1) An economy-class seat does not recline more than 40 degrees ''and has no opportunities for adequate foot and leg rest, which diminishes the probability of recuperative sleep;'' (2) ''space around the seat is not sufficient to create an adequate separation from the passengers (jostle in economy class), or guarantee any privacy;'' and (3) ''a majority of passengers are unable to sleep at all in an economy seat. With the help of sleeping aids or alcohol, some passengers succeed in obtaining some sleep, but they often feel a general malaise after sleeping in a cramped position.'' [20] The FAA agrees with the TNO Report's analysis of economy-class seats, and based on this analysis, which states that economy-class seats provide minimal amounts of recuperative sleep, the FAA has determined that economy-class seats should not be considered a rest facility in this rule.

Delta stated that it is unclear why the FAA is concerned with keeping crew rest facilities out of the coach or economy section of the aircraft. Delta believes that if the seat meets the NPRM definition requirements and the specifications provided in AC 121–3A (now AC 117–1), the geographical location of the rest facility on the aircraft should be immaterial. Delta further noted that it attempted to locate a scientific or an operational basis for the exclusionary requirement and has been unable to find any; therefore, Delta believes this is an unjustified constraint and should be removed.

[19] TNO Report at 17.

[20] *Id.* at 18.

As discussed in the preceding response, one of the reasons why an economy-class seat does not provide restful sleep is that space around the seat is not sufficient to create an adequate separation from the passengers (economy jostling). Because there are substantially more passengers in the economy section of an aircraft, that section is generally noisier and has more densely-packed people than the other sections of the aircraft. In addition, the FAA notes that economy cabins are generally located behind the aircraft engines, and thus, have to deal with louder engine noise. Due to all of these considerations, locating a rest facility in the economy section would reduce the restfulness of the sleep obtained by a flightcrew member.

Boeing stated it has concerns about the use of the phrase ''sleep opportunity'' in the definition. It noted that it considers a ''sleep opportunity'' to be a period of time during which sleep or rest can feasibly occur. Boeing suggested that the definition be revised to read: ''Rest facility means a bunk, seat, room, or other accommodation that provides a flightcrew member with comfort and quiet so as to maximize sleep and rest within a sleep opportunity period.''

Boeing's suggested definition of rest facilities has already been largely incorporated into the definitions for the Class 1 and 2 rest facilities. The FAA declines to incorporate the suggested definition for a Class 3 rest facility because there is no recommendation in the TNO Report that a Class 3 facility provide sound mitigation.

Boeing also said that it finds the new crew rest definitions to be overly prescriptive, and may drive design and configuration decisions that would run counter to the intent of the proposed rule. For example, all three classes of rest facility are defined by their location: Class 1 must be located ''separate from both the flight deck and passenger cabin;'' Class 2 must be in the passenger cabin; and Class 3 must be in the cabin or flight deck. Boeing notes that while these definitions may encompass most or many of the current airplane configurations, they preclude new and novel designs that might better match the intent of the rule. The commenter recommended that the FAA consider including a provision in the rule that would allow new or alternative designs to be qualified as ''equivalent'' to Class 1, 2, or 3, based on scientific data, such as: ''Rest facilities may be qualified to a higher Class if the quantity of sleep achieved in the facility can be demonstrated to be equal to or greater than the level achieved by that Class.''

Boeing's recommendation for recognizing new rest facilities that provide a sleep opportunity that is equivalent to the rest facilities defined by this rule is addressed by the FRMS and exemption processes. If an air carrier can show that its rest facility provides the same benefits as a Class 1, 2, or 3 rest facility, the FAA may approve an FRMS or an exemption recognizing the rest facility in question as providing the same fatigue mitigation as the rest facilities regulated by this rule.

Atlas said that the proposed rule's definition of rest facility is unworkably vague and leaves a number of uncertainties, which the FAA declined to clarify in response to questions. In particular, NACA and Atlas stated that the definition of Class 1 rest facility needs to be revised, as it is impossible to provide complete ''isolation from noise and disturbance'' on an aircraft. Atlas said that it supports changing the definition of a Class 3 rest facility to include a common coach class seat or non-crew seat on the flight deck of an all-cargo aircraft.

The definition for a Class 1 rest facility does not require that the isolation from noise and disturbance be complete. The FAA will accept a Class 1 rest facility that minimizes noise and disturbance without eliminating it completely, as complete elimination of noise and disturbance onboard an aircraft is virtually impossible. As discussed above, the FAA has declined to accept an economy-class seat as a rest facility because the TNO Report has determined that these types of seat provide a minimal amount of restful sleep.

24. Rest Period

The NPRM defined ''rest period'' as a continuous period determined prospectively during which the flightcrew member is free from all restraint by the certificate holder, including freedom from present responsibility for work should the occasion arise. None of the comments raised any significant issues with regard to this definition, and as such, this rule adopts the proposed definition.

25. Scheduled

The NPRM stated that ''scheduled'' means times assigned by a certificate holder when a flightcrew member is required to report for duty.

UPS commented that the definition does not address reschedules that occur during an FDP but only schedules assigned when the flightcrew member reported for duty. UPS suggested revising the definition as follows: ''Scheduled means times assigned by a certificate holder when a flightcrew member is required to report for duty or has been given a re-schedule during the FDP that fully complies with the requirements of this part.''

The FAA agrees with UPS that the proposed definition was ambiguous. The pertinent definition has been amended for clarification purposes.

26. Schedule Reliability

The NPRM defines ''schedule reliability'' to mean the accuracy of the length of a scheduled flight duty period as compared to the actual flight duty period.

FedEx ALPA, ALPA, CAPA, SWAPA, IPA, and Flight Time ARC proposed the following revised definition for schedule reliability: ''Schedule reliability means the accuracy of the length of both a scheduled flight duty period and a scheduled flight segment as compared to the actual flight duty period and segment.'' SWAPA offered the following rationale for the revised definition: ''To achieve schedule reliability, the individual flight segments must be considered. If a given segment within a pairing causes the pairing to exceed the limits, the certificate holder can merely leave the offending segment and change the pairing mix to bring it within limits. The segment would never be corrected. We believe that a scheduling metric must be included in § 117.9. Certificate holders now provide on-time reports to the DOT on an individual flight segment so this should not be a burdensome requirement.''

UPS said that defining schedule reliability as a comparison of an actual FDP to a scheduled FDP has no fatigue or safety implications. It recommended revising the definition as follows to match the preamble description: ''Schedule reliability means the accuracy of the length of a scheduled flight duty period as compared to the maximum FDP listed in either Tables B or C (as applicable).''

As discussed in other parts of this preamble, the FAA has largely removed the proposed schedule-reliability requirements from the final rule. As such, there is no longer a need to define schedule reliability, and that definition has been removed from this rule.

27. Short-Call Reserve

The NPRM stated that ''short-call reserve'' means a period of time in which a flightcrew member does not receive a required rest period following notification by the certificate holder to report for a flight duty period.

NACA said that the only task assigned during short-call reserve is answering the phone. Otherwise, flightcrew members are free to conduct their lives as if they were in a rest period. NACA recommended clarifying the definition by specifying that short-call reserve is not duty.

NACA, Atlas, and NAA asked the FAA to more clearly distinguish short-call reserve from airport/standby reserve. Atlas recommended revising the definition of short-call reserve to mean ''a short, designated period of time (usually three hours or less), either at home or in a hotel, during which a flightcrew member is on reserve call-up for an assignment. Because the flightcrew member has not reported for assignment and rest is available, the time on short-call reserve is not to be considered part of FDP or duty.'' NAA recommended the following revision to the definition to address its concerns: ''Short-call reserve means a period of duty time in which a flightcrew member does not receive a required rest period following notification by the certificate holder to report for a flight duty period, but is provided more than one hour notice of the required reporting time.''

In response to the above comments, the FAA notes that the distinctive feature of short-call reserve is that the flightcrew member on short-call reserve is assigned a reserve availability period. Accordingly, the definition of short-call reserve has been amended to clarify that this definition only applies to a flightcrew member who is assigned to a reserve availability period. As discussed in the pertinent portions of this preamble, the FAA has removed the cumulative-duty-period limits from this rule, in part, in response to concerns raised by commenters about the way that this cumulative limit impacted short-call reserve.

28. Split Duty

The NPRM defines ''split duty'' as a flight duty period that has a scheduled break in duty that is less than a required rest period.

NACA said that the definition of split duty should make clear that the term ''scheduled'' is used only where it is clearly applicable to the situation intended. For non-scheduled operations, NACA believed that a schedule begins when the flightcrew member shows up for an FDP. As such, NACA argued that split-duty credit should be provided for a break in nonscheduled operations that was not foreseen. Additionally, according to NACA, a scheduled split duty break should not be strictly enforced because it may be intended in a nonscheduled FDP at the time the flightcrew member shows up for the FDP but not used for real-time operational reasons.

NACA further said that the fatigue-mitigating rest must be provided in the FDP in which the split-duty credit is actually used. According to NACA, the split-duty rest can only be used if the split duty rest opportunity is actually provided. NACA recommended that the definition be revised as follows, to include the phrase ''an actual'' to address its concerns: ''split duty means a flight duty period that has an actual scheduled break in duty that is less than a required rest period.'' Atlas added that, for clarity and to strengthen split duty as a fatigue mitigation vehicle, the phrase ''a scheduled break'' in the split duty definition should be changed to ''an actual break.''

RAA said that the definition should be revised as follows: ''split duty means a flight duty period that has a scheduled break in duty in a suitable accommodation that is less than a required rest period.''

The FAA agrees with the above commenters that split duty should be based on actual and not just scheduled rest. In light of the commenters' concerns, the split duty section has been amended to clarify that actual split-duty rest may not be less than the amount of split-duty rest that was scheduled. With regard to NACA's concerns about the term ''scheduled,'' as discussed in the split-duty section of this preamble, air carriers are required to schedule split-duty before the beginning of a split-duty FDP so that flightcrew members can accurately self-assess their ability to safely complete the FDP before the FDP begins.

29. Suitable Accommodation

The NPRM defines ''suitable accommodation'' to mean a temperature-controlled facility with sound mitigation that provides a flightcrew member with the ability to sleep in a bed and to control light.

APA, ALPA, CAPA, SWAPA, FedEx ALPA, and Flight Time ARC said that operational experience has demonstrated that a single-occupancy room is required. Otherwise, disruptions such as the other person's reading, watching television, snoring, *etc.,* will disrupt the roommate's rest. To address these concerns, the commenters recommend revising the definition as follows so that it only applies to single occupancy: ''Suitable accommodation means single occupancy facility with sound mitigation that provides a flightcrew member with the ability to sleep in a bed and to control light.'' APA recommended the following revised definition: ''suitable accommodation means a single-occupancy hotel room or equivalent with a bed, sound mitigation and light and temperature controls that is reasonably free from disturbances.''

In response to the above commenters, the FAA notes that it is unaware of any scientific data showing that single-occupancy rooms are essential for split-duty rest. Until there is more data showing the safety benefits of single-occupancy rooms, the FAA will not impose the cost of obtaining these types of rooms on air carriers. In addition, upon reevaluation of the definition of suitable accommodation, the FAA has determined that a chair that allows for a flat or near flat sleeping position would also provide significant recuperative split-duty rest. Therefore, the definition of suitable accommodation has been amended accordingly.

In addition, as discussed further in the definition of ''rest facilities,'' a suitable accommodation only applies to ground facilities and does not apply to rest facilities onboard aircraft because the use of onboard rest facilities as a suitable accommodation raises concerns regarding flightcrew member safety. The use of onboard rest facilities requires that the aircraft's environmental systems be turned on and that someone monitor the continuing operation of these systems. However, if an onboard rest facility is used as a suitable accommodation while the aircraft is on the ground, there would be no one awake to monitor the continuing safe operation of these environmental systems. Consequently, the use of onboard rest facilities for ground-based sleep poses a safety risk, which is also discussed in the aircraft flight manual, and as such, this rule does not consider onboard rest facilities to be a suitable accommodation.

30. Theater

The NPRM states that ''theater'' means a geographical area where local time at the flightcrew member's flight duty period departure point and arrival point differ by no more than 4 hours.

Flight Time ARC, ALPA, CAPA, IPA, and FedEx ALPA said that the definition should provide for instances where countries such as China have just one time zone. These commenters recommended amending the definition as follows to address such instances: ''Theater means a geographical area where local time at the flightcrew member's flight duty period departure point and arrival point differ by no more than 4 time zones or 60 degrees of longitude.'' APA and SWAPA commented similarly, except they recommended referencing three time zones instead of four so that the definition reads: ''Theater means a geographical area where local time at the flightcrew member's flight duty period departure point and arrival point differ by no more than three time zones or sixty (60) degrees of longitude whichever is most restrictive.''

In support of its recommendation, APA and SWAPA said that they believe the intent of the NPRM is to define a theater as an area four time zones in width. Thus, this would be a difference of three time zones from the flightcrew member's point of origin. APA further commented that it recommended three time zones because while the United States is four time zones wide, the difference between the east and west coast is three hours or three time zones. APA believed that specifying more than this amount would be contrary to most scientific recommendations about theater and acclimation. APA also believed that its revised definition addresses the irregularities of daylight savings time.

Theater is now defined as ''a geographical area where the flightcrew member's flight duty period departure point and arrival point differ by more than 60 degrees longitude.'' The FAA has chosen to eliminate the reference to time zones in this definition because, as the commenters correctly pointed out, time zones do not provide a uniform method of measurement, as they tend to vary in different geographic regions.

31. Unacclimated

The FAA did not propose a definition for this term; however, several commenters recommended that such a definition be included in the final rule.

Flight Time ARC, ALPA, CAPA, SWAPA, IPA, APA and FedEx ALPA said that the FAA should define this term because it is used throughout the NPRM. Each of these commenters (except APA and SWAPA) defined the term as follows: ''A pilot becomes unacclimated if he has traveled to a location more than 4 time zones or more than 60 degrees of longitude from the location at which he was last acclimated.'' APA suggested the same definition except it referenced three time zones instead of four. SWAPA defined the term as follows: ''A pilot becomes unacclimated if he has a legal rest period less than 36 consecutive hours within a 72 hour period at a location more than 60 degrees of longitude from the location at which he last acclimated and has not spent 72 consecutive hours in that theater.''

The commenters believed that defining acclimated in terms of time zones is subject to the whim of government policy. For example, China has one time zone but spans five normal time zones in width. Also, 60 degrees of longitude is equivalent to four normal time zones and should be included as a supplement to the time zone metric. APA added that a location more than three time zones away is in fact in the fourth time zone or further.

In response to the above comments, the FAA notes that this rule defines ''acclimated,'' and under that definition, it lists the conditions that are necessary for a flightcrew member to be considered acclimated. If a flightcrew member does not meet those conditions, it logically follows that the flightcrew member is unacclimated. Accordingly, it is unnecessary to provide a separate definition for ''unacclimated.''

32. Unforeseen Operational Circumstance

The NPRM defines ''unforeseen operational circumstance'' as an unplanned event beyond the control of a certificate holder of insufficient duration to allow for adjustments to schedules, including unforeseen weather, equipment malfunction, or air traffic delay.

Alaska Airlines commented that it disagrees with the following explanation from the FAA's Response to Clarifying Questions document:

> To the extent the NPRM uses the term ''unforeseen circumstances,'' the agency intended the term to have the same meaning as ''unforeseen operational circumstances.'' This term does not differ significantly from the current application of ''beyond the control of the certificate holder'' in § 121.471(g) except that in the NPRM the FAA is clear that even if a situation is beyond the certificate holder's control, it may not extend beyond the general limits if the circumstances were reasonably foreseeable.

The commenter said that it disagrees with the FAA's clarification because there is a major difference between the proposed definition and the current authorization in section 121.471(g). Alaska Airlines stated that the proposed definition was extremely vague because it did not definitively state whether situations such as bad weather would always constitute unforeseen circumstances.

UPS expressed concern that the definition is not used consistently. It notes that in proposed §§ 117.15 and 117.19, the term ''unforeseen circumstance'' is used, but the related wording does not match what is used in the defined term. To address its concern, UPS suggested maintaining the current definition of ''beyond the control of the certificate holder.''

The FAA agrees with the above commenters that the proposed definition of ''unforeseen operational circumstances'' is unclear. To make the definition more definitive, ''beyond the control of the certificate holder'' was removed from the definition. As such, under the provisions of the final rule, an event constitutes an unforeseen operational circumstance as long as it was unplanned and long enough in duration that the issues associated with that event could not be resolved through minor schedule adjustments. The ''beyond the control of the certificate holder'' safeguard was moved into the reporting requirement for various FDP extensions where it is easier to understand, and it is discussed in more detail in the pertinent portions of this preamble.

Atlas, World Airways, NAA, and NACA said that while the FAA's definition works well for scheduled service, it does not work for nonscheduled service. These commenters noted that nonscheduled service includes significant unforeseen circumstances where customers determine departure airports, arrival airports, and departure times. They also included instances where ground service providers typically give low priority to low frequency ad hoc or non-scheduled operations even though service contracts are assured before aircraft arrival. NAA and NACA added that the proposed definition also does not include other operational irregularities like Minimum Equipment List issues.

To address their concerns, Atlas, World Airways, NAA, and NACA recommended the following revised definition: ''Unforeseen operational circumstance means an unplanned event beyond the control of a certificate holder of insufficient duration to allow for adjustments to schedules, including, but not limited to, un-forecast weather, equipment malfunction, or air traffic delay, charter customers' failure to present passengers and/or cargo at the scheduled time and place; and ground service providers that fail to provide services at the scheduled time.''

In response to the concerns expressed above, the FAA emphasizes that the examples provided in the definition of ''unforeseen operational circumstances'' are not intended to be exclusive. As discussed in the preceding response, an event constitutes an unforeseen operational circumstance as long as it was unplanned and long enough that the issues associated with that event could not be resolved through minor schedule adjustments. This definition includes unplanned events that are specific to supplemental operations.

Alaska Airlines stated that the impact of all weather is unforeseeable, and the duration is always unknown and beyond the control of the certificate holder. It also stated that while many weather events are foreseeable, all are beyond the carriers' control. The commenter suggested eliminating the phrase ''insufficient duration to allow for adjustments to schedules,'' and revising the definition as follows: ''Unforeseen operational circumstance means an event beyond the control of a certificate holder, including unforecast weather, equipment malfunction, or air traffic delay.''

In response to Alaska Airlines, the FAA notes that the phrase ''insufficient duration to allow for adjustments to schedules'' is intended to exclude unplanned events of relatively short duration. For example, the FAA would not consider a five-minute air traffic delay as an unforeseen operational circumstance that justifies the need for a two-hour FDP extension. Because relatively short unplanned events should not be used as a basis for extending an FDP, the FAA has decided to retain ''insufficient duration to allow for adjustments to schedules'' in the definition of unforeseen operational circumstances.

33. Window of Circadian Low

The NPRM defined window of circadian low as a period of maximum sleepiness that occurs between 0200 and 0559 during a physiological night. The FAA did not receive any comments with regard to this definition, and as such, this rule adopts the proposed definition.

C. Fitness for Duty

The goal of proposed section 117.5 was to address situations in which a flightcrew member complies with the other provisions of this proposal, but still shows up for an FDP too fatigued to safely perform his or her assigned flight duties. The proposed section 117.5 would have made fatigue mitigation the ''joint responsibility of the certificate holder and the flightcrew member.'' 75 FR 5587. This section sought to discourage certificate holders from pushing the envelope with fatigue-inducing practices such as ''scheduling right up to the maximum duty limits, assigning flightcrew members who have reached their flight time limits additional flight duties under part 91, and exceeding the maximum flight and duty limits by claiming reasonably foreseeable circumstances are beyond their control.'' *Id.* The proposed section 117.5 also sought to discourage flightcrew-member practices such as ''pick[ing] up extra hours, moonlight[ing], report[ing] to work when sick, commut[ing] irresponsibly, or simply not tak[ing] advantage of the required rest periods.'' *Id.*

To discourage the above practices, the proposed section 117.5 contained a number of restrictions. First, this section would have prohibited flightcrew members from accepting an assignment that would consist of an FDP if they were too tired to fly safely. Second, this section would have prohibited flightcrew members from continuing subsequent flight segments if they were too fatigued to fly safely. Third, the proposed section would have required the certificate holder to assess a flightcrew member's state when he or she reported for work, and, if the flightcrew member was showing signs of fatigue, this section prohibited the certificate holder from allowing that flightcrew member to fly. Fourth, this section would have required flightcrew members to report to management about other flightcrew members who they believed were too tired to fly, and in those instances, it required management to perform an evaluation to determine whether the flightcrew member in question was indeed too tired to fly safely. Fifth, this section would have required certificate holders to develop and implement an internal evaluation and audit program to monitor whether flightcrew members were reporting to work fatigued.

The FAA received numerous comments regarding the proposed section 117.5. For the sake of clarity, the FAA will analyze the substantive issues raised by the comments as those issues pertain to each of the proposed provisions of 117.5.

Proposed § 117.5(a)

Each flightcrew member must report for any flight duty period rested and prepared to perform his or her assigned duties.

Two commenters stressed the importance of pilots being fit for duty. IPA, ALPA, Flight Time ARC, and one other commenter supported the proposed provision, and emphasized that this provision does not create a policing environment in which certificate holders track or monitor flightcrew members' off-duty activities. Fifteen pilots requested the removal of the above provision, arguing that this provision unfairly places the burden of showing up fit for duty solely on the flightcrew member. Multiple commenters also emphasized that tracking fitness for duty must be the joint responsibility of the certificate holder and the flightcrew member.

Several commenters included suggestions and requests for clarification. NJASAP sought clarification regarding the repercussions of a flightcrew member reporting for duty without being properly rested. NAA and UPS recommended including the statement that flightcrew members need to be prepared to work ''up to the prescribed FDP limits in Tables B or C'' when they begin an FDP.

Section 117.5(a) does not place the burden of showing up fit for duty solely on the flightcrew member. Section 117.5(a), in conjunction with the other provisions of this rule, places a joint responsibility on the certificate holder and each flightcrew member. In order for the flightcrew member to report for an FDP properly rested as required by this section, the certificate holder must provide the flightcrew member with a meaningful rest opportunity that will allow the flightcrew member to get the proper amount of sleep. Likewise, the flightcrew member bears the responsibility of actually sleeping during the rest opportunity provided by the certificate holder instead of using that time to do other things. The consequences of a flightcrew member reporting for duty without being properly rested are addressed by subsections (b) and/or (c) of this section, which prohibit the flightcrew member from beginning or continuing an FDP until he or she is properly rested.

Turning to NAA and UPS' suggestion, the FAA has declined to add the proposed language to subsection 117.5(a). The adopted language of subsection 117.5(a) requires each flightcrew member to report for an FDP ''rested and prepared to perform his or her assigned duties.'' These assigned duties will not always extend to the outer limits prescribed in tables B and C of this rule. Indeed, a certificate holder will find it difficult to comply with the cumulative limits specified in section 117.23 if it always assigns duties at the outer limits of tables B and C. Therefore, the text of this subsection reflects the fact that a flightcrew member needs to be rested and prepared to safely perform the duties that are actually assigned to him or her.

Proposed § 117.5(b)

No certificate holder may assign and no flightcrew member may accept assignment to a flight duty period if the flightcrew member has reported for a flight duty period too fatigued to safely perform his or her assigned duties or if the certificate holder believes that the flightcrew member is too fatigued to safely perform his or her assigned duties.

Peninsula Airways, Pinnacle Airlines, and Southern Air stated that the flightcrew is the best source of determining fatigue, and as such, an air carrier should not be responsible for monitoring fatigue symptoms and assessing fatigue. ATA, CAA, NACA, and a number of other commenters stated that the proposed subsection would be impossible to implement because it places the burden of determining flightcrew member fatigue on air carriers without providing the air carriers with an objective scientific standard for measuring fatigue. ATA and Delta added that when a flightcrew member reports for duty at the beginning of an FDP, it is impossible for an airline to determine whether that flightcrew member will be fatigued toward the end of the FDP.

The NTSB supported enabling flightcrew members to self-report fatigue. NJASAP and Boeing stated that flightcrew members cannot subjectively self-assess whether they are too fatigued to safely carry out their assigned FDPs. NJASAP based its assertion on NASA fatigue research showing that when a person is fatigued, he or she suffers from impaired judgment, and may lack the ability to self-assess his or her level of alertness. Boeing asked the FAA to include non-subjective factors in the fatigue determination requirement, such as time of day and the amount of sleep received in a 24-hour period. Alaska Airlines asked that the phrase ''too fatigued'' be defined more clearly. Boeing was also concerned about flightcrew members who self-assess at the beginning of an FDP improperly assessing their competency to actually complete the FDP.

CAPA, SWAPA, and APA recommended that the FAA add a non-retaliation provision to the proposed subsection in order to prevent disciplinary action against flightcrew members who self-report fatigue. One commenter stated that fatigue reporting should be voluntary. Two commenters argued that the entire crew should be assessed to determine fitness for duty.

The FAA agrees with the commenters who stated that at this time sleep science cannot support a general regulatory standard under which air carriers would be required to monitor the exact level of flightcrew member fatigue. As these commenters correctly pointed out, there does not currently exist an objective standard for determining fatigue levels. As such, requiring air carriers to suspend flightcrew members who they ''believe'' are too fatigued would create a vague and difficult-to-apply regulatory standard. To address this concern, the FAA has eliminated the following provision from the proposed subsection: ''or if the certificate holder believes that the flightcrew member is too fatigued to safely perform his or her assigned duties.'' The remaining language in this subsection places a limited burden on the certificate holder—it prohibits the certificate holder from assigning an FDP to a flightcrew member who has informed the certificate holder that he or she is too fatigued to safely perform his or her assigned duties.

The discussion in the preceding paragraph should not be construed to imply that air carriers cannot identify flightcrew member fatigue. As the proposed AC 120–FIT (finalized as AC 117–3) pointed out, there are objective signs that could be used to identify flightcrew member fatigue. The FAA has simply chosen not to impose a mandatory regulatory requirement because the signs used to identify fatigue cannot be synthesized into a general objective standard. However, the FAA encourages air carriers to voluntarily evaluate flightcrew members who are showing signs of fatigue.

NJASAP and Boeing's concerns about the subjective nature of flightcrew member self-assessment and self-reporting are mitigated by the fact that, pursuant to statutorily-mandated Fatigue Risk Management Plans (FRMP), flightcrew members will undergo fatigue education and training. The information that the flightcrew members learn during this training will increase each flightcrew member's ability to self-assess his or her fatigue levels.

In response to the comment that fatigue reporting should be made voluntary, the FAA has decided to make fatigue reporting mandatory because allowing a flightcrew member to accept an assignment to an FDP when that flightcrew member knows that he or she is too tired to fly safely poses an unacceptable safety risk. However, the FAA cannot, at this time, impose an objective requirement on self-reporting fatigue because, as the other commenters pointed out, there is no objective science-based standard that could be used to measure fatigue levels. The FAA also cannot further define the phrase ''too fatigued'' because defining this phrase requires the creation of an objective fatigue-measurement standard, which does not exist at this time. Instead of creating a single objective fatigue-measurement standard, the above subsection requires each flightcrew member to utilize the information provided during his or her statutorily-mandated fatigue training to self-assess whether he or she feels well-rested enough to safely complete his or her assigned FDP. The FAA also emphasizes that flightcrew members who feel alert at the beginning of an FDP can immediately terminate the FDP, under subsection (c) of section 117.5, if they feel themselves becoming too fatigued to safely continue their assigned duties.

The FAA also considered the possibility of adding a non-retaliation provision to the above text, but ultimately decided against adding such a provision. As the NPRM pointed out, ''[c]arriers are entitled to investigate the causes for an employee's fatigue.'' 75 FR 55858. ''If a carrier determines that the flightcrew member was responsible for becoming fatigued, it has every right to take steps to address that behavior.'' *Id.* However, if the flightcrew member's fatigue is a result of the carrier not following the regulatory requirements of this rule, the FAA may initiate enforcement action against the carrier.

Turning to concerns about fatigue affecting other air carrier employees, as discussed in the NPRM, the FAA ''has decided to take incremental steps in addressing fatigue.'' 75 FR 55857. In accordance with this decision, the NPRM proposed a flight, duty, and rest rule that was only applicable to flightcrew members. Because the proposed rule was not applicable to other flight crewmembers, such as flight attendants, expanding the rule to those flight crewmembers at this point in time would exceed the scope of this rulemaking. However, the FAA emphasizes that its incremental approach contemplates ''future rulemaking initiatives [that] may address fatigue concerns related to flight attendants, maintenance personnel, and dispatchers.'' *Id.*

Proposed § 117.5(c)

No certificate holder may permit a flightcrew member to continue a flight duty period if the flightcrew member has reported himself too fatigued to continue the assigned flight duty period.

The FAA did not receive any comments that were specific to this subsection. To the extent any of the comments discussed in the preceding subsection are applicable to this subsection, the FAA's response to those comments can be found above.

Proposed § 117.5(d)

Any person who suspects a flightcrew member of being too fatigued to perform his or her duties during flight must immediately report that information to the certificate holder.

ATA, NACA, Delta, Alaska Airlines, and UPS stated that requiring persons to report other people who they believe to be fatigued could result in persons with no training or with ill will making erroneous reports. Multiple commenters emphasized that there is no objective scientific standard to guide personnel about when they need to make a report about another flightcrew member's fatigue. ATA stated that the proposed subsection will shift liability to airlines and impose significant costs in the form of training and retraining tens of thousands of employees.

The FAA agrees with the commenters who stated that, because there is no objective scientific standard to guide personnel about when they need to report other flightcrew members' fatigue, having a mandatory reporting requirement could lead to a multitude of erroneous reports. To address this concern, the FAA has eliminated the above subsection from the final rule. However, even though the FAA has decided not to impose a mandatory reporting requirement, each flightcrew member and covered employee is encouraged to voluntarily inform their employer when they observe a fatigued flightcrew member.

Proposed § 117.5(e)

Once notified of possible flightcrew member fatigue, the certificate holder must evaluate the flightcrew member for fitness for duty. The evaluation must be conducted by a person trained in accordance with § 117.11 and must be completed before the flightcrew member begins or continues an FDP.

Numerous commenters stated that there is no objective scientific standard under which a certificate holder could evaluate a flightcrew member's fitness for duty. The commenters also emphasized that the proposed subsection would create difficulties at remote airports where the certificate holder lacks personnel qualified to conduct a fitness-for-duty evaluation.

The FAA agrees with the commenters that there is no objective scientific standard that an air carrier could use to evaluate a flightcrew member's continued fitness for duty. Accordingly, the FAA has eliminated the above subsection from the final rule.

Proposed § 117.5(f)

As part of the dispatch or flight release, as applicable, each flightcrew member must affirmatively state he or she is fit for duty prior to commencing flight.

RAA stated that there was no benefit to requiring each flightcrew member to sign a document stating that he or she is fit for duty. Instead, RAA suggested that the PIC sign the fitness for duty affirmation on behalf of the entire crew. NJASAP asked (1) how the flightcrew members would affirm fitness for duty via the flight release, and (2) whether this requirement would apply to each flight segment.

As the FAA and other commenters pointed out elsewhere, there is no objective scientific test that the PIC could use to measure the fatigue levels of other flightcrew members. Because the PIC has no way to objectively measure other flightcrew members' fatigue, the FAA has determined that each flightcrew member should be required to monitor his or her own fatigue level. As such, each flightcrew member must either make a written affirmation that he/she is fit for duty or terminate the assigned FDP pursuant to subsection 117.5(c).

The requirement that flightcrew members make a written affirmation about their continued fitness for duty applies to each flight segment of the assigned FDP. This is because a flightcrew member who is alert at the beginning of an FDP may become dangerously fatigued once the FDP is underway. Requiring a written fitness for duty affirmation before each flight segment will help ensure that flightcrew members continuously monitor their fatigue levels during the course of an FDP. If, during the course of this monitoring, flightcrew members determine that they cannot safely continue their assigned duties, section 117.5(c) would require them to terminate their assigned FDP prior to the beginning of the next flight segment.

The affirmation on the dispatch or flight release simply needs to state that the undersigned flightcrew members affirm that they are fit for duty. The dispatch or flight release containing the affirmation must be signed by each flightcrew member. This requirement applies to each flight segment and each air carrier should inform its flightcrew members about the significance of signing a fitness-for-duty affirmation.

Proposed § 117.5(g)

Each certificate holder must develop and implement an internal evaluation and audit program approved by the Administrator that will monitor whether flightcrew members are reporting for FDPs fit for duty and correct any deficiencies.

Alaska Airlines stated that the audit requirement is duplicative of the current FRMP process. Delta added that the audit requirement is unclear about how a carrier is supposed to monitor which flightcrew members are showing up fit for duty. ATA asserted that the evaluation and audit requirement is unworkable and impossible to implement because there are no objective scientific standards that a certificate holder could apply to ''monitor'' which flightcrew members are reporting for an FDP fit for duty. ATA added that the proposed subsection is unclear about what constitutes a ''deficiency'' and how a certificate holder is supposed to correct a ''deficiency.''

The FAA agrees with Delta and ATA that the proposed subsection does not provide a workable standard for the internal evaluation and audit program. Therefore, the FAA has removed the above subsection from the final rule.

D. Fatigue Education and Training

As part of the NPRM, the FAA proposed a fatigue education and training program. Studies have shown that fatigue degrades all aspects of human performance and impedes the exercise of sound judgment.[21] Studies have also shown that, depending on the operating environment, it can be difficult for an individual to recognize that he or she is fatigued and that his or her judgment may be compromised.[22] Given the impact that fatigue has on the performance of flight-related duties, the FAA was concerned that the existing regulatory structure did not properly educate air carrier personnel about fatigue and its impact flight safety.[23]

In order to raise awareness of fatigue-related issues and provide training on fatigue mitigation strategies, the FAA proposed that certain air carrier personnel be required to undergo a fatigue education and training program. First, the proposed fatigue education and training provisions would have required fatigue education and training for each person involved with scheduling aircraft and crews, as well as all flightcrew members and individuals who conduct management oversight over covered personnel. Second, the proposed section would have required an initial 5-hour-long training session for all newly-hired covered employees and a 2-hour-long annual recurrent training session for all other covered employees. Third, this section set out a training curriculum that would have informed covered personnel about fatigue and fatigue countermeasures. Fourth, the proposed fatigue education and training section would have required certificate holders to make changes to their fatigue education and training programs after being notified of the need to do so by the Administrator.

Alaska Airlines suggested that the FAA eliminate the proposed fatigue education and training section and instead rely on the FRMP to provide the necessary fatigue-related information to airline personnel. The FAA agrees with Alaska Airlines that the fatigue education and training program proposed in the NPRM was unnecessarily cumulative.

Part 121 air carriers are currently statutorily-required to annually provide, as part of their FRMP, fatigue-related education and training to increase the trainees' awareness of: (1) Fatigue; (2) ''the effects of fatigue on pilots;'' and (3) ''fatigue countermeasures.'' *See* Public Law 111–216 sec. 212(b)(2)(B). Today's rule adopts the same standard of training as required by the statute. In addition, today's rule adopts a mandatory update of the carriers' education and training program every two years, as part of the update to their FRMP. See Public Law 111–216 sec. 212(b)(4)(A) and (B). Both of these regulatory provisions merely place the existing statutory requirements in the new flight and duty regulations for the ease and convenience of the regulated parties and the FAA.

The statute does not limit the required training to flightcrew members; however, the FRMPs developed by carriers and accepted by the FAA have generally been so limited. Today's rule would require an expansion of the training portion of the FRMPs to all employees responsible for administering the provisions of the new rule, including flightcrew members, dispatchers, individuals directly involved in the scheduling of flightcrew members, individuals directly involved in operational control, and any employee providing direct management oversight of those areas.[24] As discussed below, the FAA continues to believe that personnel responsible for crew scheduling and who play a role in assuring the carrier has operational control need to understand the causes of fatigue as well as the risk that pilot fatigue poses to safe operations.

In response to comments from ATA, Atlas Air and NAA, among others, the FAA has amended the regulatory text to clarify that the fatigue education and training requirement only applies to individuals who are directly involved in flightcrew scheduling and/or operational control and their direct supervisors. The reason for designating such a broad category of covered personnel is to ensure that each individual who has the power to alter a flightcrew member's schedule and/or change the manner in which operational control is exercised is fully aware of how his or her actions will affect flightcrew fatigue and flight safety. Direct management personnel were ultimately included in this category because a manager could order his or her immediate subordinate(s) to change flightcrew member schedules and/or change the manner in which operational control is exercised.

The FAA has decided not to limit the scope of covered personnel to specific enumerated positions because air carriers may employ individuals who exercise significant control over flightcrew scheduling and/or operational control while not occupying one of the positions commonly associated with this type of authority. To ensure that these individuals receive the appropriate fatigue-related education and training, the FAA has retained the requirement that all individuals directly involved in flightcrew scheduling and/or operational control, as well as their direct supervisors, receive the training required under this section.

In response to a question by ATA and Alaska Airlines about whether an air carrier's CEO would be required to undergo fatigue education and training, that CEO would have to undergo fatigue education and training only if he or she is either (1) directly involved in scheduling flightcrew members/exercising operational control, or (2) directly manages someone who is directly involved in scheduling flightcrew members/exercising operational control. Business decisions made by the CEO that only indirectly affect flightcrew scheduling/operational control would not trigger the fatigue education and training requirements of this section.

Alaska Airlines and Delta asserted that they already have fatigue education and training programs. Alaska Airlines asked whether the proposed education and training requirements are

[21] *See, e.g.,* NASA, *Crew Factors in Flight Operations X: Alertness Management in Flight Operations,* at 16 (Apr. 1999), http://human-factors.arc.nasa.gov/zteam/PDF_pubs/ETM.TM8_99rev.pdf (''Sleepiness can degrade essentially every aspect of human performance'').

[22] The NASA fatigue report stated that:

The level of underlying physiological sleepiness can be concealed by an environment in which an individual is physically active, has consumed caffeine, or is engaged in a lively conversation. Whereas these factors may affect the self-reported rating of sleepiness (usually individuals will report greater alertness than is warranted), they do not affect the underlying sleep need expressed by the level of physiological sleepiness.

Id. at 17.

[23] The National Institute for Occupational Safety and Health (NIOSH) provides one example of the unacceptable effects that the current lack of fatigue education has on flight safety. In its comment, NIOSH points out that ''[i]n a survey of pilots working for large operators in Alaska, 22% responded that they made a decision to fly fatigued either weekly or monthly.'' NIOSH Comments to DOT at 2.

[24] Because the statute requires FRMPs to be updated every two years, the FAA anticipates that carriers will simply expand the group of employees subject to training in their next update, scheduled for the summer of 2013.

cumulative with regard to the existing Advanced Qualification Program (AQP).[25] UPS suggested that the FAA rely on the AQP and FRMS to provide fatigue-related information to airline personnel.

Delta requested that it be permitted to include material from its existing training program in the program now required by this section and that it be given credit for the training that its employees have already received. ATA and Alaska Airlines asked whether, in the case of an employee that changes employers, training received from a prior employer would count towards the requirements of this section. These commenters asserted that because the proposed training subject areas are generic and untethered to a specific airline's operations, fatigue training from a prior employer should count toward fulfilling the requirements of this section.

The FAA has determined that the problem with simply relying on AQP and FRMS to carry out the goals of the proposed fatigue education and training section is that both AQP and FRMS are programs that have been designed as alternatives to general requirements imposed on part 121 certificate holders. An air carrier can opt into an AQP program as an alternative to general training requirements that it would otherwise be subject to. *See* 14 CFR 121.901(a). Likewise, under section 117.7(a) of this rule, an air carrier can opt into an FRMS program as an alternative to some of the restrictions imposed by this rule. If the FAA was to rely on AQP and FRMS to take the place of the proposed fatigue education and training section, it would have to change AQP and FRMS to make them mandatory non-alternative programs in order to ensure that air carriers who currently choose not to participate in these programs have properly-trained personnel. This would destroy the alternative nature that is at the core of these programs, and as such, the FAA has decided against this approach.

It should be emphasized, however, that air carriers that had fatigue education and training programs prior to development of their FRMP did not necessarily need to design a new separate program to accommodate the statutory requirement for training and may not need to do so in order to provide education and training to all personnel covered by today's rule. Instead, these carriers may have simply supplemented their existing programs to meet the additional requirements imposed by the statute. For example, an existing fatigue education and training program that was offered as part of an air carrier's AQP could have been amended so that it also met the requirements for an FRMP. That program would then satisfy the statute and the requirement adopted today, as well as the air carrier's AQP-related fatigue education and training obligations.

The FAA agrees with ATA and Alaska Airlines that, when changing employers, covered personnel do not need to repeat non-operation-specific fatigue training that they received from their previous employer if that training meets the requirements of this section.

RAA objected to the proposed method of Administrator-required revisions to the fatigue education and training program. RAA argued that the proposed language ''would open the door for changes directed at an airline's fatigue training program from any number of individuals in [FAA] field offices, without standardization and coordination among those directives and at the risk of creating confusion in the important fatigue risk mitigation programs, messages and strategies that are sought though this regulation.'' RAA suggested that the FAA update fatigue education and training programs by either: (1) Initiating a new rulemaking each time that the programs need to be updated, or (2) using its OpSpec authority under 14 CFR 119.51 to require changes to the fatigue education and training programs.

Since the regulatory requirements adopted today will be administered through the carrier's FRMP, the FAA has adopted the same language as the statute, to wit, the education and training programs must be updated every two years and the FAA will either approve or reject the updates within 12 months of submission. If an update is rejected, the FAA will provide suggested modifications for resubmission of the update.

RAA asked that this section be renamed ''Fatigue Training Program'' because the word ''education'' does not have a well-understood regulatory meaning. NJASAP asked whether distance learning would be permitted to satisfy the fatigue education and training requirements or whether the training must be conducted in person. With regard to NJASAP's question about distance learning, this section does not prohibit distance learning.

The FAA has also decided to retain the word ''education'' in the name of this program. The Merriam-Webster Dictionary defines ''educate'' as: (1) To train by formal instruction and supervised practice, or (2) to provide with information. Because covered personnel will receive formal instruction and be provided with information, the term ''education'' aptly describes the program that is required by this section. To further clarify the goals of this program, the FAA has amended the program's name to the ''Fatigue Education and Awareness Training Program.''

E. Fatigue Risk Management System

The FAA proposed a Fatigue Risk Management System (FRMS) as an alternative regulatory approach to provide a means of monitoring and mitigating fatigue. Under an FRMS, a certificate holder develops processes that manage and mitigate fatigue and meet an equivalent level of safety.

Under proposed § 117.7, an FAA-approved FRMS would include: (1) A fatigue risk management policy; (2) an education and awareness training program; (3) a fatigue reporting system; (4) a system for monitoring flightcrew fatigue; (5) an incident reporting process; and (6) a performance evaluation. In addition, if the Administrator determines that revisions were necessary to a carrier's FRMS, the certificate holder must make the requested changes upon notification.

Most commenters generally supported the concept of an FRMS as a way to manage fatigue and incorporate risk mitigation. Commenters questioned the scope and implementation of FRMS, and whether FRMS is a mature process that can be used effectively. There were few commenters, including Southern Air, who flatly disagreed that the FRMS would be effective.

Commenters were split between two approaches: those who endorsed the concept of FRMS as an alternative approach to the regulatory provisions adopted in this rule; and those who argued that FRMS should not permit certificate holders to deviate from the prescriptive measures, but rather supplement the regulatory requirements.

ATA contended that the FAA should wait for ICAO and international standards because the ambiguities presented in the proposal, as well as possible certificate holder reliance on future FAA determinations, could

[25] AQP is a systematic methodology for developing the content of training programs for air carrier flightcrew members and dispatchers. It replaces programmed hours with proficiency-based training and evaluation derived from a detailed job task analysis that includes crew resource management. The AQP provides an alternate method of qualifying and certifying, if required, pilots, flight engineers, flight attendants, aircraft dispatchers, instructors, evaluators, and other operations personnel subject to the training and evaluation requirements of 14 CFR parts 121 and 135.

competitively disadvantage U.S. carriers. Furthermore, ATA commented that the timing and approval of an FRMS is critical as operators that want to use an FRMS should be able to do so immediately once these rules are in place. UPS argued that the FRMS approval process must be available for least 12 months prior to the implementation of any final rule so that carriers can transition to an FRMS on the day that the requirements are effective. Lynden Air Cargo (Lynden) believed that the FRMP and FRMS processes are redundant and sought further explanation on the necessity of the two processes.

ALPA, IPA, FedEx ALPA, APA, SWAPA and the Flight Time ARC specifically stated that the FRMS needs to be an equal partnership that includes the FAA, the certificate holder, and the pilot body. APA further commented that successful safety programs such as Aviation Safety Action Program (ASAP)[26] and the Flight Operational Quality Assurance (FOQA)[27] are based on a three-way partnership and that FRMS should be treated the same way. ATA, however, argued for a collaborative approach, similar to that of an AQP as a relationship between the carrier and FAA with no other parties involved. The Flight Time ARC argued that pilot representatives must have the right to suspend or terminate participation in the FRMS if they determine that the program's safety purpose is not being met. Multiple entities commented that the FRMS should provide for an open reporting system and non-punitive environment.

A number of commenters questioned the process by which an FRMS is to be amended and which FAA office would provide this oversight. ATA commented that the process of the FRMS should be centrally located at the headquarters level, to provide a uniform approval scheme. RAA, however, interpreted the proposed language as enabling FAA field offices to require certificate holders to makes changes to their FRMS, which creates standardization and coordination problems and possibly confusion. NACA commented that industry must have a clear understanding of the parameters and implementation of FRMS so that competitive advantages cannot be gamed through differing interpretations and implementation of FRMS.

Some commenters, including RAA, believed that the approval of FRMS programs can best be accomplished via the same Operations Specifications authority that was established for each airline's recently filed FRMP under § 119.51. Additionally, RAA stated that generally the process for incorporating new science or advances regarding a program such as FRMS is through Advisory Circular process, where it can be presented as a new best practice. RAA further stated that if the FAA finds that future FRMS changes cannot be accommodated through the Advisory Circular process, then the agency should undertake appropriate rulemaking action and not simply skip the rulemaking process. ATA commented that the proposed regulatory text and draft AC120–103 do not provide the criteria used to approve a submitted FRMS.

APA and ALPA argued that FRMS should be limited to specific certificate holders' data and scheduled city pairs or substantially similar city pairs in terms of FDP length, start time and block, which must be scientifically and operationally validated by all stakeholders. ATA commented that in the NPRM, the FAA appears to suggest that FRMS will disfavor a system-wide approach.

Some commenters sought stronger regulatory text describing the FRMS as active, data-driven and scientifically based.

In response to the above comments, the FAA notes that, as stated in the NPRM, the option of an FRMS provides flexibility for certificate holders to conduct operations using a process that has been approved by the FAA based upon an equivalent level of safety for monitoring and mitigating fatigue for certain identified operations. A certificate holder may decide to use FRMS as a supplement to the requirements adopted in the rule, or it may use the FRMS to meet certain elements of this rule for which the adopted regulatory standard is not optimal.

The FAA has decided to adopt subsections (a) and (b) of the regulatory text as proposed. Subsection (a) provides for a certificate holder to use an approved FRMS as an alternative means of compliance with the flight duty regulations provided that the FRMS provides at least an equivalent level of protection against fatigue-related accidents or incidents. Subsection (b) specifies the components of an FMRS.

The FAA has also decided to extend the voluntary FRMS program to all-cargo operations, which are not required to operate under part 117. Under the FRMS provisions that this rule adds to subparts Q, R, and S of part 121, an all-cargo operator that does not wish to operate under part 117 can nevertheless utilize an FRMS as long as it has the pertinent FAA approval.

The implementing guidance in AC 120–103 details each component, the minimum necessary tools for a complete and effective FRMS, the steps in the FRMS process and the roles and responsibilities of all the participants. An FRMS is a data-driven and scientifically based process that allows for continuous monitoring and management of safety risks associated with fatigue-related error. See AC 120–103 at p.3. Furthermore, an FRMS is an effective mitigation strategy when the organization bases it on valid scientific principles. *Id.*

ICAO requires member states to implement some alternative means of compliance with existing rules and has recently issued Standards and Recommended Practices (SARPs) (effective December 15, 2011) that authorize the use of FRMS. In addition, ICAO, IATA and the International Federation of Air Line Pilots' Association (IFALPA) jointly issued the *Implementation Guide for Operators, 1st Edition,* in July, 2011 to provide carriers with information on implementing an FRMS that is consistent with the ICAO SARPs. The FAA concludes that incorporating an FRMS element is critical to implementing a comprehensive regulatory schedule addressing fatigue. Therefore, this rule incorporates the ability of a certificate holder to use an FRMS. The provisions adopted in this rule are consistent with the ICAO standards and AC 120–103 provides a means by which the operator may comply with these provisions.

The FAA agrees that certificate holders should be able to use an approved FRMS on the effective date of these regulations. The FAA understands that this rule may impact collective bargaining agreements and that time is needed for those changes to be adopted and for certificate holders to submit and receive approval for an FRMS.

[26] The objective of the ASAP is to encourage air carriers and repair station employees to voluntarily report safety information that may be critical to identifying potential precursors to accidents. Under an ASAP, safety issues are resolved though corrective action rather than through punishment or discipline. The ASAP provides for the collection, analysis, and retention of the safety data that is obtained. An ASAP is based on a safety partnership that will include the FAA and the certificate holder, and may include a third party, such as the employee's labor organization.

[27] FOQA is a voluntary safety program that is designed to make commercial aviation safer by allowing commercial airlines and pilots to share de-identified aggregate information with the FAA so that the FAA can monitor national trends in aircraft operations and target its resources to address operational risk issues. The fundamental objective of this new FAA/pilot/carrier partnership is to allow all three parties to identify and reduce or eliminate safety risks, as well as minimize deviations from the regulations.

Therefore, the effective date of this rule is two years after publication date. This should allow adequate time for certificate holders to take the necessary steps prior to the effective date.

The FAA indicated in the NPRM that it anticipates that all the FRMS proposals would be evaluated and approved at headquarters by individuals within Air Transportation Division, Flight Standards Service (AFS–200), who are dedicated to ensuring the continued quality of FRMS. The FAA has determined that the above course of action remains the best process to ensure consistency in the approval process.

The process of evaluating FRMS proposals will generally proceed as follows. The certificate holder will request a meeting with AFS–200 to express its interest in pursuing an FRMS authorization. During this meeting, the certificate holder will outline its plans for an FRMS. AFS–200 will then review the certificate holder's plans for an FRMS. Based upon the requirements for data collection identified by the certificate holder, the certificate holder, working in concert with AFS–200, will identify the applicable limitations from which the certificate holder may need a limited exemption for the sole purpose of data collection.

Once the certificate holder has petitioned for this exemption, AFS–200 will review the petition providing an analysis and developing applicable limitations and conditions for the exemption based upon the certificate holder's data collection plan. If AFS–200 grants the requested exemption, the resulting exemption will be limited in duration and scope for the purpose of the necessary data collection. Once the data has been collected, the data will be submitted to AFS–200 for data validation and evaluation of FRMS policies and procedures and FRMS training requirements. The FAA will publish guidance for review and approval of an FRMS authorization.

A successful FRMS will require a shared responsibility among management and the flightcrew members. In particular, developing mitigation strategies and schedule adjustments is going to be the result of a collaborative management process that includes all the stakeholders. In FAA Advisory Circular No. 120–103 Fatigue Risk Management Systems for Aviation Safety, the FAA identified four basic tools for a complete, workable, effective, and accountable FRMS: (1) Fatigue-related data; (2) fatigue analysis methods; (3) identification and management of fatigue drivers; and (4) application of fatigue mitigation procedures. As flightcrew member input is critical to implementing these tools, the FAA finds that the FRMS philosophy is consistent with the approach of the identified voluntary programs, such as ASAP and FOQA and requires participation by more than just the FAA and the certificate holder.

The FAA does not agree with the Flight Time ARC on imposing a requirement that the FRMS must be terminated or suspended if pilot representatives disagree with the program's purpose. This issue is beyond the scope of the NPRM and pilot representatives independently may raise their issues with the certificate holder.

In managing fatigue risk, the FAA has identified two types of operational evidence that are available to operators. (See AC No. 120–103, para (6)(1) and (2).) The first is monitoring flightcrew member duty schedules, which provides indirect evidence of potential fatigue resulting from inadequate or poorly timed opportunities to sleep. The second type of operational evidence is a non-punitive reporting system. Flightcrew members and other employees will be more encouraged to report subjective fatigue and to request relief from duties as necessary because of chronic fatigue. This reported information can be critical, in conjunction with other information about the conditions that contributed to fatigue, such as the work schedule for the week prior to the report.

The FAA agrees with the commenters and has deleted the proposed paragraph in § 117.7 that would have required a certificate holder to make necessary changes to its FRMS upon notification by the Administrator. Once approved by the FAA, an FRMS will be incorporated into the certificate holder's operations specifications and as contemplated in the NPRM, the FAA will use the process outlined in § 119.51 to amend operations specifications, if changes are necessary to a certificate holder's FRMS.

The FAA agrees with RAA that the use of advisory circulars is appropriate to incorporate new science or advances regarding fatigue as it relates to aviation operations. The regulations adopted in this rulemaking provide the baseline requirements for mitigating fatigue and instituting rest requirements. In the future, if the FAA concludes that the baseline regulations for flight and duty need to be revised, a rulemaking will be initiated. An approved FRMS can take advantage of the gains in science and experience, and if approved by the FAA, can permit certificate holders to exceed the baseline requirements.

The regulatory text provides the mechanism for a certificate holder to use an FRMS and the elements that must be addressed in the FRMS. The implementing guidance addresses how the certificate holder may proceed with documentation and scientific analyses to support its request to deviate from the standards adopted in this rule. The analyses and supporting documentation needed for approval are driven by how the certificate holder intends to use the FRMS and the elements of the flight and duty regulations that the FRMS is intended to supplement.

The FAA clarifies that a certificate holder may use an FRMS for any of the elements of the flight and duty requirements provided under this rule. While the FAA did state in its response to clarifying questions that ''validating an FRMS will be costly and likely to be used only on a 'route specific' basis,'' the agency was not attempting to discourage the use of an FRMS. The FAA encourages the use of an FRMS for certificate holders that can optimize their operations by doing so.

The FAA has updated its guidance in AC No. 120–103, Fatigue Risk Management Systems for Aviation Safety,[28] as a result of this rule. This AC is available at *www.faa.gov.* The FAA fully expects that as the program matures, certain carriers may apply the system to more than specific operations.

In accordance with Public Law 111–216, each part 121 air carrier had to submit to the FAA an FRMP. An FRMP is statutorily required for each part 121 air carrier; whereas, an FRMS is an optional approach to fatigue mitigation. The FRMP outlines the certificate holder's policies and procedures for managing and mitigating day-to-day fatigue from within a regulatory structure. This plan addresses the carrier's flightcrew members. The FRMP consists of three elements with respect to managing pilot fatigue: (1) Current flight time and duty period limitations; (2) a rest scheme that enables the management of fatigue and includes annual training to increase awareness of fatigue and fatigue countermeasures; and (3) the development and use of a methodology that continually assesses the effectiveness of the program.

While this plan is required under the statute, the simple adherence to this plan would not permit for any allowances by the certificate holder outside the adopted flight and duty regulations. An FRMS requires a process to apply to other individuals responsible for flightcrew fatigue other than pilots. As stated previously, there is a variety of positions held by individuals who are responsible for

[28] AC No. 120–103 was issued on August 3, 2010.

addressing fatigue other than pilots. The FRMS requires the process to include all applicable individuals. Furthermore, the FRMS is a means to permit a carrier to meet the requirements of this rule through an alternative measure. The FRMP does not contain adequate elements to allow the FAA to authorize operations or specific operations to be conducted outside the regulatory baseline requirements. Therefore, it is necessary to retain both the FRMS section and the FRMP requirement. These two processes, while sharing similar information, pose two distinct purposes.

F. Flight Duty Period—Unaugmented

One of the regulatory concepts that this rule introduces is the restriction on flightcrew members' maximum FDP. In creating a maximum FDP limit, the FAA attempted to address three concerns: (1) Flightcrew members' circadian rhythms, (2) the amount of time spent at work, and (3) the number of flight segments that a flightcrew member is scheduled to fly during his or her FDP.

First, flightcrew members' circadian rhythms needed to be addressed because studies have shown that flightcrew members who fly during their window of circadian low experience severe performance degradation.[29] Second, the amount of time spent at work needed to be taken into consideration because longer shifts increase fatigue.[30] Third, the number of flight segments in a duty period needed to be taken into account because flying more segments requires more takeoffs and landings, which are both the most task-intensive and the most safety-critical stages of flight. These takeoffs and landings require more time on task, and as pilots generally appear to agree, ''flying several legs during a single duty period could be more fatiguing.'' 75 FR 5858.

To address the concerns listed above, the FAA proposed a table limiting maximum FDP based on the time of day and the number of segments flown during the FDP period. This table was based on the conservative proposal articulated by the Flight Time ARC members representing labor, which in turn was based on the approach used by foreign flight, duty, and rest regulations such as United Kingdom Civil Aviation Authority Publication 371 (CAP–371) and European Aviation Safety Agency (EASA) Notice of Proposed Amendment No. 2009–02A. Under the FAA's proposal an FDP would begin when a flightcrew member is required to report for duty that includes a flight and would end when the aircraft is parked after the last flight and there is no plan for further aircraft movement by the same flightcrew member. Under the proposal, the maximum FDP limit would be reduced: (1) During nighttime hours to account for being awake during the WOCL; (2) when an FDP period consists of multiple flight segments in order to account for the additional time on task; and (3) if a flightcrew member is unacclimated to account for the fact that the unacclimated flightcrew member's circadian rhythm is not in sync with the theater in which he or she is operating.

In filed comments, Drs. Belenky and Graeber stated that ''there is no scientific basis'' for the different FDP limits assigned during different departure times. NACA and Atlas Air also stated that the different FDP limits are too complex and not based on science. Conversely, the National Institute of Occupational Safety and Health (NIOSH), Delta, APA, NJASAP, and three individual commenters endorsed the FAA's approach of varying FDP limits based on the time of day. In support, NIOSH pointed out that studies have shown that long night shifts significantly increase the risk of an accident, as compared to day shifts. Delta stated that its pilot working agreement has used a time-of-day-based approach ''to mitigate fatigue for many years.''

ATA, UPS, and Southwest Airlines also asserted that the reduction of the daily FDP limit to account for additional segments flown during the FDP is not supported by science or any other evidence. ATA argued that anecdotal evidence was not sufficient to support reducing the FDP limit in response to multiple flight segments assigned during the FDP. The SkyWest Airlines Pilot Association also stated that reducing FDP based on the number of flight segments disproportionately affected regional air carriers. Southwest stated that an FDP reduction based on the number of flight segments would also significantly raise the operational costs of its point-to-point business model.

Conversely, RAA stated that ''[i]t is also intuitive that there is likely correlation between the number of flight segments flown during an FDP and the level of fatigue that a flightcrew member will experience, although the exact science for that relationship remains under research.'' FedEx ALPA agreed, stating that ''[w]e also know that additional flight segments significantly increase fatigue and workload.'' APA's comment pointed to a number of scientific studies indicating that flying multiple segments is more fatiguing than flying a single segment. APA argued that Table B should reduce FDPs after the first segment instead of after the first 2–4 segments. The Families of Continental Connection Flight 3407,[31] as well as three individual commenters, also stated that flying additional flight segments, with the corresponding additional takeoffs and landings, adds to fatigue.

ATA, CAA, Capital Cargo, and UPS also argued that some of the limits set out in Table B are unreasonable and overly restrictive. These commenters asserted that the 9-hour limit is unscientific, and significantly lower than the 11-hour nighttime limit established by CAP–371 and EU Rules Subpart Q. UPS emphasized that the 9-hour FDP limit constitutes a 44% reduction from the current regulations. CAA also argued that the Campbell-Hill report indicates that regulation of FDPs under 15 hours is unnecessary because the FAA's regulatory impact analysis indicates that the rate of accidents begins to increase only after 15 hours on duty.

CAA submitted an alternative proposal in which nighttime FDPs are limited to 11 hours. Capital Cargo emphasized that, if this rule built in additional rest requirements, the longer FDPs in the CAA proposal could be implemented without decreasing safety. ATA added that the 9-hour limit for night operations is unreasonable because air carriers that regularly operate nighttime operations provide mitigation to their crews that would allow those crews to exceed the 9-hour limit. Grand Canyon Airlines argued that the 9-hour nighttime limit is unreasonable because flightcrew members who repeatedly fly at night will acclimate to working during their WOCL. SkyWest Airlines asked that the FAA increase the nighttime FDP limit to 14 hours to accommodate overnight continuous duty operations. SkyWest asserted that these types of operations are safe because ''most all [continuous duty operation] pairings provide at least 5 hours of sleep between the periods of 11:30 p.m.–4:30 a.m., spanning a 12–13-hour duty period.''

NIOSH, on the other hand, suggested that the FDP limit for night shifts be decreased to 8 hours. In support of its suggestion, NIOSH pointed out that, in general, studies have shown that ''[r]isk for worker errors and injuries are 15% higher for evening shifts and 28%

[29] *See, e.g.,* NASA, *supra* note 22, at 19–34.

[30] Folkard, *supra* note 15, at 98 (analyzing three studies that reported a trend in risk over successive hours on duty).

[31] Continental Connection Flight 3407 was operated by Colgan Air.

higher for night shifts, as compared to day shift[s].'' NIOSH also stated that ''[w]hen compared with 8-hour shifts, 10-hour shifts increased the risk by 13% and 12-hour shifts increased risk by 28%.'' NIOSH thus concluded that permitting night shifts consisting of long hours could result in risk ranging from 41% to 55%, as compared to 40-hour-week day shifts. NJASAP stated that ''it is prudent to keep the FDP at 9 hours or less when the FDP touches the [window of circadian low].''

A number of individual commenters wrote in suggesting maximum FDP limits ranging from 10 to 16 hours. Washington State University (WSU), at the behest of RAA, examined the parts of the FAA-proposed FDP limits that were different from the FDP limits proposed by the Flight Time ARC members representing industry. As part of its examination, WSU ran the different limits through its own unvalidated model, as well as the SAFTE model. Both the WSU and SAFTE models showed that, in the 0400–1759 timeframe, the FAA-proposed FDP limits were more restrictive than necessary as compared to the industry ARC members' proposed FDP limits. As a result of WSU's findings, RAA suggested: (1) That the Table B limits in the 0400 through 1059 timeframe be adjusted upward to reflect the industry ARC members' proposal, and (2) that the Table B limits for a 5-flight-segment FDP in the 1700 through 2159 timeframe be adjusted downward to reflect the industry ARC members' proposal. Continental also urged the FAA to adopt the industry ARC members' FDP-limit proposal.

In addition, ATA argued that the limits for the 0500–0559 and 0600–0659 blocks are unreasonable. ATA stated that these block times would involve flying mostly during daytime hours, and that they would involve flightcrew members who received most of their sleep during the window of circadian low. ATA emphasized that the costs associated with these limits cannot be justified in light of the fact that there is no scientific basis for the specific daily FDP limits proposed by the FAA.

Conversely, APA argued that the FDP limits for early morning and late evening duty periods should be reduced because flightcrew members on those FDPs will either (1) receive truncated window-of-circadian-low sleep, or (2) have been awake for an extended period of time. NJASAP added that the FDP limits proposed by labor ARC members promote a higher level of safety than the FDP limits proposed by industry ARC members.

In response to the above comments, the FAA finds that, as NIOSH correctly pointed out, studies have shown that human performance varies significantly depending on the time of day. Thus, for example, a NASA report on fatigue in flight operations found that ''75% of night workers experience sleepiness on every shift, and 20% report falling asleep.'' [32] To account for these time-of-day-based variations of human performance, Table B sets FDP limits that are higher for FDPs taking place during peak circadian times and lower for FDPs taking place during the WOCL.

Studies have also shown that after a person works for approximately eight or nine hours, the risk of an accident increases exponentially for each additional hour worked.[33] According to a series of studies that examined the national rate of accidents as a function of the amount of hours worked, the risk of an accident in the 12th hour of a work shift is ''more than double'' the risk of an accident in the 8th hour of a work shift.[34] To account for this data, the flight time limits in Table A restrict a flightcrew member's time on task to either 8 or 9 hours. Because Table A does not allow a flightcrew member's time on task to exceed 9 hours, the maximum FDP limits in Table B permit an FDP that is up to 14 hours, depending on the time of day.

Turning to the complex nature of the FDP limits, the reason for Table B's complexity is to avoid regulating to the lowest common denominator. As an alternative to the different FDP limits listed in Table B, the FAA could have set an across-the-board FDP limit of 9 hours. This limit would have been simple to understand, and it would have provided the necessary protection for multi-segment FDPs that take place during the WOCL. However, this limit also would have effectively reduced flight times, since with a 9-hour FDP, a flightcrew member would never reach a full 9-hour flight time. Such an approach would also fail to recognize the flexibility required for multi-segment operations, which incorporate some ''down-time'' into intermittent time-on-task. Thus, in order to provide air carriers with additional scheduling flexibility and avoid unnecessarily restricting all FDPs to the lowest common denominator, the FAA ultimately decided to utilize the somewhat more complex FDP limits listed in Table B.

Turning to the comments concerning flight segments, each flight segment that is flown by a flightcrew member includes a takeoff and a landing, which are the most task and safety-intensive parts of the flight. A flightcrew member whose FDP consists of a single flight segment only has to perform one takeoff and landing, while a flightcrew member whose FDP consists of six flight segments will have to perform six sets of takeoffs and landings. Because takeoffs and landings are extremely task-intensive, it logically follows that a flightcrew member who has performed six sets of takeoffs and landings will be more fatigued than the flightcrew member who has performed only one takeoff and landing.

While there are no studies measuring the objective performance of pilots who have flown multiple flight segments, there are studies that are based on subjective pilot reporting of fatigue that support a link between fatigue and the number of flight segments. For instance, a 2008 study of fatigue in two-pilot operations found that ''the most important influences on pilot fatigue were the number of sectors and the length of the duty period.'' [35] A 2007 study of pilot fatigue in short-haul operations found that ''[d]uty length and the number of sectors increased fatigue in a linear fashion.'' [36] A 2003 study of perceived fatigue for long and short-haul flights found that ''time pressure, number of legs per day, and consecutive days on duty contributed to increased fatigue.'' [37] Based on these studies, its operational experience, and the logical connection between fatigue and additional flight segments, the FAA has decided to retain, in Table B, the FDP-decreases caused by FDPs with multiple flight segments.

However, while there is a link between FDP and multiple flight segments, it is unclear exactly how much fatigue is caused by each flight segment. As such, Table B does not utilize the method employed by other civil aviation authorities of a linear FDP-limit decrease after the first flight segment. Instead, Table B generally does not decrease FDP limits until a flightcrew member is assigned an FDP that has five or more flight segments.

[32] *See* NASA, *supra* note 22, at 28.

[33] *See, e.g.,* Folkard, *supra* note 15, at 98.

[34] *Id.*

[35] David Powell, *et al., Fatigue in Two-Pilot Operations: Implications for Flight and Duty Time Limitations,* Aviation, Space, and Environmental Medicine, Vol. 79, No. 11, Nov. 2008, at 1047.

[36] David Powell, *et al., Pilot Fatigue in Short-Haul Operations: Effects of Number of Sectors, Duty Length, and Time of Day,* Aviation, Space, and Environmental Medicine, Vol. 78, No. 7, Jul. 2007, at 701.

[37] Samira Bourgeois-Bougrine, *et al., Perceived Fatigue for Short- and Long-Haul Flights: A Survey of 739 Airline Pilots,* Aviation, Space, and Environmental Medicine, Vol. 74, No. 3, Oct. 2003, at 1076.

For several FDP limits that are unusually high and/or that take place during critical circadian times, Table B decreases FDP limits after the first two flight segments to account for the additional fatigue caused by those FDPs.

The FAA understands that an FDP-limit decrease linked to multiple flight segments will disproportionately affect regional air carriers and point-to-point operations, such as the one employed by Southwest. That is why, given the lack of information on the specific amount of fatigue caused by each flight segment, Table B does not follow the approach taken by CAP–371 and the EU OPS subpart Q of reducing FDP after the first flight segment. However, as discussed above, there appears to be a link between fatigue and the number of flight segments, and the flightcrew members working for Southwest and regional carriers are as susceptible to multiple-flight-segment-caused fatigue as other flightcrew members. Because a flight duty and rest rule must take into account the increased fatigue caused by performing multiple takeoffs and landings in a single FDP, Southwest and regional air carriers cannot be exempted from this portion of Table B.

The FAA also agrees with NIOSH that long duty periods that take place during the WOCL substantially increase the risk of an accident. As discussed above, studies have found that human beings who work during the WOCL experience substantial degradation in their ability to safely perform their assigned duties.[38] Studies have also found that each additional hour worked after approximately 8 or 9 hours exponentially increases the risk of an accident.[39] Given this data, the FAA has restricted nighttime FDPs to 9 hours. Because a 9-hour FDP is relatively safe, the FAA has decided not to reduce the nighttime FDP limit any further. However, given the significantly increased risk of an accident posed by long nighttime FDPs, the FAA has also decided not to raise the nighttime FDP limit above 9 hours, even though this means that in many instances the flightcrew member would not reach the allowable flight limit.

In addition, the FAA has determined that there is little evidence that a flightcrew member who repeatedly works on nightshifts will experience substantial safety-relevant changes to his or her circadian rhythm through acclimation. Acclimation consists of changes to a person's circadian rhythm that are made in response to external environmental factors, such as receiving sunlight at a time when one's body is used to experiencing nighttime darkness. While people who continuously work at night may experience some acclimation, that acclimation is neither complete nor long-lasting. The nightshift acclimation also generally disappears after only a few days off.

Similarly, it does not appear likely at this time that a longer rest period would necessarily decrease the substantial risk associated with longer nighttime FDPs. This is because daytime sleep is less restful than nighttime sleep, and the additional rest provided to a nightshift flightcrew member would be taken during the day. However, the FAA is open to the possibility of allowing air carriers to exceed the 9-hour nighttime FDP limit if they can establish through an FRMS that additional daytime sleep would allow their flightcrew members to safely work on longer nighttime FDPs.

The FAA has also considered CAA's argument concerning the Campbell-Hill report's analysis, which states that the accident rate only statistically increases in the 15th hour of duty and beyond. The FAA finds the peer-reviewed studies analyzing the national accident rate to be more persuasive.[40] This is because the national-accident-rate analyses are based on the overall national accident rate, which provides a far larger sample than the number of aviation incidents on which the Campbell-Hill analysis is based. As discussed above, according to the peer-reviewed national-accident-rate studies, the risk of an accident increases exponentially for each hour worked after 8 hours.[41] Even CAA, which submitted the Campbell-Hill report, appears to have implicitly recognized that report's limitations because the alternative proposal that CAA submitted to the FAA did not use the 15-hour FDP limit suggested by Campbell-Hill. Instead, CAA's proposal limited nighttime FDPs to 11 hours and daytime FDPs to 13 hours.[42]

The FAA has also recognized that CAP–371 and EU OPS subpart Q permit higher nighttime FDP limits in some situations. However, these foreign regulators are able to safely allow higher nighttime FDP limits because their operating environment allows them to mitigate the risk associated with nighttime FDPs in other ways. For example, CAP–371 sets general nighttime FDP limits to 11 hours for one-segment nighttime FDPs. However, if a flightcrew member is scheduled for nighttime duty on five consecutive nights, CAP–371 reduces that flightcrew member's nighttime FDP limit to eight hours and imposes substantial additional rest requirements.[43] CAP–371 also imposes a mandatory split duty rest period for flightcrew members who have a nighttime FDP for at least two consecutive nights.[44] This rule, on the other hand, only requires a mid-duty rest period if a flightcrew member has a nighttime FDP for at least four consecutive nights.

Similarly, EU OPS subpart Q also appears to set slightly higher FDP limits for nighttime operations.[45] However, in exchange for these higher limits, Subpart Q limits FDP extensions to 1 hour and requires a minimum of 12 hours' rest between FDP periods.[46] This rule, on the other hand, permits FDP extensions of 2 hours and only requires 10 hours' rest between FDP periods. As these examples illustrate, some of the key provisions of this rule are fundamentally different from the provisions of its international counterparts. These differences are a result of the different operating environments in which these rules regulate, and, by themselves, these differences are insufficient to justify increasing the nighttime limits of Table B.

With regard to comments about nightshift carriers providing mitigation to their crews and continuous duty operations that employ mitigation measures, this rule takes nighttime mitigation into account through the split duty and augmentation credits. If an air carrier employs mitigation measures not addressed by this rule, that air carrier may submit its mitigation measures for FAA evaluation as part of an FRMS program.

The FAA agrees with RAA that SAFTE modeling shows that the proposed FDP limits in the 0400 through 1059 timeframe were excessive and did not increase the degree of safety as compared to the industry-ARC-members' proposal. As such, these limits have been adjusted upward to reflect the industry-ARC-members' suggested FDP limits for these timeframes. The FAA also agrees with ATA that the proposed limits for the 0500–0659 timeframe were set unreasonably low. This is because

[38] *See, e.g.,* NASA, *supra* note 22, at 19–34.

[39] *See* Folkard, *supra* note 15, at 98.

[40] *See id.*

[41] *Id.*

[42] *See* Comments of the Cargo Airline Association, Attachment C at 5 (Nov. 15, 2010).

[43] CAP–371 section 7.3.1.

[44] *Id.* section 7.3.

[45] EU Rules, Subpart Q, OPS 1.1105, sections 1.3 and 1.5.

[46] *Id.* OPS 1.1105, section 2.1; OPS 1.1110, section 1.1.

flightcrew members who fly during those times obtain most of their sleep at night and sleep through most of their WOCL. The upward adjustment that the FAA made in response to RAA's SAFTE modeling increases the FDP limits in this timeframe to a reasonable level, and should address ATA's concerns in this area.

The FAA declines to make a downward adjustment to the five-segment FDP limit in the 1700–2159 timeframe.[47] This is because the flight time limits contained in Table A substantially restrict a flightcrew member's time on task. The time-on-task restriction allows the FAA to safely impose a higher FDP limit for a five-segment FDP in this timeframe. As such, the FAA has not made downward adjustments to this limit.

In addition, the FAA declines APA's suggestion of decreasing FDP limits for early morning and late evening FDPs. The primary time-of-day safety concern on which Table B is based is that flightcrew members who fly during the WOCL suffer a severe degradation of performance. FDPs that begin in the early morning or end late in the evening do not infringe on the WOCL, and thus, do not trigger this concern. Also, as ATA correctly pointed out, flightcrew members assigned to these FDPs are able to obtain most of their sleep at night, and nighttime sleep is the most restful type of sleep. Moreover, as discussed above, RAA's SAFTE modeling showed that a slight upward adjustment to early morning FDPs would not decrease safety. For all these reasons, the FAA has decided not to decrease the FDP limits for FDPs that begin early in the morning or end late in the evening.

UPS stated that because the FDP limits are determined by actual pilot reporting time and not the pilot's scheduled reporting time, air carriers are put in an untenable position of having to track the fluctuating and unpredictable FDPs of individual pilots. The Aerospace Medical Association (AMA) asserted that the different FDP limits were inefficient and would crowd departure times at busy airports. AMA suggested that, instead of changing FDP limits based on reporting time, duty time that takes place during the window of circadian low be counted as time-and-a-half or double time. APA suggested that FDP limits not be associated with specific reporting times, but that they instead be determined through a linear function, which could then be utilized by modern scheduling software. This approach, APA argued, would be better than the FAA-suggested approach in which a 1-minute reporting difference can result in a 1-hour FDP limit difference.

The FAA has determined that an approach to daily FDP limits that requires a linear function or mathematical computations in order to determine the applicable limit would be unduly complex. Under the FAA's approach to Table B, a flightcrew member can determine his or her FDP limit simply by finding the cell in Table B that applies to his or her scheduled FDP. Given that some commenters find even this approach to be unduly complex, the FAA has decided not to add any more complexity to this section.

In response to UPS' concern, the FAA clarifies that FDP limits are determined by scheduled reporting time and not by actual reporting time. Thus, an air carrier can determine a flightcrew member's maximum FDP limit simply by looking at that flightcrew member's schedule. The labels for Tables B and C are amended to clarify that the applicable limits are based on scheduled start time.

The FAA also emphasizes that FDP is defined as beginning at the time that a flightcrew member is ''required'' to report for duty. Thus, if a flightcrew member is late for an FDP, the FDP begins to run at the time that the flightcrew member was scheduled to report for an FDP, not the time that he or she actually reported for the FDP.

Aloha Air Cargo (AAC) recommended upward modifications to the proposed maximum FDPs. At AAC, flightcrews report for night flight duty between 1935 and 2142 local time and end at 0700 each morning. To support flightcrew rest periods occurring at the same time each day, AAC schedules its crews to assure that flightcrews complete their duty by 0700 each morning. This system naturally reduces the FDP for later report times without artificially constricting earlier report times. AAC has evaluated this fatigue mitigation process for over nine months through daily reviews of FRMP crew data, and through selective crew debriefs when FRMP data results flagged elevated fatigue risk. AAC asserted that this method has proven to be more reliable in mitigating fatigue risk within AAC's flight operation than the FAA's current proposal. Therefore, AAC recommended that the FAA consider the table below as an alternative to the proposed table, and that the FAA include ''Time of Completion'' (the end of the FDP) as an additional criterion to support adequate rest in consideration of the flightcrew's circadian rhythms.

Time of start (home base or acclimated)	Maximum flight duty period (hours) for lineholders based on number of flight segments						
	1	2	3	4	5	6	7+
1300–1659	12	12	12	12	11.5	11	10.5
1700–2159	*12	*12	*11	*11	*10.5	*10	*10
2200–2259	*11.5	*11.5	*10.5	*10.5	*10	*10	*9.5
2300–2359	*10.5	*10.5	*10	*10	*9.5	*9.5	*9

* Proposed changes.

The FAA has declined to adopt AAC's suggestion of requiring FDPs to terminate at a certain time. This rule applies to many different air carriers with differing business models, and the approach taken by AAC may not work for an air carrier conducting supplemental operations whose schedule is subject to the demands of its clients. In order to take into account the diverse business models subject to this rule, the FAA has chosen not to include a ''Time of Completion'' as part of its FDP restrictions. The FAA notes that, because Table B sets higher FDP limits for FDPs that begin earlier in the evening, AAC will be able to retain its existing business model if it opts to operate its all-cargo operations under part 117 so long as each scheduled FDP

[47] The FAA has actually increased the FDP limit in question to account for concerns expressed by supplemental carriers. The increases based on supplemental-carrier comments are discussed more fully below.

complies with the limits set out in Table B.

Turning to the specific FDP limits proposed by AAC, the FAA has chosen not to make further upward adjustments to FDPs in the 1700 to 2359 timeframe. FDPs that begin during this timeframe will infringe on the WOCL, and, as discussed above, this infringement raises significant safety concerns.

NACA and a number of other commenters stated that the limits in the proposed Table B unduly focus on domestic scheduled service and do not recognize the needs of non-scheduled operations currently flown under Subpart S. These commenters suggested the following alternative to the FAA-proposed Table B:

Time of start	Acclimated segments			
	1–4	5	6	7+
0000–0559	12	11	10	9
0600–1159	14	13	12	11
1200–1259	13	12	11	10
1300–2359	12	11	10	9

The SkyWest Airlines Pilot Association similarly asked the FAA to increase the FDP limits to avoid disproportionately impacting regional air carrier pilots. SkyWest Airlines stated that the proposed FDP limits would significantly increase its operating expenses, as well as the amount of time that its flightcrew members spend resting away from home. SkyWest, NAA, and Northern Air Cargo suggested that the FAA permit air carriers to schedule FDPs that are either 12 or 14 hours, depending on whether they infringe on the window of circadian low. Allegiant also supported permitting a 14-hour FDP for FDPs that included two or less flight segments.

Conversely, American Airlines and American Eagle Airlines supported the FDP limits set out in Table B. The Families of Continental Connection Flight 3407 also endorsed the maximum 13-hour FDP limit, asserting that it effectively limits the fatigue exposure of regional airline pilots. APA supported the 13-hour maximum FDP limit, citing studies showing a higher likelihood of an accident for each additional hour worked, a conclusion supported by the crash of American Airlines Flight 1420, in which fatigue was a causal factor, and which occurred at the 13:06 point in the flightcrew members' FDP. APA added that duty days that exceed 13 hours could result in flightcrew members being awake for 16 to 17 hours before the beginning of their FDP. APA cited a study showing that a person who has been awake for 17 hours exhibits the same level of performance as a person who is legally drunk. NJASAP expressed concern over increasing the maximum FDP limits, citing a NASA study in which a poll of corporate pilots revealed fatigue concerns for duty time over 8 and 10 hours.

Due to the WOCL considerations discussed above, the FAA has declined the suggestion by air carriers conducting supplemental operations to increase nighttime FDP limits to 12 hours. However, the FAA notes that these concerns do not apply to daytime FDPs that begin in the morning, especially since flightcrew members' time on task is restricted by the flight time limits of Table A. As such, and in response to the comments made by regional carriers, and those conducting only supplemental passenger operations, the FAA has made upward adjustments to some of the FDP limits in Table B.

First, the FAA has increased the one- and two-segment FDP limits in the 0600 to 0659 timeframe from 12 to 13. However, the FAA did not further increase the FDP limits for FDPs with four or less segments in this timeframe to 14 hours (as the supplemental carriers suggested) because an early morning FDP that starts between 0600 and 0659 does not start during peak circadian alertness. As such, without additional FRMS-provided data, the FAA cannot justify permitting longer multi-segment early morning FDPs.

Second, the FAA has increased most of the FDP limits in the 0700 to 1659 timeframe to reflect the limits suggested by NACA's proposal. The reason for this increase is that the FDPs in this timeframe mostly take place during the day and do not infringe on the WOCL. Given the 8 and 9-hour flight time restrictions contained in Table A, the FAA has determined that an increase to the FDP limits in the 0700 to 1659 timeframe would not have a detrimental effect on safety.

It should also be noted that, in the 0700 to 1159 timeframe, the FAA has only allowed one- and two-segment FDPs to go to 14 hours. The reason that the FAA did not follow NACA's suggestion of allowing three- and four-segment FDPs to be 14 hours long is because, as discussed above, additional flight segments increase fatigue. Since a 14-hour FDP is a very long FDP, the FAA has chosen to disallow 14-hour-long multi-segment FDPs without additional data showing that a multi-segment FDP greater than 2 segments of this duration does not decrease safety. The FAA has also chosen not to increase the FDP limit to 14 hours for FDPs that begin after 1159 because this type of increase would result in more FDPs infringing on the WOCL.

Third, the FAA has reevaluated the FDP limits in the 1700 to 2359 timeframe and has made slight upward adjustments to those limits to reflect the safety mitigation provided by the time on task restrictions of Table A. These adjustments are not as high as the supplemental air carriers recommended because FDPs that begin during these times infringe on the WOCL.

The FAA has considered the concern raised by APA, NJASAP, and the Families of Continental Connection Flight 3407 about raising the maximum FDP limit above 13 hours. However, there are a number of reasons why the FAA considers a 14-hour FDP limit for FDPs that begin in the morning to be safe. First, most of the 14-hour FDP would take place during the day after a flightcrew member has had a full night's sleep and thus, this type of FDP does not raise any circadian-rhythm concerns.

Second, the flight time restrictions in Table A have been adjusted downward to 9 hours in order to restrict the amount of time on task that a flightcrew member can be subjected to in a 14-hour FDP. Thus, a flightcrew member in a 14-hour FDP can only be asked to fly an aircraft for 9 of those hours, and the remaining 5 hours must be spent on non-flight activities. The FAA notes that the studies cited by APA in support of a 13-hour-maximum FDP limit did not impose any time-on-task (flight-time) restrictions. The FAA agrees with APA that a 14-hour unaugmented FDP in which a flightcrew member spends the entire 14 hours flying an aircraft would be unsafe, which is why, as discussed more fully elsewhere, the FAA has decided to retain the flight-time limits set out in Table A.

Finally, the cumulative limits in this rule limit the frequency at which an air carrier can assign long FDPs to its flightcrew members. For example, under the 60-hour weekly FDP limit set out in section 117.23(c)(1), if an air carrier insists on repeatedly assigning a 14-hour FDP to its flightcrew members, those flightcrew members will reach their weekly FDP limit after slightly more than four days of work, and will be unable to accept an FDP for the remainder of the week. Under the 190-hour monthly FDP limit set out in section 117.23(c)(2), if an air carrier regularly assigns 14-hour FDPs, its flightcrew members will reach their monthly limits after slightly over 13 days, and will be unable to accept an FDP for the remainder of the month. Thus, the cumulative FDP limits contained in section 117.23(c) severely limit the frequency at which air carriers can assign the longer FDPs permitted by Table B. Given these numerous safeguards, a 14-hour FDP that consists of only one or two flight segments and takes place during peak circadian times does not raise significant safety concerns.

UPS objected to basing the FDP limits for an unacclimated flightcrew member on the time at that flightcrew member's home base. UPS stated that, under this approach, an unacclimated flightcrew member could be assigned a long FDP during a local night. UPS added that the FAA's acclimation approach does not take into account flightcrew members who change their acclimation status mid-pairing. UPS provided an example of an international flight arriving early and, as a result, the flightcrew on that flight having enough time in a new theater to unexpectedly become acclimated. Because this unexpected acclimation could lead to a reduced FDP limit for the return trip, UPS argued that this type of scenario was ''patently absurd'' because in this scenario a flightcrew that unexpectedly received additional rest would be subjected to a lower FDP limit.

In response, the FAA notes that this section does not determine unacclimated flightcrew members' FDP limits based on local time. This is because the circadian rhythm of flightcrew members who are unacclimated is not synchronized to the theater in which they are operating. Consequently, in order to accurately take into account each flightcrew member's WOCL and general circadian rhythm, this section determines FDP limits based on the local time at the theater with which a flightcrew member's circadian rhythm is synchronized.

With regard to mid-pairing acclimation, the FAA has amended the language in section 117.13(b)(2) to state that an unacclimated flightcrew member's FDP limit is determined by the local time at the theater in which that flightcrew member was last acclimated. The reason for this change is that a flightcrew member may be away from his or her home base for a significant amount of time. If that happens, the flightcrew member's circadian clock will not be synchronized with his or her home base, but rather, with the theater in which he or she was last acclimated.

Turning to UPS' scenario, it is indeed possible that a flightcrew member who arrives in a new theater unexpectedly early will experience unanticipated acclimation. Depending on the local hours, this acclimation may reduce that flightcrew member's FDP limit for the return trip. The reason for this reduction is that the longer amount of time that this flightcrew member will spend in-theater will result in his or her body becoming synchronized with the local time in that theater. Once this synchronization takes place, the flightcrew member will experience the circadian penalties associated with working during non-peak local times. As such, this rule prevents acclimated flightcrew members from accepting longer FDPs during non-peak local times. This result is not ''patently absurd'' because the shorter FDPs that may stem from unexpected acclimation are not a result of longer rest, but rather, a result of more time that a flightcrew member spends in-theater.

NACA and NAA also stated, without elaboration, that when a pilot is unacclimated, the FDP in Table B should be decreased by one hour instead of half an hour. The 30-minute FDP-limit reduction for unacclimated flightcrew members was imposed to account for the additional fatigue experienced by these flightcrew members. However, at this time, the FAA is unaware of any reasons for increasing this reduction to one hour.

NJASAP sought clarification of how acclimation is determined when a flightcrew is made up of flightcrew members who are based in different time zones. In response, the FAA emphasizes that acclimation and FDP limits are specific to each flightcrew member. As such, the unacclimated flightcrew members on a flightcrew are subject to subsection (b) of this section. However, the acclimated flightcrew members on that flightcrew are only subject to subsection (a) of this section.

Drs. Belenky and Graeber criticized the maximum FDP limits for not taking into account onboard rest facilities, which, they argued, allowed a flightcrew to obtain rest onboard the aircraft prior to descent. Boeing also endorsed the concept of controlled napping. AMA stated that controlled in-cockpit naps should be ''vigorously encouraged,'' but should not be allowed to increase the maximum FDP. In response, the FAA notes that there is currently insufficient data about whether a controlled nap could safely be taken by a flightcrew member during an actual unaugmented flight. As such, the FAA is not prepared to regulate for controlled napping as a mitigation measure at this time. Once more data becomes available, the FAA may conduct a rulemaking to add controlled napping to the flight, duty, and rest regulations.

NACA and NAA stated that the time-of-day windows in Tables A and B are not synchronized. However, the reason that Tables A and B are not synchronized is that Table B uses many different FDP limits ranging from 9 to 14 hours, and multiple rows were necessary to clearly distinguish each different set of FDP limits. Table A, on the other hand, only uses 8 and 9 hours as flight time limits, and as such, fewer rows were necessary to clearly convey the flight time limits for each phase of the day.

G. Flight Time Limitations

As discussed above, studies indicate that if a person works for longer than 8 or 9 hours, the risk of an accident increases exponentially for each additional hour worked.[48] Given this data, the FAA was hesitant to eliminate current flight time regulations, which generally limit flightcrew members to 8 hours of flight time regardless of the time of day. Thus, instead of relying solely on FDP limits to regulate acute fatigue, the FAA proposed flight time limits ranging from 8 to 10 hours (depending on the time of day) for unaugmented flights. The FAA also proposed a 16-hour flight time limitation for augmented flights.

ATA, NACA, CAA, RAA, and multiple air carriers objected to including daily flight time limits in this rule. ATA, RAA, International Air Transport Association (IATA), and a number of other commenters argued that the daily flight time limits were arbitrary, not scientifically justified, inconsistent with leading international

[48] *See* Folkard, *supra* note 15, at 98.

standards, operationally unwieldy, unduly burdensome to carriers, and against the public interest.

The above commenters stated that the daily flight time limits were unnecessarily redundant. The commenters emphasized that this rule creates a large number of regulatory limitations, and an additional limitation on flight time limits only unnecessarily adds complexity to this rule. These commenters stated that flight time is considered to be part of an FDP, and thus, flight time is subject to the FDP limits. The commenters emphasized that being awake is what causes fatigue, and this fatigue factor is addressed through FDP limits better than through flight time limits.

ATA stated that this rule also indirectly regulates flight times through mandatory rest periods because a flightcrew member cannot fly an aircraft during a rest period. UPS stated that industry ARC members' acceptance of FDP limits was predicated on the abolition of flight-time limits.

In filed comments Drs. Belenky and Graeber stated that there was no justification for flight time limits in addition to FDP limits apart from regulating for ''differences in workload.'' Drs. Belenky and Graeber stated that the differences in workload are taken into account in the FDP limits through the different limitations on circadian timing and the number of flight segments. As such, Drs. Belenky and Graeber concluded that there was no remaining justification for retaining flight time limits in this rule. ATA, CAA, and a number of air carriers supported Drs. Belenky and Graeber's analysis.

ATA, IATA, CAA, and a number of air carriers noted that other regulatory regimes, such as CAP–371 and EU OPS subpart Q, have largely eliminated the concept of daily flight-time limits. These commenters argued that this demonstrates that a flight-time limit is unnecessary, and that imposing this limit on U.S. carriers will make them less competitive with carriers operating under other regulatory regimes. The commenters asked the FAA to eliminate the daily flight-time limit to make this rule more consistent with the other regulatory regimes.

Conversely, NJASAP, AAC, and a number of labor groups supported the flight time limits. NJASAP emphasized that ''[m]ultiple stressors are present in flight operations such as weather and [air traffic control] that take a cumulative toll on fatigue levels.''

In response, the FAA notes that existing regulations generally limit flight time to 8 hours. Studies have shown that fatigue accumulated by working longer than 8 or 9 hours significantly increases the risk of an accident.[49] Given this data, the FAA needs to ensure that flightcrew members are not permitted to fly an aircraft for longer than 8 or 9 hours. This rule accomplishes this goal by setting flight-time limits at 9 hours for peak circadian times, and 8 hours for all other times.

As the industry commenters correctly pointed out, the FDP limits in this rule also limit flight time. However, abolishing flight-time limits and relying solely on FDP limits to regulate flight time poses a significant problem. This problem arises from the fact that the FDP limits do not differentiate between flight time and non-flight activities. For example, if a flightcrew member spends 5 total hours flying an aircraft and 4 hours sitting in an airport on a layover, that flightcrew member's FDP is 9 hours. However, if another flightcrew member spends 8 total hours flying an aircraft and 1 hour sitting in an airport on a layover, that flightcrew member's FDP is also 9 hours. Thus, the FDP limits would treat the above two flightcrew members identically, even though one of them spent an additional 3 hours engaged in the more fatiguing activity of flying an aircraft.

To resolve the above problem and differentiate between flight time and less-fatiguing non-flight activity conducted on behalf of the certificate holder, the FAA has decided to impose flight-time limits in addition to FDP limits. Setting flight-time limits at 8 or 9 hours ensures that flightcrew members do not fly an aircraft for longer periods of time. This also allows the FAA to provide air carriers with more scheduling flexibility by setting higher FDP limits because with flight-time limits in place, longer FDPs will simply include more non-flight activities instead of longer flight times.

An alternative approach that the FAA considered was eliminating flight-time limits, and setting lower FDP limits to ensure that flightcrew members do not fly an aircraft for longer than 8 or 9 hours. However, the FAA ultimately rejected this approach because it would have resulted in peak-circadian-time FDP limits of approximately 10 or 11 hours, which would have greatly hampered the scheduling flexibility of air carriers. This approach also would have unnecessarily limited non-flight activities, which are generally not as fatiguing as flying an aircraft.

The FAA also considered ATA's comment that rest requirements indirectly limit flight time. However, the problem with relying solely on rest requirements to regulate flight time is the same as the problem with relying solely on FDP limits—neither provision differentiates between non-flight and flight activities. In addition, the proposed rest requirements do not even closely approximate levels that would effectively limit flight time to acceptable levels. As such, the FAA has chosen not to use the rest requirements in this rule as a replacement for flight-time limits.

Turning to UPS' comment that industry ARC members' acceptance of FDP limits was predicated on the abolition of flight-time limits, the FAA notes that the ARC's recommendations are advisory.[50] Thus, for example, in response to industry concerns that were raised in the comments, the FAA has increased some of the FDP limits in Table B beyond the levels suggested by the ARC members. Similarly, to address scientific data showing that the risk of an accident greatly increases after a person has worked for 8 or 9 hours,[51] the FAA has decided to set firm flight-time limits to ensure that flightcrew members do not fly an aircraft for longer than 8 or 9 hours.

As Drs. Belenky and Graeber correctly pointed out, the number of flight segments flown by a flightcrew member is taken into account by the FDP limits. However, while takeoffs and landings associated with multiple flight segments are the most task-intensive portions of a flight, they are not the only task-intensive portion of the flight. When flying an aircraft after takeoff, a flightcrew member must, among other things, keep track of weather patterns, communicate with air traffic control, and respond to unforeseen developments that may arise during the flight. All of these tasks (as well as the constant alertness needed to perform these tasks) increase fatigue, and they are not fully taken into account by the FDP limits, which do not distinguish between a flightcrew member flying an aircraft and a flightcrew member sitting at an airport during a layover. To account for these fatigue-inducing tasks, the FAA has decided to retain flight-time limits in this rule.

Turning to the foreign aviation standards cited by some of the commenters, the FAA notes that the

[49] *See id.;* John A. Caldwell, *Fatigue in aviation,* Travel Medicine and Infectious Disease, 3, at 88–90 (2005).

[50] The FAA also notes that the near-total lack of consensus among ARC members as to the appropriate levels to adopt indicates that the ARC members understood that the FAA could not assume either industry or labor support of all aspects of its proposal.

[51] *See supra* note 50.

Administrative Procedure Act requires the FAA to consider the specific operating environment that it is regulating instead of simply following the foreign standards. The FAA notes that while other regulatory regimes have eliminated daily flight-time limits, the elimination of these limits has resulted in more stringent requirements elsewhere. For example, EU OPS subpart Q sets the maximum FDP limit at 13 hours and requires 12 hours of rest between FDP periods.[52] This rule, on the other hand, sets a maximum FDP limit at 14 hours (for peak circadian times) and requires a rest period of only 10 hours between FDP periods. One of the reasons why some provisions of this rule are less stringent than their EU OPS counterparts is because this rule contains a daily flight-time limit that regulates how long flightcrew members can fly an aircraft.

The FAA also notes that the other regulatory regimes did not completely eliminate flight-time limits. While other regulations do not contain daily flight-time limits, many of them still retain cumulative flight-time limits.[53] These cumulative flight-time limits are significantly lower than the cumulative flight-time limits imposed by this rule.[54]

Over 1,300 individual commenters objected to the proposed 10-hour flight-time limit for the 0700–1259 timeframe. These commenters emphasized that the 10-hour limit constitutes a 25% flight time increase over existing limitations, and as such, will increase fatigue. A number of commenters stated that flight time limitations should not be greater than 8 hours. NJASAP emphasized that existing regulations limit flight time to 8 hours, and, given studies that show the risk of an accident increasing exponentially for each additional hour worked, there is no reason to increase the existing flight-time limits. The Families of Continental Connection Flight 3407, Captain Sullenberger, International Brotherhood of Teamsters (IBT) Local 1224, and multiple labor groups stated that there are no scientific findings supporting an increase in flight time to 10 hours, and that this type of increase should be permitted only if it is supported by FRMS-provided data. NTSB cautioned the FAA about increasing flight-time limits to 10 hours without first studying adverse consequences that could result from this increase. Many of the above commenters recommended reducing the 10-hour flight-time limit to 9 hours, emphasizing that this would still be a 12.5% increase over existing flight-time restrictions. A number of labor groups recommended that the early morning and late evening flight-time limits be reduced to 7 hours "to reflect the unanimous view of the ARC."

Conversely, RAA stated that there is no scientific evidence that a small increase in the current flight time limits would adversely affect safety. SkyWest objected to decreasing the flight time limits, arguing that it would impose additional hardships upon air carriers. Delta stated that increasing flight time limits beyond 8 hours is safe because the maximum FDP limits reduce the amount of time that flightcrew members spend at work.

The FAA agrees with the overwhelming number of commenters who stated that a 10-hour flight-time limit is not justified by current scientific data. A series of studies examining the national accident rate has shown that 10 hours spent at work pose a much greater risk of an accident than 8 or 9 hours spent at work.[55] A study examining the number of aviation accidents determined that "[f]or 10–12 hours of duty time, the proportion of accident pilots with this length of duty period is 1.7 times as large as for all pilots." [56] Another study found that "20% of all U.S. commercial aviation mishaps appear to occur at the 10th hour [of pilot duty] and beyond." [57] Because scientific data shows that the risk of an accident substantially increases when a person's time on task is 10 hours, the FAA has decided to limit flight-time that begins during 0700–1259 to 9 hours.

The FAA has also decided not to reduce any of the proposed 9-hour flight-time limits to 8 hours. The existing regulations impose an across-the-board 8-hour flight-time limit. However, that limit regulates to the lowest common denominator because it does not take into account the fact that people are capable of safely working longer hours during periods of peak circadian alertness. Accordingly, this rule retains the 8-hour flight-time limit for shifts encompassing non-peak circadian times, but increases the flight-time limit to 9 hours for shifts encompassing periods of peak circadian alertness.

Turning to comments about the ARC recommendations, the FAA notes that the ARC's recommendations are advisory and there was no consensus on the hourly limitations with industry generally supporting more generous limits and labor generally supporting more restrictive limits. The existing regulations impose an 8-hour flight-time limit, and the FAA has been administering this limit for over 50 years. Based on its operational experience, the FAA does not believe that an 8-hour flight-time limit for non-peak circadian times is unsafe, especially if that limit is based on actual and not scheduled flight time. As such, the FAA has decided not to decrease any of the flight-time limits below 8 hours.

ATA, IATA, UPS, United, and a number of other air carriers also objected to the lack of an extension for daily flight-time limits. These commenters stated that an inflexible daily flight time limit would severely restrict scheduling because air carriers would have to build in large scheduling buffers to account for unforeseen circumstances occurring after takeoff. IATA emphasized that the prohibition on continuing an FDP that exceeds the flight-time limits may result in flightcrew members unsafely rushing to complete preflight activities to avoid violating the flight time limits. UPS stated that, without a flight time extension, unforeseen delays could leave crews stranded in international destinations. United asserted that an inflexible flight-time limit may, as a result of unforeseen delays, result in cancellations of multi-leg itineraries after some of the legs have been completed. Southwest stated that large numbers of flights would be disrupted by an inflexible flight-time limit because small delays would eventually build up during the day, and these would require air carriers to cancel flights in order to comply with the rigid flight-time limits. The above commenters suggested that flight time limits be based on scheduled and not actual flight time.

Conversely, ALPA, FedEx ALPA, IBT Local 1224, and a number of other labor groups supported the lack of a flight-time extension, arguing that air carriers currently do not build sufficient buffers into their schedules. These commenters stated that air carriers currently schedule flights up to the last permissible limit of flight time, even when the air carriers know that a high possibility of a delay makes their schedules unrealistically optimistic. These commenters emphasized that an inflexible flight-time limit was particularly important in this case because this rule does not have a compensatory rest provision.

[52] EU Rules, Subpart Q, OPS 1.1100, section 1.3 and OPS 1.1110, section 1.1.

[53] *See, e.g.,* EU Rules, Subpart Q, OPS 1.1100, section 1.2.

[54] *See id.;* CAP–371, section 21.1.

[55] *See* Folkard, *supra* note 15, at 98.

[56] Jeffrey H. Goode, *Are pilots at risk of accidents due to fatigue?,* Journal of Safety Research, 34, at 311 (2003).

[57] Caldwell, *supra* note 50, at 90.

The flight-time limits apply to actual and not scheduled flight time because actual flight time is what impacts safety. Flight-time calculations are based on the en route times contained in the flight plan. Once a flightcrew member flies an aircraft for a certain amount of time, that flightcrew member's risk of being involved in an accident increases exponentially for each additional hour worked.[58] This exponential increase in risk is based on actual hours worked and not the hours that someone was scheduled to work. Thus, a flightcrew member who flies an aircraft for 11 hours does not have a lower risk of an accident simply because he or she was scheduled to fly the aircraft for only 9 hours. In order to account for the factors that control accident risk, the flight-time limits in this rule are based on actual and not scheduled flight time.

Turning to the concerns expressed by industry commenters, the FAA notes that air carriers currently utilize schedules that are unrealistically optimistic and do not include sufficient buffers for unforeseen circumstances. It has been the FAA's experience that an air carrier subject to an 8-hour scheduled flight-time limit will sometimes schedule a flight that, on paper, lasts 7 hours and 59 minutes when the air carrier knows that the actual flight will likely take well over 8 hours to complete. Because many current air carrier schedules are unreasonably optimistic, air carriers can prevent many of the pre-takeoff situations listed in their comments simply by incorporating reasonable buffers for unforeseen circumstances into their scheduling practices.

However, in evaluating the above comments, the FAA noted that different considerations apply after an aircraft has taken off. If unexpected circumstances significantly increase the length of the flight while an aircraft is in the air, the only way for a flightcrew member to comply with the flight-time limits imposed by this rule would be to conduct an emergency landing instead of piloting the aircraft to its intended destination. Because this is not the preferred method of complying with flight-time limits, the FAA has amended this section to provide a post-takeoff flight-time extension to the extent necessary to safely land the aircraft at its intended destination airport[59] if unexpected circumstances occur after takeoff. To monitor the use of this post-takeoff extension, the FAA is requiring certificate holders to report their flightcrew members who exceed the flight-time limits and describe the circumstances surrounding the exceeded flight time.[60]

The FAA emphasizes that this extension only applies to unexpected circumstances that arise after takeoff. If a flightcrew member becomes aware, before takeoff, that he or she will exceed the applicable flight-time limit, that flightcrew member may not take off, and must return to the gate.

One hundred sixty-seven individual commenters opposed increasing the augmented flight-time limit to 16 hours. AMA supported the 16-hour flight-time limit for augmented operations, stating that peer review studies and SAFTE/FAST modeling show that after 16 hours on duty crew performance falls off dramatically.[61] NJASAP stated that flight-time limitations are necessary for augmented operations, and that use of an FRMS to extend maximum flight times should be subject to high levels of scrutiny and oversight. Conversely, Continental asked that augmented FDPs be allowed to exceed the 16-hour flight-time limit. Atlas Air stated that, for some augmented FDPs, the 16-hour FDP flight time would exceed the applicable FDP limit.

Continental submitted supplemental comments objecting to the 16-hour flight time limit for augmented flights. Continental objected to this limitation on ultra long range (ULR) flights, and it submitted new studies, which it claimed showed that ULR flights do not pose additional fatigue risk. ALPA submitted a response to Continental's supplemental submission, pointing out that "[f]lights over 16 hours block conducted by U.S. carriers are rare so there is only limited actual experience with the fatigue factors of such flights." ALPA also asserted that the studies submitted by Continental were actually a single study (based on the composition of the subjects), and that the study suffered from a number of biases, including an age, gender, and volunteer participation. ALPA also stated that the sample size that the study examined was too small to provide meaningful data for a system-wide standard.

A 16-hour flight-time limit was proposed for augmented operations because, for a four-pilot crew working in shifts of two, a 16-hour flight time supposes that each pilot will be at the duty station for about 8 hours. In response to industry comments, the FAA has concluded that a slight increase of the limit for four-pilot augmented FDPs would not impact safety. As such, the augmented flight-time limit for a four-pilot crew has been increased to 17 hours. Seventeen hours was selected as the limit because each member of a four-pilot crew that works on a 17-hour flight in shifts of two would only be at the duty station for 8.5 hours. Eight and a half hours of manning the duty station falls within the 8-to-9-hour flight-time range that, as discussed above, the FAA considers to be safe.

Upon reevaluation of the augmented flight-time limit, the FAA has also concluded that a separate flight-time limit is necessary for a three-pilot flightcrew. This is because if a three-pilot crew works in shifts of two on a 17-hour flight, each flightcrew member will be at the duty station for approximately 11 hours. Because this falls outside the 8-to-9-hour flight-time range that the FAA considers to be safe, the flight-time limit for three-pilot augmented flightcrews has been reduced to 13 hours. A 13-hour flight-time limit ensures that each member of a 3-pilot crew only needs to be at the duty station for approximately 8.5 hours.

Turning to Continental's supplemental comment, as ALPA correctly pointed out, there are currently very few flights that exceed 16 hours of flight time, and as such, there is little data concerning the safety issues presented by these very long flights. The studies put forward by Continental are not particularly helpful in this regard because they analyzed a small sample of flights. Due to the small size of this sample, the data provided by these studies is not sufficient to justify further increasing the augmented flight-time limits. However, the FAA may relax the limits for ULR flights (through either an FRMS or a future rulemaking) if more data is provided showing that longer flight times do not adversely affect safety.

H. Flight Duty Period—Augmented

In formulating this rule, the FAA considered the fact that augmentation is currently used by air carriers to mitigate fatigue. An augmented flight is staffed by more than the minimally-required number of flightcrew members, and the extra staffing allows the flightcrew members to work in shifts and rest during the flight. Existing regulations allow higher flight times for augmented flights, and this allows air carriers to conduct longer flights.

[58] *See* Folkard, *supra* note 15, at 98.

[59] If the destination is unavailable, the aircraft would land at the designated alternate airport.

[60] The "FDP Extensions" section contains a more detailed discussion of the reporting requirements that apply to flightcrew members who exceed the applicable FDP and/or flight-time limits.

[61] Citing Colquhoun, P., *Psychological and Psychophysiological Aspects of Work and Fatigue,* Activitas Nervosa Superior, 1976, 18:257–263.

Augmentation has three significant impacts on flight safety. First, flightcrew members on augmented flights work in shifts, and therefore, do not spend as much time engaged in the fatiguing task of piloting an aircraft. For example, on a 17-hour flight staffed by 4 flightcrew members working in shifts of 2, each flightcrew member will only be on the flight deck for approximately 8.5 hours. This is in contrast to unaugmented flights, in which each flightcrew member must be on the flight deck for the full length of the flight.

Second, when they are not on the flight deck, flightcrew members on an augmented flight have access to an onboard rest facility, which will allow them to sleep during the flight. This in-flight rest will, depending on the quality of the rest facility, help mitigate against some of the fatigue accumulated during the FDP. Third, the redundancy created by augmentation allows fatigued flightcrew members to ask for assistance from other flightcrew members. Thus, if a flightcrew member discovers, mid-flight, that he or she is unduly fatigued, that flightcrew member can ask one of the extra flightcrew members to take over his or her duties and safely land the aircraft at its intended destination.

Because augmentation significantly mitigates fatigue, the FAA has found that longer FDPs can safely be permitted for augmented flights. In determining the specific FDP limits, the FAA took note of the recommendations set out in the TNO Report. The TNO Report was created to provide science-based advice on the maximum permissible extension of the FDP related to the quality of the available onboard rest facility and the augmentation of the flightcrew with one or two pilots. The TNO Report recommended that: (1) An aircraft with a Class I rest facility provide an FDP extension equal to 75% of the duration of the rest period; (2) an aircraft with a Class II rest facility provide an FDP extension equal to 56% of the duration of the rest period; and (3) an aircraft with a Class III rest facility provide an FDP extension equal to 25% of the duration of the rest period.[62]

Based on the TNO Report, the FAA proposed Table C, which set out separate FDP limits for augmented flights. These limits were generally based on the unaugmented FDP limits, and then were increased in accordance with the available rest facility by the TNO–Report-recommended extension. If a flightcrew member was unacclimated, the augmented FDP limits were reduced by 30 minutes, and the applicable FDP limits were determined based on the local time at the flightcrew member's home base. Because augmented FDPs were generally intended to be used for longer flights, the proposal limited augmented FDPs to three flight segments. In addition, to ensure sufficient in-flight rest for augmented flightcrew members, the proposal would have required: (1) Two consecutive hours of in-flight rest during the last flight segment for flightcrew members who would be manipulating the controls during landing, and (2) ninety consecutive minutes of in-flight rest for all other flightcrew members. The proposal also would have required that at all times during flight, at least one flightcrew member with a PIC type-rating must be alert and on the flight deck.

Drs. Belenky and Graeber stated that ''there is no scientific basis for the different hours assigned as limits for different departure times.'' They asserted that ''[u]npublished alertness modeling data provided to the ATA (and presumably the ARC) demonstrated that a rest provided during the second half of a long-haul flight equal to (flight time minus two hours) divided by two produced roughly equivalent alertness regardless of time of departure.'' Drs. Belenky and Graeber concluded that, based on the modeling data, there is no need to differentiate between the different departure times so long as in-flight rest was provided during the second half of the flight. ATA added that augmented flights departing later in the day would provide in-flight sleep during the WOCL for flightcrew members who would be manipulating the controls during landing, and thus, that in-flight sleep would be more restful.

NACA and a number of air carriers who conduct supplemental operations submitted the following FDP limits as an alternative to the proposed Table C.

NACA PROPOSED TABLE C TO PART 117—FLIGHT DUTY PERIOD: AUGMENTED OPERATIONS

Acclimated	Maximum flight duty period (hours) based on rest facility and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000–2359	18	20	17	19	16	18

The above proposal for augmented operations extends the flight duty period limits for augmented operations by four to six hours, depending on the number of pilots used and the type of rest facilities available onboard the aircraft. Because in-flight rest is provided through onboard rest facilities, the proposal made by the air carriers who conduct supplemental operations does not decrease a flightcrew member's flight duty period limits when the pilot flies during the WOCL.

UPS suggested that ''four person augmented operations with a class one rest facility should provide a 16-hour FDP regardless of report time.'' UPS asserted that this type of augmented FDP limit ''would allow U.S.-based certificate holders to compete globally without an FRMS.''

Atlas Air asserted that most of its augmented flights have FDPs lasting between 18 and 20 hours, many of which are single-stop and nonstop flights in support of AMC missions. Atlas Air stated that it would not be able to keep operating those flights under the limits set out in Table C. As such, Atlas Air suggested that the FAA increase the FDP limits in Table C.

Conversely, ALPA, IPA, CAPA, Flight Time ARC, and other labor groups submitted the following alternative to the proposed Table C, arguing that, in applying the TNO Report, Table C utilized a rounding process ''that doesn't adequately represent the actual calculations used in the ARC process.''

[62] TNO Report at 19.

REVISED TABLE C—FLIGHT DUTY PERIOD: ACCLIMATED AUGMENTED FLIGHTCREW

Time of start (local time)	Maximum flight duty period (hours) based on rest facility and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000–0559	13:50	16:05	12:55	14:20	11:45	12:15
0600–0659	15:10	17:40	14:10	15:40	12:55	13:25
0700–1259	16	18	15:25	17:05	14	14:30
1300–1659	15:10	17:40	14:10	15:40	12:50	13:20
1700–2359	13:50	16:05	12:55	14:20	11:45	12:15

APA criticized the proposed Table C for not applying the TNO Report's rationale to the unaugmented FDP limits for the late evening and early morning hours. APA's alternative to Table C had significantly lower FDP limits for the late evening and early morning hours. APA also stated that the TNO Report has not been validated in the aviation context, and that consequently, the FAA should proceed more cautiously in increasing the existing limits for augmented operations.

Table C differentiates between different FDP departure times because of the type of rest that flightcrew members receive prior to beginning the FDP. As discussed in more detail below, section 117.25 requires a 10-hour rest period with a minimum 8-hour sleep opportunity immediately before a flightcrew member begins his or her FDP. Based on this requirement, flightcrew members who begin an FDP in the morning will obtain their pre-FDP sleep at night during the WOCL. Conversely, flightcrew members who begin an FDP later in the day or at night will obtain their pre-FDP sleep during the daytime. Because sleep taken at night during the WOCL is more restful than sleep taken during the day,[63] flightcrew members who begin their FDP in the morning will be better rested than flightcrew members who begin their FDP later in the day or at night. Accordingly, Table C sets higher FDP limits for augmented FDPs that begin in the morning and lower FDP limits for augmented FDPs that begin later in the day or at night.

In selecting the specific timeframes for Table C, the FAA was primarily concerned with the quality of pre-FDP rest obtained by the flightcrew members, and not with whether those flightcrew members' FDP required them to work during the WOCL. This is because the redundancy inherent in an augmented operation ensures that there are extra flightcrew member(s) available to take over the duties of someone who becomes unduly fatigued during the WOCL. Since the timeframes of the unaugmented FDP limits in Table B were calibrated to ensure that unaugmented flightcrew members with long FDPs do not work during the WOCL, the specific timeframes of the augmented FDP limits in Table C (which address a different concern) are different from the timeframes of Table B.

The FAA has considered Drs. Belenky and Graeber's suggestion that, based on unpublished modeling data studying long-haul flights, there is no need to differentiate between the different departure times so long as in-flight rest was provided during the second half of the flight. The FAA notes that the modeling data cited by Drs. Belenky and Graeber relies on in-flight rest being provided during the second half of the flight. However, in order to provide operational flexibility to air carriers, this rule requires that only the pilot who will be flying the aircraft during landing receive his or her in-flight rest during the second half of the FDP. As such, the FAA is unpersuaded by the fatigue modeling data cited by Drs. Belenky and Graeber because that data does not take into account the fatigue levels of all the members of the augmented flightcrew.

The FAA has also considered ATA's argument that augmented flights leaving later in the day would provide in-flight sleep during the WOCL for flightcrew members who would be manipulating the controls during landing. However, there is little real-world data concerning the extent of the mitigation provided by in-flight sleep during the WOCL. The FAA is particularly concerned about whether the benefits of in-flight WOCL sleep would outweigh the less-restful daytime sleep obtained by flightcrew members who begin FDPs later in the day. Consequently, the FAA has decided to retain the shorter FDP limits for augmented FDPs that begin later in the day, but this position may change if FRMS-provided real-world data addresses the FAA's concerns in this area.

The FAA has decided to retain the departure-time-based approach in Table C because, as discussed above, that approach is necessary to take into account the quality of rest that a flightcrew member receives immediately prior to beginning an FDP. However, in response to industry concerns, the FAA has determined that a slight upward adjustment to the FDP limits in Table C would not have an adverse effect on safety. This is because, as discussed in the Flight Time section, the flight-time limits for augmented operations effectively limit the time that each augmented flightcrew member spends flying an aircraft to approximately 8.5 hours. Accordingly, the FAA has increased each of the FDP limits in Table C by one hour. The FAA is also open to the possibility of further increasing the FDP limits in Table C if additional data is provided, as part of the FRMS process, showing that longer augmented FDPs do not have an adverse impact on safety.

The FAA has considered the labor groups' concern that the specific limits in Table C somewhat deviate from the TNO Report's rationale. However, the FAA believes that these deviations are justified in light of the fact that the flight-time limits in this rule curtail the time that flightcrew members spend engaged in the fatiguing activity of piloting an aircraft. As discussed above, each of the augmented flight-time limits has been calibrated so that each flightcrew member only spends approximately 8.5 hours flying the aircraft. Because the remainder of each flightcrew member's FDP is spent either resting or doing less-fatiguing activities, the FAA has determined that an upward deviation from the TNO Report is justified in this case.

The FAA agrees that the TNO Report has not yet been validated in the aviation context. However, the TNO

[63] *See, e.g.,* James K. Wyatt, *et al., Circadian temperature and melatonin rhythms, sleep, and neurobehavioral function in humans living on a 20-h day,* Am. J. Physiol. 277 (4), at R1160–62 (1999); Torbjorn Akerstedt & Mats Gillberg, *The Circadian Variation of Experimentally Displaced Sleep,* Sleep, Vol. 4, No. 2, at 159–69 (1981).

Report contains the latest scientific evaluation of onboard rest facilities, and the report also contains the most comprehensive evaluation of these facilities. Consequently, the FAA finds the TNO Report to be persuasive in this case.

The FAA understands the need to proceed cautiously with setting the limits for augmented operations. That is why this rule largely retains the existing flight-time limits for augmented flights. These flight-time limits curtail the time-on-task of each flightcrew member and serve as a crucial mitigation measure against fatigue. The specific flight-time limits are set at levels with which the FAA has significant operational experience and that have scientifically been shown to be relatively safe.[64] As discussed above, given the time-on-task mitigation provided by the flight-time limits, the FAA has determined that a slight increase to the proposed FDP limits would have no adverse impact on flight safety.

NACA stated that the proposed language was unclear as to whether the two-hour in-flight rest opportunity was required for each augmented flight segment. Drs. Belenky and Graeber criticized the proposed requirement that flightcrew members manipulating the controls during landing receive their in-flight rest during the last flight segment. They stated that the last flight segment on an augmented flight may be short, in which case the flightcrew members manipulating controls during landing would not receive their in-flight sleep during the most optimal FDP time. As an alternative, Drs. Belenky and Graeber suggested allowing in-flight rest to occur before the last flight segment, but then limiting the flightcrew members to only conducting one more landing after their in-flight rest. ATA and CAA endorsed Drs. Belenky and Graeber's analysis.

ATA, CAA, Atlas Air, Delta, and UPS criticized the proposed requirement that in-flight rest for flightcrew members manipulating the controls occur during the last flight segment. ATA stated that to accommodate this requirement, the last flight segment would have to be at least 3.5 hours long, which would not accommodate some current operations. ATA and UPS added that turbulence or other factors affecting the final leg—such as a diversion—may also prevent the landing pilot from receiving a full two hours' rest on the last leg. UPS stated that a customer in a supplemental operation may require a short final segment. Atlas Air stated that some of its customers request short flight segments as the last segments of an FDP.

ATA and Delta recommended that the in-flight rest for flightcrew members landing the aircraft be permitted to take place during the last six hours of the FDP. UPS recommended that the required in-flight rest for the landing flightcrew take place during the last eight hours of the FDP.

NACA recommended doing away with the two-hour and ninety-minute in-flight rest requirements altogether, arguing that shorter amounts of rest were also recuperative. In support, NACA cited a NASA study showing that a short in-cockpit nap mitigated short-term fatigue. NACA also stated that NTSB records do not reveal a single accident involving an augmented crew in which fatigue was a factor.

Drs. Belenky and Graeber also argued that the 2-hour required in-flight rest opportunity could be broken up and distributed over multiple flight segments. In support, they cited the 2003 Bonnet and Arand clinical review for the proposition that rest of less than 2 hours would be beneficial in the augmentation context. They also cited a NASA study showing that short cockpit naps could be used to mitigate short-term fatigue.

ALPA, IPA, CAPA, Flight Time ARC, and other labor groups suggested that the 2-hour sleep requirement for the flightcrew member manipulating the controls during landing apply to both flightcrew members who will be occupying a control seat during landing. These commenters emphasized that both flightcrew members manipulate the controls, *i.e.,* the non-flying pilot normally operates flaps, landing gear and radios and performs monitoring so he must be equally alert. The commenters added that there are also other high workload circumstances where both pilots are manipulating the controls such as when a landing must be rejected or decision-making is required for diversion. Conversely, Delta stated that only one flightcrew member actually manipulates the controls to land an aircraft while the other flightcrew member at the control station performs secondary functions.

NJASAP asked whether the 2-hour and 90-minute rest requirements for augmented operations were cumulative. Specifically, NJASAP asked whether flightcrew members who will be manipulating the controls during landing are required to have in-flight rest totaling 3.5 hours. NJASAP and North American Airlines also asked whether there was a minimum length for a flight segment in an augmented FDP. NJASAP suggested that each flight segment in an augmented FDP should be long enough for a flightcrew member to gain sufficient amounts of in-flight rest. North American Airlines suggested that subsections 117.19(c) and (d) be eliminated in order to prevent confusion. NJASAP also asked when the flightcrew member who will land the plane should end his or her in-flight nap and take his or her space at the flight controls.

The reason that the proposed rule required two hours of rest during the last flight segment for flightcrew members who will be manipulating the aircraft controls during landing was to ensure that the landing flightcrew members obtain fatigue-mitigating rest close to the time that they begin the landing. However, the FAA agrees with commenters that requiring the rest to take place during the last flight segment unnecessarily limits existing operations, some of which use a short flight segment as the last segment of an augmented operation. As such, this section has been amended to require that the flightcrew member who will be flying the aircraft during landing receive his or her in-flight rest during the second half of the FDP. This amendment allows air carriers flexibility with scheduling flight segments for augmented FDPs while at the same time ensuring that the landing flightcrew member receives at least two hours of continuous rest close to the time that he or she will be landing the aircraft.

The FAA has also considered the NASA study cited by NACA. This NASA study showed that a 40-minute sleep opportunity resulting in a 20–26 minute nap created a relative improvement in alertness for the 90-minute period following the nap. However, this study does not justify eliminating the requirement that the flightcrew member who will be flying the aircraft during landing receive two hours of rest during the second half of the FDP. This is because the NASA study did not establish whether the 20–26 minute nap mitigated fatigue for more than 90 minutes after the nap was taken. As such, if a landing flightcrew member takes his or her in-flight rest at the beginning of the FDP, it is unclear from the results of the NASA study whether the benefits from the short in-flight nap would still exist at the end of that flightcrew member's FDP when that flightcrew member is engaged in the safety and work-intensive task of landing an aircraft.

The FAA also notes that it is retaining the requirement that the 2 hours of rest be continuous. This is because there is an overhead cost associated with getting

[64] *See* Folkard, *supra* note 15, at 98 (showing an exponential increase in accident risk after the 8th and 9th hour of work).

to sleep, and a person waking up from a nap also does not immediately become fully alert upon waking up. Consequently, if a person takes only one continuous nap, the going-to-sleep/waking-up costs only have to be paid once. However, if a single nap is split up into multiple naps, those costs have to be paid each time a nap is taken. Because augmented flights will only be in the air for a limited amount of time, the additional going-to-sleep/waking-up costs would reduce the total amount of time available for recuperative in-flight rest. As such, to maximize the amount of recuperative rest obtained by augmented flightcrew members and minimize the costs associated with going to sleep and waking up, the minimum in-flight rest requirements in this section require that the rest be continuous.

As Delta pointed out, only one flightcrew member actually flies the aircraft during landing while the other flightcrew member on the flight deck performs secondary functions. While these secondary functions are important, they are not as task-intensive as landing an airplane. Therefore, this section only requires two hours of in-flight rest in the second half of the FDP for the pilot who will be flying the aircraft during landing. The regulatory language in this section has been clarified accordingly. The regulatory language in this section has also been amended to clarify that the ninety-consecutive-minute rest opportunity is only necessary for the pilot who will be performing the secondary monitoring duties on the flight deck during landing.

In addition, the 2-hour and 90-minute rest requirements for augmented operations are not cumulative. If a flightcrew member only performs secondary monitoring duties during landing, that flightcrew member is only required to have a minimum of 90-minutes of in-flight rest. If a flightcrew member flies an aircraft during landing, that flightcrew member is required to have a minimum of 2 hours of in-flight rest in the second half of his or her FDP.

Based on these rest requirements, at least one flight segment in the second half of the augmented FDP of a flightcrew member who will be flying an aircraft during landing must exceed two hours so that the flightcrew member can obtain his or her minimum continuous in-flight rest. This flight segment need not be the last flight segment of the FDP. The two hours of in-flight rest simply needs to take place in the second half of the FDP of the flightcrew member who will be flying the aircraft during landing.

The flightcrew member who will be flying the aircraft during landing should end his or her in-flight nap and assume control of his or her duty station before the top of the descent, which is about 45 minutes to 1 hour before landing. This is will allow the flightcrew member to take into account all of the surrounding circumstances before reducing the aircraft's altitude in preparation for an eventual landing.

NJASAP asked whether certificate holders could use augmentation on domestic operations. ATA asked that the FAA ''affirmatively state in the rule text that for the purposes of operational reliability and flexibility, carriers can augment any flight that would not otherwise require and/or qualify for augmentation.'' A number of air carriers stated that augmentation on domestic flights should be permitted because the science underlying domestic and international augmentation is the same.

Conversely, three individual commenters, APA, NJASAP, and Captain Sullenberger stated that augmented flightcrews should be used only on international and not domestic flights. NJASAP emphasized that ''[a]ugmented crews were intended to allow an aircraft to fly to a destination which was too far to reach under the flight rules governing two flightcrew members, meaning a flight route too long over a geographical region which prohibited the allowing of changing crews.'' APA stated that domestic flights are capable of replacing the crew between flight segments, and thus, they do not have the same need for augmentation as international flights.

This rule permits augmentation on domestic and international FDPs that meet the criteria set out in section 117.17. This is because, as the air carriers correctly pointed out, augmentation mitigates fatigue the same way on both domestic and international flights. Therefore, augmentation allows air carriers to safely schedule longer FDPs both domestically and internationally.

While augmentation was originally designed to allow air carriers to schedule longer flights, that is not a sufficient justification to limit augmentation to international flights. As an initial matter, some domestic flights are longer than some international flights. Thus, for example, a flight from Atlanta to Mexico City, which is an international flight, is shorter than a flight from Washington DC to Los Angeles, which is a domestic flight. In addition, augmentation provides safety benefits on shorter flights as well as longer flights. A flightcrew member working on an 8-hour augmented FDP will be able to obtain in-flight rest and all of the other benefits of augmentation. Consequently, the augmented flightcrew member will have a less-fatiguing FDP than an unaugmented flightcrew member working on a similar FDP.

The FAA has determined that the ability to replace flightcrew members between flight segments is also not a sufficient justification for prohibiting augmentation on domestic flights. Many of the air carriers that fly international routes have a substantial international presence and could easily replace flightcrew members between flight segments on international flights. Conversely, some air carriers do not have a substantial presence at some of the smaller domestic airports, and these air carriers may find it more difficult to replace flightcrew members between domestic flight segments involving those airports.

Because augmentation provides the same amount of fatigue mitigation on both domestic and international flights and because there is no meaningful justification for prohibiting augmentation on domestic flights, this rule permits augmentation on both domestic and international flights.

NACA, CAA, North American Airlines, and Capital Cargo objected to augmented flights being limited to three flight segments. Capital Cargo stated that multi-segment augmented FDPs are safe because flightcrew members on those FDPs receive in-flight rest. Conversely, ALPA, IPA, CAPA, NJASAP, Flight Time ARC, and other labor groups stated that the TNO report was only intended for one-segment flights, and as such, multi-leg augmentation should only be allowed when no crew change is possible. ALPA emphasized that ''[m]ulti-leg augmentation should never be allowed solely for the purpose of extending a flight duty period.'' NJASAP asserted that multi-leg domestic augmentation is counter to the intent behind augmentation. IPA, CAPA, and IBT Local 1224 suggested that only two flight segments should be permissible for an augmented FDP.

As discussed in the Unaugmented FDP section, there is evidence that additional flight segments increase flightcrew member fatigue. Because existing augmented operations generally do not exceed three flight segments, the FAA has little data concerning the effects of FDPs consisting of more than three flight segments on the fatigue levels of augmented flightcrew members. As such, the FAA has decided to permit augmented FDPs of three flight segments or less, which are used in existing operations, and to require additional FRMS-provided data from air carriers wishing to exceed the three-flight-segment limit.

ATA and UPS stated that the FDP limits for four-pilot crews are counter to science because they permit longer FDPs for pilots who land during the WOCL than for pilots who do not land during the WOCL. As such, ATA suggested that the limits for four-pilot operations ''be adjusted to uniformly reflect the maximum values currently set forth in the table.'' ATA stated that such an adjustment would make this rule similar to other standards like CAP–371.

Conversely, IPA, CAPA, IBT Local 1224, and Flight Time ARC suggested that the FAA not allow four-pilot augmentation for flights with a Class 3 rest facility. These commenters argued that a Class 3 rest facility only provides marginal rest, and placing more pilots on board with this type of facility would just increase the likelihood that there will be more fatigued pilots.

As discussed above, the specific timeframes in Table C were calibrated to take into account only the quality of rest received by each flightcrew member before beginning an FDP. Because of the redundancy safeguards inherent in augmentation, the FAA determined that there was less of a safety concern associated with augmented pilots flying an aircraft during the WOCL.

Turning to the distinction between three- and four-pilot flightcrews, the reason that Table C sets lower limits for three-pilot crews than it does for four-pilot crews is that, in a three-pilot crew, each pilot spends more time piloting the aircraft. Take, for example, a 12-hour flight segment. Because two pilots are required to operate the aircraft, pilots in a four-pilot crew working in shifts of two would each spend 6 hours on the flight deck. Conversely, pilots in a three-pilot crew working in shifts of two would each spend 8 hours on the flight deck. Because pilots working as part of a three-pilot crew spend more time piloting the aircraft and less time resting, Table C sets lower FDP limits for three-pilot crews.

The FAA understands that this distinction makes this rule different from other regulatory rules, such as CAP–371, which do not distinguish between three and four-pilot augmented crews. Here, while CAP–371 does not distinguish between three- and four-pilot crews, it addresses the safety issues associated with augmentation flights in other ways by requiring three hours of in-flight rest during augmented operations[65] instead of the ninety minutes to two hours required by this rule.

The FAA has also decided to retain augmentation for four-pilot flightcrews on flights with a Class 3 rest facility because, even though these flights have a lower-quality rest facility, each of the pilots in the four-pilot flightcrew will spend less time piloting the aircraft than the pilots in a three-pilot flightcrew. Consequently, the members of the four-pilot augmented flightcrew will accumulate less fatigue during their flight than the members of the three-pilot augmented flightcrew. The lower quality of the Class 3 rest facility is instead reflected in the relatively-low FDP limits associated with that facility.

APA suggested amending subsection 117.19(e) to add a requirement that the PIC-type-rated flightcrew member be fully qualified and landing current. APA stated that the flightcrew member(s) flying the aircraft need to be capable of performing a landing because unforeseen circumstances during the flight may require the flightcrew member(s) in the cockpit to make a prompt emergency landing. NJASAP stated that all flightcrew members in an augmented operation should be type-rated.

In response to APA's concern, the language in section 117.19(e) has been amended to require that at least one flightcrew member on the flight deck must be qualified in accordance with 14 CFR 121.543(b)(3)(i). A flightcrew member qualified in accordance with section 121.543(b)(3)(i) will be both fully qualified and landing current.

Turning to NJASAP's concern about all flightcrew members being type-rated, the FAA notes that the existing regulations require the second in command (SIC) to be type-rated for all non-domestic flights. *See* 14 CFR 61.55(a)(3). While these regulations do not require the SIC to be type-rated on domestic flights, the FAA has determined that 14 CFR 121.543(b)(3)(i) requires a high degree of training, and having at least one flightcrew member on the flight deck who is qualified in accordance with this section provides sufficient staffing to safely operate the aircraft and respond to any unforeseen circumstances that may arise.

Boeing asked for clarification about whether FDPs consisting of a mix of augmented and unaugmented flights are subject to Table B or Table C.

The FDP and flight-time limits for augmented operations were set at higher levels based on the assumption that flightcrew members working on those operations would obtain the fatigue-mitigation benefits of augmentation. A flightcrew member who works on an unaugmented flight does not obtain these fatigue-mitigation benefits. As such, if an FDP contains both an augmented and an unaugmented flight, that FDP is subject to the unaugmented FDP-limits set out in Table B and the unaugmented flight-time limits set out in Table A.

IPA, CAPA, Flight Time ARC, and other labor groups also suggested that, to ensure proper in-flight rest, this rule require a Class I rest facility for any augmented FDP in which the flight time exceeds 12 hours.

As discussed in the Flight Time section, the flight-time limits for augmented FDPs have been set so that each flightcrew member flies the aircraft for approximately 8.5 hours. Because this flight-time restriction limits each flightcrew member's time-on-task to acceptable levels, there is no need to impose minimum rest facility limitations for sub-categories of augmented operations.

NACA suggested, without elaboration, that the FDP limits for unacclimated flightcrew members be decreased by 1 hour instead of the proposed 30 minutes. ALPA, IPA, IBT Local 1224, and Flight Time ARC argued that the proposed 30-minute reduction for unacclimated flightcrew members is too simplistic. As an alternative, these commenters proposed a Table D, containing FDP limits for unacclimated flightcrew members, which decreased unacclimated flightcrew member FDP times by values ranging from 20 to 50 minutes (depending on the time of day).

The 30-minute FDP-limit reduction for unacclimated flightcrew members was imposed to account for the additional fatigue experienced by these flightcrew members. The FAA is unaware of NACA's reasons for suggesting that the FDP reduction for unacclimated flightcrew members be increased to one hour.

Turning to the suggestions put forward by the labor groups, because the unacclimation reductions set out in the commenters' suggested Table D are relatively close to the FAA-proposed 30-minute reduction, the FAA has decided to retain the 30-minute reduction for the sake of regulatory simplicity. As commenters have pointed out elsewhere, parts of this rule are somewhat complex, and as such, the FAA has determined that adding another table solely for unacclimated flightcrew members would add undue complexity to this section.

ALPA, IPA, CAPA, and IBT Local 1224 recommended changing the label in Table C for ''Time of start'' to clarify that the timeframes specified in Table C are based on home base or acclimated

[65] CAP–371, section 15.3.

time. The FAA adopts this recommendation, and the label in Table C has been changed to clarify that the ''Time of start'' in Table C is based on home base or acclimated time.

I. Schedule Reliability

In the NPRM, the FAA proposed reporting requirements to facilitate realistic scheduling by the certificate holders. Proposed § 117.9, Schedule reliability, would have required the certificate holder to adjust (1) its system-wide FDPs if the total actual FDPs exceed the scheduled FDPs more than 5% of the time; and (2) a specific FDP if it is shown to exceed the schedule 20% of the time. The certificate holder would have to adjust its schedule within 60 days for any FDP(s) that exceeded the above-stated percentages.

The FAA also proposed that each certificate holder must submit a report every two months detailing the adjustments described above (the overall schedule reliability and pairing-specific reliability) and include the following information: (1) The carrier's entire crew pairing schedule for the previous two-month period, including the total anticipated length of each set of crew pairings and the regulatory limit on such pairings; (2) the actual length of each set of crew pairing; and (3) the percentage of discrepancy between the two data sets on both a cumulative, and pairing-specific basis.

No commenters supported the requirements for schedule reliability as proposed. Many commenters argued that the proposed requirements were unnecessary as they would not do anything to mitigate transient, cumulative or chronic fatigue. Others believe that the proposal was seriously flawed and that adjustments to the proposed requirements were necessary.

Pinnacle, RAA, ATA, Alaska Airlines, Continental, American Airlines and Capital Cargo International Airlines (CCIA) contend that the schedule reliability section should be deleted entirely. They argue that these proposed requirements do not advance fatigue mitigation and present unjustified costs and burdens on certificate holders. RAA stated that the NPRM did not set forth any discussion of a statistical basis/reality check for the selection of a 5% FDP ''late arrival'' rate for the certificate holder's operation as a whole, or as the trigger point for when the certificated holder must take action to ''adjust.'' Similarly, RAA states that there is no discussion to support the selection of 20% for a particular FDP that actually exceeds the scheduled time. RAA also commented that there is limited likelihood that the flightcrew member FDP reliability analysis under the NPRM would differ greatly from an airline's on-time arrival statistics even if the proposed regulatory text is changed to reflect a 14-minute ''grace period'' that DOT affords in its on-time reporting statistics.

Several commenters, including CAA, UPS, World Airways, American Eagle Airlines (AE), and ALPA, also objected to the schedule reliability provision and suggested that instead of reporting when actual FDPs exceed scheduled FDPs, certificate holders should only report FDPs that exceed the maximum limits under the regulations. They argue that as long as the flightcrew member's FDP falls within the parameters of the maximum permitted under the regulation, the certificate holder must have the operational flexibility to manage schedules as they determine. The commenters also stated that a reporting schedule which requires a certificate holder to detail occurrences that exceed the maximum limits provided in Tables B and C, and to adjust the schedules that consistently exceed those limits, is reasonable.

Commenters also submitted varying timeframes for the reporting. Some recommended 30 days, other suggested quarterly reporting. There were various comments on how long the certificate holder had before taking corrective action.

IBT Local 1224, IPA, the Flight Time ARC, and FedEx ALPA recommended that the schedule reliability section extend to flight segments as well.

IATA commented that any reporting requirements should relate directly to fatigue and not to compliance with published schedules. UPS stated that the reporting requirements should be seasonal to comport with schedule changes. UPS also argued that schedule reliability would actually increase fatigue because certificate holders would pad time spent on the ground during multi-segment FDPs, which would result in a corresponding reduction in restorative layover rest. UPS and NAC contend that this section addresses domestic scheduled operations and is illogical for others, particularly non-scheduled operators.

The FAA acknowledged in its Response to Clarifying Questions that the NPRM discussion on schedule reliability was confusing. The FAA also acknowledges that this section as proposed raised considerable concerns from virtually all commenters. After reviewing the comments, the FAA concludes that the concept of schedule reliability is better addressed by the simpler approach recommended by the group of commenters, who suggested reporting actual FDPs that exceed the maximum regulatory limits. This is discussed in detail in the next section.

J. Extensions of Flight Duty Periods

The FAA agrees that FDPs that exceed the maximum FDP permitted under Table B are the ones that directly impact fatigue and must be addressed by the certificate holder. Adopting this approach will make the certificate holder accountable for scheduling FDPs realistically. While a certificate holder can schedule FDPs up to the maximum presented in the tables, it is unlikely to do so because of the cumulative limits (weekly and monthly) on FDPs. This approach addresses a significant portion of the commenters' concerns. Proposed section 117.9 is deleted and the FAA adopts new § 117.19 Flight Duty Period Extensions.

This new section sets forth the limits on the number of FDPs that may be extended; implements reporting requirements for affected FDPs; and distinguishes extended FDPs due to unforeseen operational circumstances that occur prior to takeoff from those unforeseen operational circumstances that arise after takeoff. For purposes of maintaining all requirements for FDP extensions in a single section, the provisions permitting extended FDPs based on unforeseen circumstances proposed in § 117.15 FDP: Un-augmented operations and § 117.19 FDPs: Augmented flightcrew are now codified in § 117.19.

RAA, Southwest Airlines and World Airways object to the pilot in command being the decision maker on whether to extend an FDP. Continental, however, recommends that the decision to extend a FDP should be a joint decision between the pilot in command and the certificate holder. APA commented that the decision of the pilot in command is crucial in determining whether to extend an FDP.

The FAA agrees that the responsibility for determining whether a FDP needs to be extended rests jointly with the pilot in command and the certificate holder. This ensures that one party is not taking excessive action over another party, and that proper considerations are factored into the decision-making. Paragraph (a)(1) of this section permits, under unforeseen operational circumstances that arise prior to takeoff, the pilot in command and the certificate holder to extend the maximum FDP permitted in Table B and C by two hours.

In the NPRM, the FAA specifically questioned whether the proposed two-hour extension was appropriate.

SWAPA opposed any extension beyond the free 30-minute extension and argued that this would invite abuse. NJASAP supported one extension up to two hours, as long as compensatory rest was applied following the extension. IPA supported the two-hour extension as reasonable but opposed the three-hour extension for augmented operations because greater rest opportunities are not provided for those operations. APA supports the limits on extensions and argues in particular that the 12–13 hour period repeatedly has been cited as a point at which accident risk increased dramatically. APA also commented, however, that there are certain circumstances in which a FDP can be safely extended beyond the two hours contemplated in the NPRM. NACA supports a two-hour extension for both augmented and unaugmented operations.

The FAA agrees that an extension must be based on exceeding the maximum FDP permitted in Table B and C. It is unreasonable to limit extensions on FDPs that are less than what the certificate holder can legally schedule. In addition, there is a 30-minute buffer attached to each FDP to provide certificate holders with the flexibility to deal with delays that are minimal. However, after the 30-minute buffer, any time that the FDP needs to be extended, the requirements and limitations of this section apply. In the NPRM, the FAA proposed a two-hour FDP extension for unaugmented operations due to unforeseen operational circumstances and a three-hour FDP extension for augmented operations under similar situations. The FAA concludes that there is no distinction for FDP extension based on whether the operation is conducted by an augmented flightcrew. The difference between unaugmented and augmented operations is accounted for by the different hourly limits in Tables B and C. The hourly limits of Table C were developed in consideration of the extra flightcrew members and rest facilities onboard the aircraft for augmented operations that mitigate the effects of longer FDPs. There is no further mitigation that warrants an additional hour for an augmented crew. The FAA believes that two hours is reasonable and provides the certificate holder with sufficient operational flexibility to adjust for unforeseen operational circumstances. If an unforeseen operational circumstance occurs prior to takeoff, a flightcrew member cannot accept an extended FDP if the completion of that FDP would be more than two hours beyond the maximum FDP permitted under Table B and C for that flight.

In the NPRM, the FAA proposed that an extension of an FDP of more than 30 minutes may occur only once in any 168 consecutive hour period. Hawaiian Airlines, IPA, IBT Local 24, Alaska Airlines, Aloha Air Cargo and several individual commenters supported this proposal. One commenter suggested one extension in a 90-day period. SkyWest, United, FedEx Express, ATA, and CAA argue that one extension is too restrictive and does not allow any operational flexibility to recover a schedule after an event. SkyWest suggested up to three extensions per week with a total of eight per month. ATA argued that the once in 168 hours rule ''is another example of a requirement made unnecessary by other mitigations in the NPRM and which will result in unjustified adverse impacts.'' ATA and CAA support the statements submitted from Drs. Belenky and Graeber, who commented ''that clear science supports that extended work hours over consecutive work days reduces the opportunity for sleep, which can lead to cumulative sleep loss and fatigue. However, there is no scientific evidence to support limiting an extension to once in seven days.'' They further comment that extensions should not be permitted on consecutive days in order to allow for sleep recovery and no more than two extensions within any one 168 hour period. RAA, Continental, North American, Southwest and two individuals requested two extensions in a 168 consecutive hour period. Kalitta Air and North American Airlines support two non-consecutive extensions in 168 hours, with a 16-hour rest period required if the second extension actually occurs.

Lynden Air Cargo, Southern Air and NACA object to the limit on extensions. They argue that supplemental, non-scheduled operations require flexibility to schedule their operations that is not needed by the domestic scheduled community because they have crews on reserve for use in lieu of extensions.

The FAA is not persuaded by the commenters that more than one extension is appropriate within a 168 consecutive hour period with one exception, discussed below. The elements of the flight and duty requirements adopted in this rule present a conceptual departure from the practice that is in place under the current rules. Under the current rules, extensions of flight time were largely unrestricted as long as a flightcrew member was provided with compensatory rest. Under the requirements adopted today, rest is prospective and the certificate holders are responsible to schedule realistically so that FDP limits can be maintained. Permitting weekly extensions simply encourages scheduling to those extensions and undercuts the purposes of strict limits on FDPs.

In response to the commenters however, the FAA is modifying one aspect of this requirement. In the NPRM, an FDP extension was limited to once every 168 consecutive hour period. While this limited potential abuse of extensions, it did result in an illogical outcome based on certain facts. For example, a flightcrew member that has an FDP extended on Day 1 and then has two days off would be unable to accept another extended FDP on Day 4. After having 48 hours rest, that flightcrew member would not be subject to fatigue based on a two-hour extended FDP. Paragraph (a)(2) provides that an extension of the FDP of 30 minutes or more may occur only once prior to receiving a rest period described in § 117.25(b).[66] This provides certificate holders with one extended FDP but resets the clock for the 168 consecutive hours limit if a rest period of 30 hours or more has been received. Furthermore, the FAA is mindful of the daily tracking and recordkeeping/compliance burden placed on both individual flightcrew members and the certificate holders by a rolling 168 consecutive hour period. This modification will alleviate this tracking requirement.

The FAA has included, in paragraph (a)(3), that a flightcrew member's FDP may not be extended due to unforeseen operational circumstances that occur prior to takeoff if such extension could cause the flightcrew member to exceed the cumulative FDP limits specified in § 117.23(c). The basis for this provision is that prior to takeoff a flightcrew member will know whether the delay will result in the flightcrew member exceeding the cumulative limits. If so, the flightcrew member cannot continue the flight.

In lieu of the reporting requirements proposed under the schedule reliability, the FAA adopts a two-prong requirement for reporting extended FDPs. In addressing unforeseen operational circumstances, it is critical to distinguish those situations that arise prior to takeoff and those that arise after takeoff. Under both situations, the certificate holder must report to the FAA within 10 days any FDP that

[66] Section 117.25(b) provides that before beginning any reserve or FDP, a flightcrew member must be given at least 30 consecutive hours free from all duty in any 168 consecutive hour period, subject to certain limitations.

exceeded the maximum FDP permitted by Table B or C by more than 30 minutes. In this report, the certificate holder must describe the FDP and the circumstances surrounding the need for an extension. If the situation giving rise to the extension occurred prior to takeoff, the certificate holder must address in this report whether the circumstances giving rise to the extension were within its control. Since it is prior to takeoff, once the certificate holder becomes aware of such issue, the certificate holder and pilot-in-command have discretion to evaluate the situation and determine whether it is permissible and appropriate to extend the applicable FDPs and continue with the flight or whether it is more appropriate to replace the affected flightcrew member. Therefore, in situations where the circumstances were within the certificate holder's control, the certificate holder must include in its report the corrective actions that it intends to take to minimize the need for future extensions. The certificate holder then has 30 days to implement such corrective actions. For situations that are not within the certificate holder's control, it is unlikely that there is a corrective action that can be taken. Therefore, under these scenarios, the certificate holder must simply report the extension within 10 days and provide the details surrounding the need for the extended FDP.

Similarly for situations that arise after takeoff, the certificate holder and pilot in command have very little discretion concerning FDPs and flight time limits. Therefore, if an FDP or flight time needs to be extended due to unforeseen circumstances that occur after takeoff, the pilot-in-command and the certificate holder may extend the subject FDPs and flight time, to the extent necessary to safely land the aircraft at the next destination airport or alternate airport, if appropriate. In addition, the extended portion of the flightcrew member's FDP and flight time will be permitted in the flightcrew member's weekly and annual cumulative limits on FDP and flight time limitations. The certificate holder also must report the extension to the Administrator within 10 days of occurrence with the same level of detail as described above.

The reports for extended FDPs and flight time will be forwarded to the appropriate certificate-holding district office where the FAA will monitor all extensions filed. The FAA will review the circumstances surrounding the need for the extensions and if appropriate, whether the circumstances were, in fact, beyond the certificate holder's control. As explained in the NPRM, this determination is on a case-by-case basis. Certificate holders must be aware of scheduling operations into and out of chronically delayed airports. Similarly, certificate holders must be mindful of anticipated weather conditions, *e.g.,* predicted snow storms/blizzards affecting certain airports in the winter. Obviously, not all weather occurrences, ATC delays, or a variety of other situations can be anticipated and addressed by the certificate holder. However, situations that result from inadequate planning are within the certificate holder's control and will warrant corrective action.

The FAA believes that the above requirements will result in realistic scheduling of FDPs. The FAA selected 10 days for the time period to file a report because it is within the time period for retrieval of ATC and weather data in the event that data is necessary for an investigation. This information may be necessary in addressing extended FDPs so it is critical that the FAA receive the report within the same timeframe. In addition, when situations occur that require an extension, the certificate holder must look at the offending segment and identify whether adjustments are needed.

It must be noted that the FAA will investigate each filed report denoting an extended FDP and flight time. This investigation would be conducted by the certificate management office responsible for day-to-day oversight of the air carrier. If the circumstances are found to be within the certificate holder's control, the certificate holder has responsibility to determine the corrective action and to implement that corrective action within the time period required under the regulations. Failure to adhere to the adopted requirements may result in enforcement by the FAA.

K. Split Duty

Sleep studies show that sleep which takes place during the day is less restful than sleep that takes place at night.[67] Other studies indicate that working during the WOCL substantially degrades the ability of a flightcrew member to safely perform his or her duties.[68] One of the problems that this rule was intended to address is the performance degradation experienced by flightcrew members who conduct overnight FDPs and perform their duties during the WOCL after receiving less-restful daytime sleep. This rule addresses this problem by incentivizing fatigue mitigation measures.

One of these fatigue mitigation measures is split duty which is based on the premise that there are times during an unaugmented nighttime FDP when a certificate holder could reasonably provide a flightcrew member with an opportunity for rest. This rest opportunity (opportunity to sleep) would allow a flightcrew member to get some sleep during the night. The nighttime sleep could be used to mitigate the performance degradation created by working through the WOCL.

To incentivize split duty rest, the FAA proposed that a flightcrew member who received a split duty rest opportunity be allowed to extend his or her FDP by 50% of the available split duty rest opportunity. Under the FAA's proposal, the split duty rest opportunity had to be at least 4 hours long, and it could not be used to extend an FDP beyond 12 hours. The rest opportunity had to be calculated from the time that the flightcrew member actually reached the suitable accommodation (sleep facility).

NJASAP opposed the proposed split duty extension, but noted that the proposed rule presented an improvement over existing limitations on such operations. NJASAP argued that split duty sleep is a theoretical concept that may result in cumulative fatigue and circadian disruption. In support of its argument, NJASAP cited to a study showing that pilots who obtained 7 hours of sleep at night scored consistently worse than pilots who obtained 9 hours of sleep at night. Given this study and the theoretical nature of split duty, NJASAP cautioned the FAA against awarding an FDP extension based on split duty rest.

Conversely, ATA stated that ''science and operational experience supports the concept that a flightcrew member can recuperate because of the opportunity to sleep during a period of their FDP.'' CAA strongly supported the recognition of split duty as a fatigue mitigation measure. One individual commenter also supported the extension of FDPs through split duty schedules.

NJASAP also asked whether the four-hour threshold was mandatory or whether split duty credit could be obtained for split duty rest that was less than four hours. ATA and UPS argued that the four-hour split duty threshold is arbitrary and not science-based. ATA also criticized as unscientific the NPRM's assumption that there is increased overhead involved with falling asleep during a split duty rest. Conversely, FedEx ALPA supported the four-hour split duty threshold, stating

[67] *See, e.g.,* Wyatt, *supra* note 64, at R1160–62; Akerstedt, *supra* note 64 at 159–69.

[68] *See* NASA, *supra* note 22, at 19–34.

that the four-hour threshold is a valid conservative approach until more scientific data is collected.

Drs. Belenky and Graeber cited a 2003 Bonnet and Arand clinical review for the proposition that ''any sleep longer than 20 minutes provides full minute-by-minute recuperative value.'' Based on this review, Drs. Belenky and Graeber asserted that, for night operations, ''any time behind the door of more than 30 minutes would have recuperative value.'' As such, Drs. Belenky and Graeber argued that the four-hour split duty threshold is not supported by science. ATA, CAA, and FedEx supported this conclusion.

NACA, Kalitta Air, Atlas Air, and NAA cited a NASA study, which states that a 45-minute cockpit nap, including use of a jump seat, with a 20-minute recovery resulted in increased alertness for a minimum of 90 minutes of the flight. These commenters argued that, if this type of benefit could be achieved through a cockpit nap, it could definitely be achieved through a ground rest facility.

The FAA agrees with ATA and CAA that split duty is a valid fatigue mitigation measure. Science has shown that naps can serve to mitigate fatigue.[69] Consequently, split duty naps taken at night will permit a flightcrew member to obtain restful nighttime sleep in the middle of his or her FDP. This restful nighttime sleep will decrease that flightcrew member's fatigue level, and will allow him or her to safely work for a longer period of time. As such, the FAA has retained the split duty FDP extension in this rule.

In response to comments about specific split duty provisions, the FAA conducted further SAFTE/FAST modeling to examine the safety-relevant effects of changing the provisions of the split duty section. The SAFTE/FAST model works by predicting flightcrew member effectiveness on a 0 to 100 scale for each minute of that flightcrew member's FDP. Lower predicted flightcrew member effectiveness results in a lower SAFTE/FAST number. An effectiveness level of 77 is approximately equivalent to the effectiveness of someone with a blood alcohol concentration of 0.05.

With regard to the 4-hour threshold, that threshold was included in the proposal to ensure that all flightcrew members obtain a minimum amount of restful sleep during split duty. Upon further modeling, the SAFTE/FAST model showed that a split duty break of less than 3 hours with the corresponding FDP extension would, over a 5-night period, result in flightcrew member effectiveness dropping below 77 for a portion of the FDP. Conversely, a split duty break of at least 3 hours resulted in flightcrew member effectiveness consistently staying above 77 over a 5-night period. Accordingly, this section has been amended to reduce the threshold for the split duty extension to a 3-hour split duty break. In response to NJASAP's question, split duty rest that is less than 3 hours simply counts as part of a flightcrew member's FDP and does not serve to extend the maximum FDP limits.

The FAA disagrees with Drs. Belenky and Graeber's assessment of the Bonnet and Arand clinical review. The studies examined in this clinical review tested the impact that sleep fragmentation had on restfulness and the potential resultant daytime sleepiness. During the course of the studies, subjects would be allowed to fall asleep, and their sleep would then be intermittently disrupted. The studies found that if one's sleep is interrupted every 20 minutes following sleep onset during the night (when one is normally sleeping), that person's daytime sleepiness, as measured by the Mean Sleep Latency Test (MSLT), is the same as someone who has not had their sleep interrupted.

There are two problems with applying the Bonnet and Arand clinical review to split duty. The first problem is that the MSLT results measured by the studies analyzed in the clinical review do not necessarily mean that the performance capabilities of subjects who had their sleep interrupted at 20-minute intervals were equivalent to subjects who did not have their sleep interrupted. All the MSLT results mean is that, when MSLT measurements were taken of subjects who had their sleep interrupted, these subjects did not fall asleep within the MSLT's protocol termination at 20 minutes.

The second problem with applying these studies to split duty sleep is that split duty sleep does not involve sleep fragmentation, but rather a restriction on the total amount of sleep provided during the night. A flightcrew member engaging in split duty sleep will presumably not have his or her sleep cycle intermittently disrupted. Instead, that flightcrew member's total split duty sleep amount may be significantly lower than the 8-hour minimum necessary to recover from fatigue. Because the Bonnet and Arand clinical review did not analyze any studies that actually examined the ''recuperative value'' of receiving less than 8 hours of sleep, that review is not applicable to the minimum threshold necessary to ensure a sufficient amount of split duty sleep.[70]

As the commenters correctly pointed out, a NASA study showed that a 40-minute sleep opportunity resulting in a 20–26 minute nap created a relative improvement in alertness for the 90-minute period following the nap. However, there are three problems with using this study to justify extending a night FDP. First, the NASA study was conducted to see if alertness might be maintained or improved long enough to more safely complete a scheduled flight. The NASA study was not conducted to determine the conditions necessary to extend the flight duty period. Second, the study did not establish whether the 20–26 minute nap mitigated fatigue for more than 90 minutes after the nap was taken.

The third problem with using the above study to extend an FDP is that this study did not explore the full extent of the fatigue mitigation created by the 20–26 minute nap. For example, if a 20-minute split-duty nap was to be used to extend an FDP so that it infringes deeper into the WOCL, would the 20-minute rest provide sufficient mitigation to counter the extra fatigue created by the additional infringement on the WOCL? Because the study concerning the 20–26 minute nap did not provide an answer to the issues discussed above, the FAA has declined to utilize it in determining the threshold rest amount for the split duty FDP extension.

NJASAP asked whether the split duty rest must be scheduled in advance or whether it could be adjusted as necessary by the certificate holder. ATA stated that the 4-hour threshold is operationally unsound because split duty periods are ''calculated dynamically in real time, based upon the actual amount of rest opportunity afforded.'' ATA provided an example of ''split duty rest periods [that] may occur during breaks at a hub while cargo is loaded on an aircraft.'' In those cases, ''[c]rewmembers [would] receive rest in ground facilities during the aircraft loading process.'' UPS disagreed with the extension being based on the flightcrew member's actual rest time ''behind the door'' because it removes an air carrier's ability to shorten split

[69] *See* Daniel J. Mollicone, *et al., Optimizing sleep/wake schedules in space: Sleep during chronic nocturnal sleep restriction with and without diurnal naps,* Acta Astronautica 60, at 354–61 (2007) (examining the fatigue mitigation potential of naps taken during the day).

[70] In a previous Bonnet article, the author also states that ''* * * [i]t does appear that any repetitive stimulation of sufficient magnitude to precipitate any changes in ongoing EEG is sufficient to make sleep nonrestorative.'' Bonnet MH. *Sleep restoration as a function of periodic awakening, movement, or electroencephalographic change.* Sleep, Vol. 10, at 371 (1987).

duty rest in response to an unforeseen circumstance, such as a weather event. UPS stated that this is a significant change from current practice because, currently, split duty rest most often occurs during an unforeseen circumstance. To adjust for this change, UPS asserted that air carriers would have to delay outbound flights, which will increase pilot fatigue by delaying the onset of post-FDP rest.

The FAA has amended the split duty section to clarify that split duty rest must be scheduled in advance, and that the actual split duty rest break may not be less than the scheduled split duty break. The reason for the advance scheduling requirement is that section 117.5(b) requires flightcrew members to determine at the beginning of their FDP whether they are sufficiently rested to safely perform the assigned FDP. In order to accurately perform this assessment at the beginning of their FDP, flightcrew members need to know approximately when their FDP is going to end. Thus, flightcrew members must be notified of any planned split duty extensions before they begin their split duty FDP so that they can accurately self-assess, at the beginning of the FDP, whether they are capable of safely performing their duties throughout the entire FDP. Thus, for example, a flightcrew member who feels fit to accept an overnight FDP that contains five hours of split duty sleep may not feel fit to accept an overnight FDP that contains only three hours of split duty sleep.

In addition, knowing in advance about split duty rest allows a flightcrew member to prepare for, and to maximize, the rest opportunity. For example, a flightcrew member who does not know whether he or she will have a split duty break may drink a cup of coffee only to subsequently find out that he or she must take a three-hour split duty rest 20 minutes later. In contrast, a flightcrew member who knows in advance when he or she is taking a split duty break will not drink coffee shortly before the break. Because flightcrew members must determine their fitness for duty before beginning an FDP and because they must conduct themselves in a way that maximizes their rest opportunities, they must be informed prior to commencing an FDP, about the full extent of the split duty rest that they will receive during the FDP.

The FAA understands that this departs from the current air carrier practice of reducing split duty rest in order to recover a schedule during unforeseen circumstances. To mitigate the impact of this change and account for unforeseen circumstances, this rule provides air carriers with a two-hour FDP extension (discussed previously) that they can use to recover their schedules if unforeseen circumstances arise.

NJASAP asked whether an air carrier could obtain the split duty credit if its flightcrew members do not actually occupy the suitable accommodation during the split duty rest opportunity. UPS criticized the split duty regulation as not taking into account the actual amount of sleep that a pilot receives.

Split duty rest taken under this section does not begin to count until the flightcrew member reaches the suitable accommodation. If the flightcrew member never reaches the suitable accommodation, then that flightcrew member's split duty break will not qualify for a longer FDP. The FAA also emphasizes that, as discussed above, section 117.5(a) requires a flightcrew member to report for duty rested. By virtue of that requirement, flightcrew members must take advantage of any rest periods that are provided, and use them for their intended purpose, which is to sleep.

The FAA has considered UPS' suggestion of amending the split duty extension to track the actual amount of sleep that a flightcrew member receives instead of the length of the split duty break. However, this type of standard would be very difficult to implement because air carriers would need to track when each flightcrew member actually falls asleep. Because this would place a substantial burden on air carriers, the FAA ultimately decided to give credit for the length of the split duty rest opportunity instead of the amount of actual sleep received by the flightcrew members.

Drs. Belenky and Graeber asserted that the 50% split-duty credit was unreasonably conservative for split-duty rest that is taken during usual bedtime hours. However, Drs. Belenky and Graeber cautioned that the 50% credit ''may be warranted for split duties that require daytime sleep.'' ATA stated that the 50% credit was unjustified because a sleep opportunity longer than 20 minutes provides a full minute-by-minute recuperative value. ATA criticized the NPRM's underlying assumption that a four-hour sleep opportunity would only result in two hours of sleep, arguing that this assumption did not apply to ground-based suitable accommodations.

Northern Air Cargo asked for a more generous split duty credit. ATA proposed a split duty credit that increases in proportion to the length of the split duty rest. CAA and FedEx proposed a split duty credit ranging from 100 to 300%, based on the time of day in which the credit is given.

As stated above, in response to comments, the FAA conducted further SAFTE/FAST modeling to determine whether the split duty provision could be modified without decreasing safety. The modeling has revealed that a 100% credit for split duty rest would not result in flightcrew member effectiveness dropping below 77 for any portion of a series of 5-night FDPs. As such, the split duty credit has been increased to provide for an extension equal to 100% of the split duty rest. The FAA has considered CAA and FedEx's suggestion of providing more than a 100% credit, but, due to the concerns associated with nighttime flying, the FAA would need additional data to provide more than a 100% credit for split duty.

The FAA was also concerned with the fact that the above comments appear to show some misunderstanding of how the split duty section works. In order to clarify the meaning of the split duty section, the FAA has amended this section as follows.

First, the split duty framework, as set out in the NPRM, would count split duty rest as part of a flightcrew member's FDP, and then extend that FDP by the amount of the split duty credit. Now that the split duty credit has been increased to 100%, the FAA has determined that the NPRM's split duty framework is needlessly complicated. As such, this section has been amended so that split duty rest that meets the requirements of this section will simply not count as part of the FDP.

Second, split duty rest was intended to be taken at night so that it could provide flightcrew members with restful nighttime sleep. *See* 75 FR 55866. To ensure that the split duty rest credit is not awarded for rest taken during the day, this section has been amended to require that split duty rest only be taken between 22:00 and 05:00 local time.

Third, as the name implies, ''split duty'' rest should be provided in the middle of a flightcrew member's FDP. To ensure that split duty rest is not taken earlier, the FAA has added a condition that split duty rest cannot be provided before the completion of the first flight segment in an FDP. Finally, the FAA has moved all of the split duty conditions into subsections to improve their readability. These changes should provide additional clarity, and ensure that the split duty section is used in the intended manner.

UPS, Kalitta Air, and ATA stated that the credit given for split duty rest in ground-based suitable accommodations was less than the credit given for some augmented flights, which provide a lower quality rest in aircraft-based rest facilities. UPS pointed out that, under the proposed rule, ''[a] 90-minute rest opportunity for a relief officer on an augmented flight in an aircraft with a Class I rest facility permits five additional hours of operation versus an un-augmented flight.'' UPS added that this disparity between augmented flights and split duty ''is even more illogical given that at a ground facility, all flightcrew members receive the same sleep opportunity, whereas while on board, only one pilot can sleep at a time.'' NACA proposed a split duty credit that is consistent with the credit given for Class 1, 2, and 3 rest facilities in augmented FDPs.

Augmented flights and split duty provide different amounts of credit because they pose different safety risks. An augmented flight contains more than the minimum number of flightcrew members, which allows the flightcrew members to work in shifts during a flight to safely fly the aircraft. If, during the flight, a flightcrew member realizes that he or she is too tired to safely perform his or her duties, the extra flightcrew member(s) can simply take over those duties and safely land the flight at its intended destination.

Split duty, on the other hand, applies only to unaugmented flights, which contain the minimum number of flightcrew members necessary to safely fly an aircraft. If, during an unaugmented flight, a flightcrew member realizes that he or she is too tired to safely perform his or her duties, there is no one there who could take over those duties. Instead, the fatigued flightcrew member must eventually land the aircraft to the best of his or her ability. Because a fatigued flightcrew member on an unaugmented flight presents a far greater safety risk than a fatigued augmented flightcrew member, the FAA used a more conservative approach in determining the split duty credit than it did in determining the limits for augmented operations. However, the FAA is open to the possibility of awarding greater credit for split duty within the scope of an FRMS if a certificate holder is able to provide data that shows that additional credit would not reduce safety.

ATA suggested that the FAA allow split duty FDPs to extend beyond the proposed limit on split duty extensions in order to consistently apply the principles that underlie augmented operations. RAA criticized the 12-hour split-duty FDP limit as arbitrary, arguing that it unnecessarily limits FDPs that contain a large amount of restful split duty sleep. RAA also pointed out that the 12-hour limit permits greater split duty extensions for less-safe overnight flights that have a shorter FDP limit. RAA proposed abolishing the limit on split duty extensions. SkyWest proposed setting the split duty FDP limit at 14 hours if the split duty rest is at least 4 hours long. CAA and FedEx stated that the split duty FDP limit should be set at 15 hours.

The SAFTE/FAST modeling that was conducted in response to comments shows that there are no safety concerns with increasing the split duty limit to 14 hours. This section has been amended accordingly. However, the FAA has reservations about a split duty limit that exceeds 14 hours. This is because section 117.25 now requires a 10-hour rest period, and if an FDP is longer than 14 hours, a flightcrew member's FDP/rest cycle will exceed 24 hours. This type of cycle, if done consecutively, will result in the beginning of a flightcrew member's FDP being pushed back each day by the number of hours that the previous day's FDP/rest cycle exceeded 24.

As an example, take an FDP that begins at 5 p.m. That FDP is normally 12 hours long, but with a 7-hour split duty break, that FDP would end at noon. The flightcrew member must then obtain 10 hours of rest, which means that he or she would start the next day's FDP at 10 p.m. The 10 p.m. FDP is normally 11 hours, but with 6 hours of split duty rest, it would end at 3 p.m. the next day. The flightcrew member would then receive 10 hours of rest, which would result in his or her next FDP starting at 1 a.m. Thus, with no limit on split duty FDPs, a flightcrew member could, in three days, go from a 5 p.m. to a 10 p.m. to a 1 a.m. FDP start time. This type of shifting of FDP start times could have serious adverse effects on cumulative fatigue, and without more data, the FAA has determined not to take the risk of allowing split duty FDPs to exceed 14 hours.

NACA, Atlas Air, and NAA stated that, because section 117.5 gives a flightcrew member the discretion to terminate an FDP, there is no need to further restate the flightcrew prerogative to accept or decline split duty accommodations or FDP extensions here.

The FAA agrees with the above commenters, and this section has been amended accordingly. The FAA once again emphasizes that, as discussed above, section 117.5(a) requires a flightcrew member to report for duty rested. By virtue of that requirement, flightcrew members must use their rest periods for the intended purpose which is to obtain sleep.

L. Consecutive Nights

As discussed above, one type of fatigue that this rule addresses is cumulative fatigue. In formulating this rule, the FAA was particularly concerned about cumulative fatigue caused by repeatedly flying at night. *See* 75 FR 55867. SAFTE/FAST modeling showed substantially deteriorating performance after the third consecutive nighttime FDP for flightcrew members who worked nightshifts during the WOCL and obtained sleep during the day. *Id.* However, the FAA noted that if a sleep opportunity is provided during each nighttime FDP, that sleep opportunity may sustain flightcrew member performance for five consecutive nights.

To account for the above factors, the FAA proposed to limit nighttime FDPs to three consecutive nights. However, the FAA proposal allowed a flightcrew member to exceed the three-night limit if that flightcrew member received at least four hours of split duty rest during each of his or her nighttime FDPs.

ATA, NACA, AAC, five individual commenters, and a number of air carriers objected to the consecutive-night limit, arguing that it was unreasonable and ignored operational experience. ATA stated that ''[t]he industry's substantial experience with nighttime operations shows that pilots who frequently perform night duty are well suited to consecutive night duties because they have training and experience specific to such operations.'' NACA, NAA, and Kalitta Air suggested completely removing the consecutive-night limit, arguing that restricted nighttime FDP limits made the consecutive-night limit redundant. AAC also suggested removing the consecutive nighttime limit, arguing that some pilots are capable of adjusting their circadian rhythm to effectively sleep during the day. AAC asserted that a three-consecutive-night limit would unfairly penalize those pilots.

Conversely, one individual commenter stated that consecutive nighttime operations lower alertness. NJASAP, IPA, and IBT Local 1224 supported the consecutive-nights limit. IPA and IBT Local 1224 indicated that, according to science and operational experience, a flight duty period encompassing the hours of 0200 and 0600 is challenging, as fatigue is more likely. These commenters stated that the additional fatigue is a result of working during the WOCL and having the rest period occur during the daytime.

Nighttime operations are particularly fatiguing because flightcrew members who work during these operations do so during the WOCL after obtaining less-restful daytime sleep. Studies have shown that this type of work not only leads to transient fatigue, but also leads to cumulative fatigue if repeated over a series of consecutive nights.[71] SAFTE/FAST modeling also shows flightcrew member effectiveness decreasing after a flightcrew member works on consecutive nighttime FDPs. In addition, a study conducted by the Federal Motor Carrier Safety Administration (FMCSA) found in a laboratory setting that working five nights in a row while sleeping during the day leads to impaired continued performance even if a 34-hour ''restart'' rest period is provided at the conclusion of the five-night work period.[72] This study indicates that simply relying on the required 30 hour rest period in a rolling 168 hour (one week) period is insufficient to assure sustained performance for individuals working nighttime FDPs.

In order to address cumulative fatigue caused by consecutive nighttime FDPs, the FAA has decided to retain the consecutive-night limitation. This limitation is necessary because the restricted nighttime FDP limits in Table B only address the transient fatigue caused by working at night. The limits in Table B remain the same regardless of how many consecutive nighttime FDPs a flightcrew member works, and as such, they do not address the cumulative fatigue caused by repeatedly working through the nighttime hours. With regard to AAC's suggestion that some flightcrew members can effectively sleep during the day, this suggestion (which may be true for certain individuals) generally goes against scientific evidence showing that working on consecutive nighttime FDPs creates a sleep debt.[73] Since regulations are drafted to address the majority of the population, the FAA believes the approach adopted here is appropriate.

Drs. Belenky and Graeber cited the Mollicone 2007 and 2008 laboratory studies for the proposition that a sleep period that was split into two naps (one at night and one during the day) had the same effect as a single continuous block of sleep taken at night. Drs. Belenky and Graeber suggested that 2 hours of split duty rest ''should sustain performance across more than three consecutive nights'' as long as flightcrew members obtained at least 5 hours of sleep during the day. ATA, CAA, and UPS endorsed Drs. Belenky and Graeber's analysis and recommendation.

RAA, ATA, UPS, FedEx and a number of other air carriers added that requiring a 4-hour split duty break in order to exceed 3 consecutive nights would result in more first-night shifts and more day and night duty schedule switches because air carriers will schedule pilots for multiple 3-night series of FDPs rather than a single 5-night FDP series. SkyWest stated that a consecutive-night restriction may disrupt its continuous duty operations, which operate at night and provide flightcrew members with a 4–6 hour rest opportunity. UPS emphasized that the proposed consecutive-night restriction would significantly disrupt its existing business operations. Atlas Air added that cargo air carriers cannot reasonably provide a 4-hour mid-duty break under their current business models.

ATA and CAA emphasized that the consecutive-night limit would disproportionately impact the cargo industry because that industry relies heavily on night operations. UPS stated that, during a night shift, its ''flightcrew members typically enjoy, on average, at least a two hour rest in [its] state of the art sleep facilities.'' FedEx stated that its flightcrew members are typically provided mid-duty rest ranging from 2 to 4.5 hours while freight is offloaded, sorted, and reloaded. UPS asked the FAA to recognize the recuperative value of mid-duty sleep that exceeds 20 minutes.

The Mollicone studies cited by Drs. Belenky and Graeber have, at best, only a limited applicability to the consecutive-night limit because the subjects in those studies received a large block of anchor sleep at night and mid-duty rest breaks during the daytime. In contrast, flightcrew members working on night shifts receive their large block of anchor sleep during the daytime, which, as other studies have shown, provides them with sleep that is less restorative than nighttime sleep.[74]

The FAA was concerned, however, with comments indicating that the 4-hour-mid-duty rest threshold for exceeding the 3-consecutive-night limit was operationally unworkable. The FAA notes that, even though all-cargo operations are not required to abide by part 117, those all-cargo operations that opt into part 117 would be subject to the consecutive-night limit. In response to concerns raised by the commenters, the FAA conducted further SAFTE/FAST modeling to examine the safety ramifications of changing the length of the mid-duty rest break necessary to exceed the 3-consecutive-night limit. The SAFTE/FAST modeling showed that a 5-night FDP, in which a flightcrew member was provided with a 2-hour mid-duty rest break each night, was actually safer than a 3-night FDP with no rest break. The modeling also showed that breaks of less than 2 hours were insufficient to account for the cumulative fatigue of working on multiple consecutive nights.

In response to the data provided by the SAFTE/FAST modeling, the FAA has amended the consecutive-night limit to allow a flightcrew member to work for up to 5 consecutive nights if he or she receives a 2-hour mid-duty rest break each night. This amendment will greatly reduce the burden of the consecutive-night limit on cargo industry that opts into this rule because FedEx and UPS' comments indicate that these carriers already provide their crewmembers who work nightshifts with an average of 2 hours of mid-duty rest. This will allow continuous duty operations to be conducted 5 nights a week if these operations provide flightcrew members with at least 2 hours of mid-duty rest.

RAA, Kalitta Air, Kalitta Charters, Capital Cargo, and four individual commenters suggested amending the consecutive-night limit to permit four nights without any mid-duty rest breaks. ALPA, IPA, SWAPA, IBT Local 1224, and Flight Time ARC suggested allowing four consecutive nighttime FDPs if there is a 12-hour rest period after each FDP. UPS suggested that, if the FAA restricts consecutive nighttime operations, unaugmented flightcrews should be allowed to operate at Table C FDP limits so long as they have received a sleep opportunity in a rule-compliant ground-based facility.

This rule does not allow 4 consecutive nighttime FDPs without a mid-duty rest break because flightcrew member performance deteriorates after a third consecutive nighttime FDP. Increasing the length of the rest between FDP periods is not the preferred way of resolving the issue because nightshift workers get their between-FDP rest during the daytime. Because daytime sleep is less restful than nighttime sleep, the FAA has chosen to focus its regulatory efforts on nighttime mid-duty rest breaks instead of longer daytime

[71] *See* Philippa H. Gander, *et al., Flight Crew Fatigue IV: Overnight Cargo Operations,* Aviation, Space, and Environmental Medicine, Vol. 69, No. 9, Sec. II (Sep. 1998) (discussing sleep debt that builds up over successive nighttime work shifts); Philippa H. Gander, *et al., Crew Factors in Flight Operations VII: Psychophysiological Responses to Overnight Cargo Operations,* NASA Technical Memorandum 110380 (Feb. 1996) (discussing the impact of night shifts on flightcrew members).

[72] *See* Hans P.A. Van Dongen, Gregory Belenky, *Investigation Into Motor Carrier Practices to Achieve Optimal Commercial Motor Vehicle Driver Performance,* Report No: FMCSA–RRR–10–005.

[73] *Id.*

[74] *See* Wyatt, *supra* note 64; Akerstedt, *supra* note 64.

rest breaks. However, if air carriers provide the FAA with FRMS data showing that longer daytime breaks can sufficiently mitigate cumulative fatigue, the FAA may allow those air carriers to exceed the consecutive-night limit. In addition, as discussed in the preceding section, the FAA has reduced to 2 hours the mid-duty-break threshold necessary to work during 5 consecutive nights. This reduction will greatly reduce the burden of the consecutive-night limit on air carriers.

The FAA also declines UPS' proposal of allowing an unaugmented flightcrew working a nightshift to work at the FDP levels specified in Table C. As discussed above, the augmented FDP limits in Table C are higher than the unaugmented FDP limits in Table B because augmentation provides a number of fatigue-mitigation benefits. In contrast, the consecutive-night limit is simply intended to account for the cumulative fatigue caused by working at night and does not replicate the benefits provided by augmentation. Accordingly, imposition of the consecutive-night limit is not sufficient to allow unaugmented flightcrews to work on the longer FDPs that are permitted for augmented flightcrews.

A number of commenters asked the FAA to define ''nighttime FDP.'' Many of the commenters suggested that ''nighttime FDP'' be defined as an FDP that infringes on the WOCL. The consecutive-night limit is intended to apply to FDPs that infringe on the WOCL because operations conducted during the WOCL significantly increase cumulative fatigue. Consistent with the commenters' suggestion, the consecutive-nighttime-operations section has been amended to clarify that the consecutive-night limit only applies to FDPs that infringe on the WOCL. In addition, in light of the amendments that have been made to the split-duty section, the consecutive-nighttime-operations section has also been amended to clarify that an FDP whose split-duty rest infringes on the WOCL counts as a nighttime FDP for the purposes of this section.

NJASAP asked the FAA for clarification about how the rule determines whether two nighttime FDPs are ''consecutive.'' Consecutive nights are determined based on calendar nights. Thus, if a flightcrew member works on a WOCL-infringing FDP during one night, and then works during a WOCL-infringing FDP during the following night, that flightcrew member will have worked on two consecutive nights. If, however, the flightcrew member works one night, has the next night off, and then works the following night, these nighttime FDPs would not be considered ''consecutive'' for the purposes of this section.

ATA also objected to applying the consecutive-night limit to augmented operations. It stated that augmented flightcrew members receive significant inflight rest, and that the consecutive-night limit was redundant as applied to augmented FDPs.

Rest on the ground in a suitable accommodation is superior to rest onboard an aircraft while that aircraft is in flight. As such, any augmented operations that span more than three consecutive nights must mitigate the fatigue of these operations by providing flightcrew members with the two hours of mid-duty rest in a suitable accommodation required by this section.

ATA stated that, because simulator training is now considered part of an FDP, the consecutive-night limit would also limit training opportunities for flightcrew members. ATA argued that this is an unnecessary burden because flightcrew members would receive a full rest period after training.

Simulator training is only considered to be part of an FDP if it takes place before a flightcrew member flies an aircraft and there is no intervening rest period taken pursuant to section 117.25. This is because all duty after a legal rest and prior to flight is part of an FDP. If the simulator training does not take place before a flightcrew member flies an aircraft, the simulator training is not considered to be part of an FDP, and it is unaffected by the consecutive-night limit.

Two individual commenters asked the FAA to prohibit air carriers from switching pilots from night to day shifts. These commenters also asked that circadian rhythms not be shifted by more than two hours from the prior day. However, these suggestions are outside the scope of this rulemaking.

M. Reserve

As stated in the NPRM, the term ''reserve'' has not been addressed in the part 121 regulations; however this term has been the subject of several legal interpretations which include a determination of when a flightcrew member is on duty and whether the required rest associated with a duty period is impeded by a flightcrew member being in a reserve status. The FAA proposed that unless specifically designated otherwise, all reserve is considered long-call reserve. Additionally, the time that a flightcrew member spent on airport/stand-by reserve would be part of that flightcrew member's FDP. For short-call reserve, the NPRM proposed that all time spent within the reserve availability period is duty; the reserve availability period may not exceed 14 hours; no flightcrew member on short call reserve may accept and no certificate holder may schedule the flightcrew member's next reserve availability period unless that flightcrew member is given at least 14 hours rest; and the maximum reserve duty period for an unaugmented operation is the lesser of:

—16 hours, as measured from the beginning of the reserve availability period;
—The assigned FDP, as measured from the start of the FDP;
—The FDP in Table B of this part plus 4 hours, as measured from the beginning of the reserve availability period; or
—If all or a portion of a reserve flightcrew member's reserve availability period falls between 0000 and 0600, the certificate holder may increase the maximum reserve duty period by one-half of the length of the time during the reserve availability period in which the certificate holder did not contact the flightcrew member, not to exceed 3 hours.

For an augmented operation, the NPRM proposed that the maximum FDP is the lesser of the assigned FDP, as measured from the start of the FDP; the FDP in Table C plus 4 hours, as measured from the beginning of the reserve availability period; or if the reserve availability period falls between a portion of 0000–0600, the maximum reserve availability period may be increased by one-half the length of the time during which the certificate holder did not contact the flightcrew member but capped at 3 hours.

The FAA proposed that long-call reserve does not count as duty and that a flightcrew member would need to receive a 12-hour notice of report time from the certificate holder if the flightcrew member is being assigned an FDP that would begin before and operate into his or her WOCL.

Lastly, the NPRM proposed provisions that would permit a certificate holder to shift a flightcrew member's reserve availability period subject to meeting certain conditions.

Commenters stated overall that the entire section was overly complicated and complex, with some commenters stating that it also was confusing and illogical. Industry largely objected to the classification of short-call reserve as duty. ALPA, COPA, FedEx ALPA, SWAPA and APA all commented favorably on short-call reserve as part of duty. These comments were addressed in the Definitions section, which removed short-call reserve from the definition of the term ''duty.''

NACA, Atlas, NAA, and Kalitta argue that limiting short call reserve to 14 hours is unwarranted for their operations. Kalitta separately recommended that the reserve availability period should be 16 hours followed by 8 hours off. Under Kalitta's recommendation, if a flightcrew member on short-call reserve is called out within the first six hours of that reserve availability period, he or she can utilize the entire maximum FDP, as described in Table B or C. If the flightcrew member is called out after the first six hours of the reserve availability period, then all the time in short-call reserve should be subtracted from the maximum FDP, unless the un-interrupted short-call reserve included the flightcrew member's WOCL. Then the full period of the WOCL should be considered rest. Kalitta argues that this will permit long-haul, non-scheduled operators the ability to continue current operations.

NACA, Atlas, and NAA also argue the proposal is too restrictive because the controlling limitation will always be the assigned FDP, which is a maximum of 13 hours. UPS and ATA state that there is no justification for limiting unaugmented short call reserve to assigned FDP. They contend that this restriction materially deviates from the ARC recommendation concerning this element of reserve.

ATA further comments that using the FDP to set the maximum reserve duty period directly contradicts the NPRM's definition of ''reserve duty period'' as the reserve availability period plus the flight duty period.

RAA proposed instead that for unaugmented operations, if a flightcrew member is given an FDP while on short-call reserve, the FDP, measured from the time for reporting for assignment, is limited to the Table B maximum FDP minus the full time spent on reserve during the Reserve Availability Period (RAP) up to the report time. Northern Air Cargo (NAC) contends that there is no logic in not allowing for the full FDP after callout. Delta argued that while on reserve, limiting reserve duty periods to scheduled FDP rather than maximum is overly restrictive.

ALPA, COPA, FedEx ALPA, SWAPA and APA submitted the chart below depicting the maximum FDP permissible based on the start of time of the reserve availability period:

Table E—Short Call Reserve Duty Period

Time of Start of RAP (Home Base or Acclimated Local Time)	Maximum Flight Reserve Duty Period (hours) Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000-0359	13	13	13	13	13	13	13
0400-0459	14	14	13	13	13	13	13
0500-0559	15	15	15	15	14	13.5	13
0600-0659	16	16	16	16	15	15	14.5
0700-1259	16	16	16	16	16	16	15
1300-1659	16	16	16	16	15.5	15	14.5
1700-2159	15	15	14	14	13.5	13	13
2200-2259	14.5	14.5	13.5	13.5	13	13	13
2300-2359	13.5	13.5	13	13	13	13	13

They argue that the maximum reserve duty period, which would include phone availability and/or FDP assignments, is measured from the start of the RAP and ends at the earlier of the start of the RAP time plus the value in Table E or the FDP in Table B. The purpose of this process is to ensure that the reserve pilot does not have an allowable FDP limit that is greater than the FDP of the line holder whom that reserve flightcrew member is paired with and does not impact the certificate holder because the line holder and reserve flightcrew member end point will be the same.

Peninsula Airways questions whether under this section, a flightcrew member on short-call reserve must have had 14 hours of rest period at the beginning of the current reserve availability period.

The FAA agrees that the proposed reserve provisions were overly complicated and has made numerous changes to reduce the complexity. The ARC came to a number of conclusions during its discussion of reserve. The FAA has decided to rely on the expertise represented in the ARC to address the issue of reserve duty. The FAA does not support Kalitta's proposal described above, which would increase the permissible reserve availability period to 16 hours. Kalitta has not provided supporting rationale that warrants modifying the collective opinion of the ARC. Therefore, this rule adopts the proposal that limits the short-call reserve availability period, in which the flightcrew member is not called to report to work, to 14 hours.

The FAA has modified the regulatory provisions addressing the reserve duty period and unaugmented FDPs. Under the NPRM, the maximum reserve duty period would be the lesser of 16 hours, the assigned FDP, or the FDP under Table B plus four hours. The FAA agrees with the commenters that limiting the reserve duty period to the assigned FDP was overly restrictive and could result in situations where the reserve duty period was unnecessarily short, and would be unworkable for the certificate holders. The FAA has deleted that provision but retains the other two proposed limitations for unaugmented operations. Therefore, the adopted regulatory provisions addressing reserve and unaugmented operations provide that the total number of hours a flightcrew member may spend in a flight duty period and reserve availability period may not exceed 16 hours or the maximum applicable flight duty period in Table B plus four hours, whichever is less. This will allow most FDPs to be accommodated by a flightcrew member on short-call reserve. Additionally, the proposed provisions for giving credit for not calling during the window of circadian low are complicated and unnecessary given the above adopted modifications. Therefore, the credit provisions have been dropped from this rule.

In response to the question posed by Peninsula Airways regarding whether the flightcrew member, who has concluded a reserve availability period, must have a 14 hour rest period before beginning the next reserve availability period, the FAA modified this provision in accordance with the amendments in § 117.25 Rest period. A flightcrew member must be given a 10 consecutive hour rest period immediately before beginning the reserve or flight duty period. The regulation governing reserve has been adjusted for consistency with the rest provisions. Therefore, if a flightcrew member completes a reserve availability period, he or she must receive a rest period, as required in § 117.25(e), prior to accepting a subsequent reserve availability period.

The FAA also does not agree with the comments from the labor organizations that another Table is necessary for the short-call reserve duty period. Those organizations argue that incorporating the above chart would ensure that the reserve flightcrew member would not have an allowable FDP that is greater than the line holder with whom he or she is paired. This argument is not persuasive. Each flightcrew member is subject to the maximum permissible FDP given that flightcrew member's recent assignments and rest requirements. Consequently, it isn't reasonable to artificially limit a reserve pilot to the FDP limit of the line holding pilot when no such limit applies to the line holding flightcrew members.

Kalitta and UPS questioned why a flightcrew member on long-call reserve and assigned an FDP that begins before and operates in the WOCL, would require a 12-hour rest. These commenters argue that a line holder may be scheduled for duty during the WOCL with 9 hours rest and that the long-call reserve flightcrew member should have similar treatment as the line holder.

This provision simply requires that the affected flightcrew member must receive 12 hours notice that he or she will be on duty during the WOCL and will need to plan his or her rest during the day. This way, the flightcrew member can structure the rest period in order to provide the best sleep opportunity. As daytime rest is not as restorative as nighttime rest, the flightcrew member may choose to take multiple naps rather than attempting to get a full consecutive 8 hours of sleep during the day. This is comparable to a lineholder who knows in advance that he or she is scheduled for duty during the WOCL, and adjusts his or her sleep opportunity accordingly.

NJASAP questions why the rule does not limit long-call reserve. APA also added that flightcrew members on long call reserve should receive a rest period that includes a physiological night prior to assignment. There is no reason to limit long-call reserve because, by definition, the certificate holder must notify the flightcrew member prior to receiving rest under 117.25(e). Similarly, as the flightcrew member is receiving a 10 hour rest period prior to the flight, it is not reasonable to limit that rest to only the hours between 0100 and 0700. This would unnecessarily restrict the certificate holder's ability to use long-call reserve.

Kalitta and UPS oppose the provisions limiting the shifting of reserve availability periods. RAA also opposes these provisions and argues that they actually hinder fatigue reduction by forcing more flightcrew schedule disruptions through delay or cancellations than would otherwise be necessary. NACA, Atlas, and NAA contend that the provisions addressing the shift of reserve availability periods are unworkable because it restricts forward shifts to a maximum of 12 hours, which can ultimately result in stranded flights. These commenters illustrate, as an example, if a flight is delayed for 13 hours, this rule would require the aircraft to sit on the ground for hours because the reserve flightcrew would be unable to operate the next flight until they have completed the required rest.

The organizations representing labor also seek to limit, to once in a rolling 168 hour period, the provision that would require a short call reserve flightcrew member coming off of a 14 hour reserve availability period to have a 14 hour rest before accepting an FDP that begins before the flightcrew member's next reserve availability period. The commenters contend that without this once per 168 hour limitation, a flightcrew member could be in a cycle of continuous reserve availability periods.

Since the rest requirements mandate a rest period prior to accepting any short-call reserve period and given the above modifications to the rule, the FAA concludes that the limits on shifting reserve availability periods are unnecessary and would have added a level of complication that is not warranted. This provision is not adopted.

N. Cumulative Limits

In formulating this rule, the FAA found that "[s]cientific studies suggest that long periods of time on duty infringe upon an individual's opportunity to sleep, thus causing a 'sleep debt' which is also known as cumulative fatigue." [75] To limit the accumulation of cumulative fatigue by flightcrew members, the FAA proposed a cumulative duty-period limit of 65 hours in a 168-hour period (7 days) and a limit of 200 hours in a 672-hour period (28 days). These cumulative duty-period limits were slightly increased for short-call reserve and for deadhead transportation in a seat that allows for a flat or near flat sleeping position.

The FAA also proposed cumulative FDP limits based on the standards of other aviation authorities. The proposed cumulative FDP limits restricted FDP to 60 hours in a 168-hour period and 190 hours in a 672-hour period. In addition, the FAA proposed retaining the existing cumulative flight-time limits, which are 100 hours in a 28-day period and 1,000 hours in a 365-day period.

Alaska Airlines stated that the proposed subsection 117.23(a) concerning cumulative FDP limits was ambiguous and arguably made this section apply to flights that a flightcrew member conducted on his or her days off. Alaska Airlines and Delta argued that an air carrier should not be held responsible for flights that a flightcrew member performs on his or her days off that are not assigned by the air carrier. Conversely, SWAPA stated that, due to the complexity of the cumulative limits, the certificate holder should have the sole responsibility of determining whether flightcrew members are in compliance with the applicable cumulative limits.

The cumulative limits in section 117.23 include any flying performed by the flightcrew member on behalf of any certificate holder, or 91K Program Manager during the applicable periods. It does not include personal flying. Subsection 117.23(a) has been amended to clarify this point. The reason that this section includes all flights conducted for a certificate holder or program manager is because a flightcrew member accumulates fatigue on those flights. A

[75] 75 FR 55871 and n.42 (citing scientific studies).

flightcrew member accumulates fatigue whenever he or she flies an aircraft. The flightcrew member does not accumulate less cumulative fatigue simply because the flying is conducted for another operator.

The FAA has considered the air carriers' argument that the proposed subsection 117.23(a) may affect their scheduled flights as a result of flights that they do not assign to their flightcrew members. However, the FAA believes that its cumulative-limit approach is justified in light of the fact that compliance with this rule is a joint obligation that applies to flightcrew members as well as air carriers. Thus, the FAA expects flightcrew members to inform their employing air carriers of flying that they conduct on days off that would impact the cumulative limits set out in this rule, thus allowing all parties to abide by the applicable cumulative limits.

The FAA also declines SWAPA's suggestion that air carriers bear sole responsibility for determining compliance with the cumulative limits. As discussed in the preceding paragraph, without flightcrew member assistance, air carriers may not even know about some of the flying performed by flightcrew members. While the rolling time periods used in this section may not be as easy to keep track of as calendar periods, the FAA expects both flightcrew members and air carriers to be aware of how many hours the flightcrew members have worked and to abide by the cumulative limits of this section.

RAA opposed the cumulative duty-period limits, arguing that duty was a nebulous concept that was hard to define, and that cumulative duty-period limits are unnecessary in light of the cumulative FDP limits. NACA and NAA stated that an air carrier should be able to assign additional duty time if no further FDPs are contemplated because ''[t]here is no further risk of an aviation accident unless flight is involved.'' NACA, UPS, and a number of other air carriers added that the inclusion, in duty limitations, of administrative duties adversely affected flight-qualified management personnel and addressed work-life issues that had nothing to do with aviation safety. IPA disagreed, arguing that ''[j]ust as the certificate holder tracks flight time and flight duty periods, administrative duties should also be tracked.'' IPA stated that subordinate officials who work in an office all day and fly at night are more likely to be fatigued.

ATA and UPS stated that the proposed rule unfairly expands the concept of duty to ''circumstances beyond the carriers' control such as, random drug tests.'' RAA stated that the duty-period limits essentially limited the time that flightcrew members spend on non-flying tasks, but that this was not a significant factor in flightcrew scheduling. These commenters added that air carriers could not always control the types of seats available to deadheading flightcrew members, and that they should not be penalized for being unable to provide deadheading flightcrew members with flat or near flat seats.

The FAA agrees with industry comments that cumulative duty-period limits are unnecessary in this rule. Cumulative duty-period limits were intended to address the following: (1) Deadheading, (2) short-call reserve, and (3) air carrier directed non-flight activities that lead to fatigue during flight. As discussed in other portions of this preamble, the FAA has amended other parts of this rule to address fatigue-related concerns raised by deadheading and short-call reserve.

Turning to the fatigue-related issues of non-flight activities, on reevaluation, the FAA has determined that the FDP limits in this rule fully address the non-flight activities that could contribute to flightcrew member fatigue. This is because the only non-flight activities that have a significant impact on fatigue during flight are activities that occur immediately before the flight without an intervening rest period. Since there is no intervening rest between the non-flight activities and piloting an aircraft, the fatigue accumulated while performing these non-flight activities remains with the flightcrew member when that flightcrew member pilots an aircraft. Therefore, all non-flight activities that occur immediately before a flight without an intervening rest period are part of an FDP and are appropriately restricted by the FDP limits.

The other non-flight (non-FDP) activities do not significantly affect the fatigue experienced during flight because there is an intervening rest period between these activities and the beginning of an FDP. Consequently, the FAA has eliminated the cumulative duty period limits from this rule.

RAA, NACA, and a number of air carriers opposed the cumulative flight-time limits, arguing that FDPs were the actual source of flightcrew member fatigue. Because FDPs are limited by the proposed cumulative FDP limits, these commenters argued that the cumulative flight-time limits are unnecessary.

Existing regulations impose 30-day flight-time limits of 100 hours and calendar-year flight-time limits of 1,000 hours. The FAA has administered these cumulative flight-time limits for over four decades, and based on its operational experience, the FAA has found that cumulative flight-time that falls within these limits is safe. Because the FAA is unaware of any data showing that flight times exceeding these limits are safe, the FAA has decided to retain cumulative flightcrew member flight-time limitations within the existing limits.

As the commenters correctly point out, because FDPs include flight time, the FAA could have addressed the concern discussed in the preceding paragraph by calibrating the cumulative FDP limits. However, as discussed in the Flight Time Limits section of this preamble, the FAA chose to retain the concept of flight-time limits in order to set higher FDP limits and provide air carriers with more flexibility. If the FAA eliminated the cumulative flight-time limits from this rule, it would need to drastically reduce the cumulative FDP limits from the limits that were proposed. This is because without cumulative flight-time limits, the proposed cumulative FDP limits would allow flightcrew members to accumulate flight time that significantly exceeds the cumulative flight time permitted by existing regulations. To keep that from happening and provide air carriers with more scheduling flexibility, this rule largely retains the existing flight-time cumulative limits and sets higher cumulative FDP limits than would otherwise have been permissible.

ATA, RAA, and a number of air carriers stated that imposing cumulative limits for three different regulatory concepts (FDP, duty, and flight time) was unjustified and overly burdensome. ATA stated that cumulative limits would result in additional flight cancellations that inconvenience the general public. RAA stated that the multiple limits overlapped to a significant degree, and the numerous cumulative regulatory restrictions would be very difficult to keep track of in practice.

RAA stated that the standards of other authorities were not applicable to this rulemaking because, instead of simply being concerned with safety, ''CAP–371 and the EASA regulations envision a system of 'fair and equitable' crew scheduling that is justified in a European context by its intent of spreading more fatiguing assignments among the entire flightcrew member community.'' While RAA accepted the proposition that some cumulative restrictions were necessary, it believed that this proposal included too many cumulative restrictions.

As discussed above, the FAA has decided to eliminate the cumulative duty-period limits, which should greatly simplify compliance with this section. Thus, the only remaining cumulative limits are FDP and flight-time limits. The FAA has decided to retain both of these cumulative limits because (1) the FDP limits restrict the amount of cumulative fatigue that a flightcrew member accumulates before and during flights, and (2) the flight-time limits allow the FAA to provide air carriers with more scheduling flexibility by setting higher cumulative FDP limits in this rule. This additional scheduling flexibility justifies the added complexity of the cumulative flight-time limits, which can easily be tracked by scheduling programs currently in use throughout the industry. The FAA also notes that complying with the cumulative flight-time limits in addition to the FDP limits should not present a significant burden to many air carriers because they are already required to keep track of pilot flight time in order to comply with a statutory provision that limits flight time on interstate domestic flights to 85 hours per month.[76]

The FAA understands that standards such as CAP–371 and EASA were drafted to achieve goals that may be somewhat different from the safety goals of this rule. In light of this fact and the requirements of the Administrative Procedure Act, while the FAA has examined the provisions of the various standards of other authorities, the FAA ultimately made its own independent decisions based on the needs and concerns of the stakeholders and the FAA about how to structure this rule. That is why some of this rule's provisions are similar to other standards and other provisions are very different from the standards adopted by other aviation authorities.

RAA, NACA, AMA, Boeing, and a number of air carriers opposed the 365-day cumulative flight-time limit, arguing that there was no safety-based justification for this limit. These commenters stated that the 28-day flight-time limits, as well as the other proposed cumulative limits, restricted cumulative fatigue to acceptable levels on a continuing basis without the need for an annual flight-time limit. Four individual commenters and SWAPA suggested that the 365-day flight-time limit be increased to 1,200 hours. SWAPA noted that the proposed regulations allow a flightcrew member to have 100 flight-time hours in a month, and ''[i]f flying 100 hours per month for ten months in a row does not create a cumulative fatigue problem, we find it hard to imagine that there would be a cumulative fatigue issue in month 11 or 12.'' One individual commenter asserted that the individual monthly flight-time limits should add up to the annual limit.

The 1,000-hour 365-day flight-time limit comes from existing regulations, which limit yearly flight-time to 1,000 hours and monthly flight time to 100 hours. To meet the 1,000-hour limit, air carriers must restrict the average monthly flight times of flightcrew members to approximately 83 hours. However, because the 1,000-hour limit is a yearly limit, air carriers have the flexibility to exceed the 83-hour monthly average and fly up to 100 hours during peak months so long as they fly a reduced number of hours during off-peak months.

The FAA has significant operational experience with the 1,000-hour annual limit, and based on this experience, the FAA has determined that a flight-time average of approximately 83 hours per month is safe. For the sake of regulatory simplicity, the FAA has also considered eliminating the 1,000-hour annual flight-time limit and reducing the monthly flight-time limit to 83 hours. However, the FAA ultimately determined that such a reduction would unnecessarily limit air carriers by prohibiting them from scheduling extra flight-time hours during peak months. Thus, in order to preserve existing air carrier scheduling flexibility, this rule retains the 1,000-hour flight-time limit imposed by the existing regulations.

A number of commenters suggested using calendar periods for cumulative limits instead of rolling periods of hours and calendar days. Boeing, Allegiant, and a number of individual commenters suggested that the annual flight-time limit be based on calendar months instead of 365 days. Boeing and Allegiant stated that the existing regulations have a 12-calendar-month limit, and switching to a 365-day limit would: (1) Increase costs because air carriers would have to change their existing scheduling systems; and (2) make it more difficult for individual flightcrew members to keep track of the annual limit.

Boeing also argued that the cumulative FDP limits should, for the sake of regulatory simplicity, use 28 calendar days as a time-period measurement instead of 672 hours. SkyWest also suggested using calendar periods instead of hourly limits for the sake of simplicity. Conversely, NJASAP supported the use of hourly time periods instead of calendar days or months as a cumulative-limit measurement. IPA supported the use of hourly time periods for daily and weekly limits, but stated that the monthly and annual limits should be based on calendar days. AMA also supported the proposal's use of rolling calendar day and hourly cumulative time periods, asserting that the use of calendar periods would be subject to abuse.

The FAA has largely used consecutive hours to express time periods in this section in order to create a consistent and uniform enforcement standard. One problem with calendar periods is that different air carriers use calendar periods in different ways. Thus, for example, one air carrier's calendar day may start at midnight, while another air carrier's calendar day may start at 9am.

Another problem with calendar periods is that a single calendar period can cover different lengths of time. Thus, a calendar month could cover a time period ranging from 28 to 31 days. A calendar year would also present problems if it is measured in months instead of days because a 28–31-day monthly period would create lookback problems. To avoid these types of issues with calendar periods, this section expresses the cumulative time periods largely as a function of consecutive hours, which are an unchanging uniform standard that applies the same way to all air carriers. The FAA does not believe that this will create an undue burden for air carriers and flightcrew members because modern scheduling programs and spreadsheets can easily keep track of time periods consisting of consecutive hours.

In light of its preference for consecutive hours, the FAA has amended subsection 117.23(b)(1) so that it expresses the corresponding cumulative limit as a function of consecutive hours instead of calendar days. However, the FAA has decided to retain the flight-time limit in subsection 117.23(b)(2) as an expression of calendar days because expressing 365 days as a function of hours would result in a very high number of hours that would be difficult to apply in practice.

Boeing, Kalitta Air, and Omni Air objected to the FDP limits for the 672-hour (28-day) time period, arguing that cumulative fatigue is already taken into account by the 168-hour cumulative limits. Boeing stated that there is no scientific evidence ''proving that an event 672 hours ago has a predictable effect on alertness now.'' Conversely, NACA and a number of labor groups

[76] 49 U.S.C. 42112(b)(1). This statutory provision incorporates National Labor Board Decision number 83, which, among other things, limits monthly flight time to 85 hours.

supported the concept of cumulative limits for 28-day periods.

The different cumulative FDP limits work on the same flexibility principle as the 672-hour and 365-day cumulative flight-time limits. The cumulative FDP limit for the 672-hour period is 190 hours. To comply with this 190-hour limit, an air carrier has to average approximately 47.5 cumulative hours of FDP in each 168-hour period. However, the 60-hour cumulative FDP limit for each 168-hour period allows air carriers to exceed the 47.5-hour FDP average during peak weeks as long as they go below this average during off-peak weeks. Just like the different flight-time limits, this system provides air carriers with scheduling flexibility while keeping the average weekly cumulative FDP times within acceptable bounds.

APA asked that the FAA add in a cumulative flight-time limit for the 168-hour period, arguing that, without this limitation, air carriers could schedule a significant amount of flight time in this period of time.

The existing regulations for domestic and flag operations impose 30–32 hour cumulative flight-time limits for 7-day periods. However, the existing regulations for supplemental operations do not impose cumulative flight-time limits for 7-day periods. Based on its operational experience administering supplemental operations without a 7-day cumulative flight-time limit, the FAA has determined that there is no need to impose a 168-hour flight-time limit in addition to the other cumulative limits in this rule.

NACA, NAA, and Northern Air Cargo asked the FAA to increase the cumulative FDP limits to match the limits suggested for cumulative duty periods, arguing that the proposed limits did not take into account the needs of supplemental operations. Conversely, AAC, AFA–CWA, ALPA, and a number of other union groups asserted that the proposed cumulative limits were appropriate. ALPA stated that the proposed limits should neither be expanded nor reduced and AAC stated that the FAA should not impose additional cumulative limits.

The proposed cumulative-duty-period limits in this rule were higher than the proposed cumulative FDP limits because duty encompassed more non-flight activities than FDP. Since most of the additional non-flight activities covered by duty did not raise significant fatigue-related concerns, the FAA set the cumulative-duty-period limits at a higher level. As discussed above, because duty periods did not have a significant effect on aviation safety independent of FDPs, cumulative-duty-period limits have been eliminated from this rule.

The FAA has also decided against increasing the proposed cumulative FDP limits. Because this rule retains cumulative flight-time limits, the cumulative FDP limits in this section are set at sufficiently high levels that should allow air carriers full utilization of the cumulative flight-time limits in this section. Thus, for example, the cumulative FDP limit for the 672-hour period is 190 hours, which is almost double the cumulative flight-time limit of 100 hours for this time period. Because the proposed cumulative FDP limits were already set at relatively high levels, the FAA has decided against increasing these limits further without additional FRMS-provided data.

NJASAP asked whether the time spent on reserve will count towards the cumulative FDP limits of this section. Only the time that is spent on airport/standby reserve is considered to be FDP. As such, only the time that is spent on this type of reserve counts toward the cumulative FDP limits of this section.

O. Rest

Rest is a significant element of this rule because it is the most critical component of fatigue mitigation. In this rulemaking, the FAA has addressed the following concerns with the present regulatory scheme governing rest: (1) Part 121, subparts Q, R, and S provide rest limits within a 24-hour period, however certificate holders conducting operations with airplanes having a passenger seating configuration of 30 seats or fewer and a payload capacity of 7,500 pounds or less, may comply with the less stringent requirements of 14 CFR 135.261 and 135.273; (2) the lack of any mechanism to assure that rest is provided prior to flight; and (3) no clear requirement that the 9 hour rest period must provide for an 8 hour sleep opportunity. The FAA also sought to specifically articulate what it means for a flightcrew member to be free from duty, as this and other related issues under the current scheme have resulted in more than 55 legal interpretations issued by the FAA regarding rest.

Sleep science has settled on the following points: The most effective fatigue mitigation is sleep; an average individual needs to have an 8-hour sleep opportunity to be restored; 8 hours of sleep requires more than 8 hours of sleep opportunity; and daytime sleep is less restorative than nighttime sleep.[77] For most people, 8 hours of sleep in each 24 hours sustains performance indefinitely.[78] There is a continuous decrease in performance as sleep is lost. Examples of this reduction in performance include complacency, a loss of concentration, cognitive and communicative skills, and a decreased ability to perform calculations. All of these skills are critical for aviation safety.[79]

In the Flight Time ARC meetings, scientific presenters stated that during long pairings with significant time zone shifts, a minimum of 24 hours off would be necessary for flightcrew members to find an adequate sleep opportunity, and sufficient time free from duty.[80] A minimum of two nights of sleep might be necessary to acclimate to a different time zone.[81]

The scientific presenters also noted that an individual's circadian clock is sensitive to rapid time zone changes. They added that long trips present significant issues requiring mitigation strategies.[82] Twenty-four or 48 hours of rest may not be adequately restorative during a trip pairing where a flightcrew member is working 20 days separated by 24-hour layovers. In some cases, shorter rest periods, such as 18 hours or less,

[77] Akerstedt, T., & Gillberg, M. (1981). The circadian variation of experimentally displaced sleep. Sleep, 4 (2), 159–1659. Akerstedt, T., & Gillberg, M. (1990). Subjective and objective sleepiness in the active individual. International journal of neuroscience, 52 (1–2), 29–37. Gander, P.H., De Nguyen, B.E., Rosekind, M.R., & Connell, L.J. (1993). Age, circadian rhythms, and sleep loss in flight crews. Aviation, Space, and Environmental Medicine, 64 (3), 189–195.

[78] Rosekind, M.R., Gander, P.H., Gregory, K.B., Smith, R.M., Miller, D.L., Oyung, R., Webbon, L.L., & Johnson, J.M. (1996). Managing fatigue in operational settings 1: Physiological considerations and countermeasures. Behavioral Medicine, 21, 157–165.

[79] Caldwell, J.A., Mallis, M.M., Caldwell, J.L., Paul, M.A., Miller, J.C., & Neri, D.F. (2009). Fatigue countermeasures in aviation. Aviation, Space, and Environmental Medicine, 69 (1), 29–9.

[80] Gander, P.H., Myhre, G., Graeber, R.C., Anderson, H.T., and Lauber, J.K. (1985). Crew factors in flight operations: I. Effects of 9-hour time-zone changes on fatigue and the circadian rhythms of sleep/wake and core temperature (NASA/TMm 1985–88197). Moffett Field, CA. NASA Ames Research Center.

[81] Lamond, N., Petrilli, R.M., Dawson, D., and Roach, G.D. (2006). Do short international layovers allow sufficient opportunity for pilots to recover? Chronobiology International, 23(6), 1285–1294. Lamond, N., Petrilli, R.M., Dawson, D., and Roach, G.D. (2005). The impact of layover length on the fatigue and recovery of long-haul flight crew. Adelaide/Whyalla, Australia: University of South Australia, centre for Sleep Research.

[82] See also, Gander, P.H., Graeber, R.C., Connell, L.J., and Gregory, K.B. (1991). Crew factors in flight operations: VIII. Factors influencing sleep timing and subjective sleep quality in commercial long-haul flight crews (NASA/TMm 1991–103852). Moffett Field, CA: NASA Ames Research Center. Rosekind, M.R., Gander, P.H., Gregory, K.B., Smith, R.M., Miller, D.L., Oyung, R., Webbon, L.L. and Johnson, J.M. (1996). Managing fatigue in operational settings 2: An Integrated Approach. Behavioral medicine, 21, 166–170.

may be more restorative because of circadian issues.

In the NPRM, the FAA proposed requirements for FDP/reserve period rest, acclimation rest upon returning to home base, and reduced rest under limited conditions. For pre-FDP/reserve assignments, the FAA proposed that prior to accepting a reserve duty period or FDP, the flightcrew member must be given a rest period of at least 9 consecutive hours measured from the time the flightcrew member reaches the hotel or other suitable accommodation.

In addition, the FAA proposed that a flightcrew member must be given at least 30 consecutive hours free from all duty in any 168 consecutive hour period prior to beginning a reserve period or FDP. This provision included two exceptions. The first is that during an FDP or series of FDPs, if a flightcrew member crosses more than 4 time zones on FDPs that exceed 168 consecutive hours, that flightcrew member must be given a minimum of three physiological nights' rest upon return to home base. The second is if a flightcrew member is operating in a new theater, he or she must receive 36 consecutive hours of rest in any 168 consecutive hour period.

The proposal also would have permitted a one-time reduction in the pre-FDP/reserve rest period from 9 to 8 consecutive hours in any 168 consecutive hour period. Additionally and in the event of unforeseen circumstances, the pilot in command and the certificate holder could reduce the 9 hour rest period to 8 consecutive hours. Lastly, the FAA proposed that during a rest period, the certificate holder could not assign and no flightcrew member could accept any assignment for reserve or duty.

Commenters raised two issues concerning the proposed pre-FDP/reserve rest requirement. The first issue was the FAA's selection of the 9 hour rest period. The second issue was the beginning measurement of the rest period. As these two issues interrelate, the comments for both are summarized below.

In the NPRM, the FAA noted that the ARC members supported a domestic rest requirement of 10 hours that was comprised of an 8 hour sleep opportunity, with 30 minutes on each end for transportation and 30 minutes on each end for physiological needs such as eating, exercising and showering. The ARC members also discussed whether the rest requirement should be increased to 12 hours for international operations. The ARC members cited the following reasons for the two added hours for international operations: To provide a longer layover rest period for non-acclimated flightcrews; potential to address increased stress associated with communicating with air traffic control in countries where English is not the native language; and time to transit customs/immigration or travel a long distance to hotel accommodations in foreign destinations.

The FAA decided not to propose two different rest periods and instead put forth one standard rest period for all operations. The FAA was not persuaded that added rest was necessary to deal with air traffic control communications in a foreign airspace. Furthermore, acclimation for determining the length of an FDP was addressed by other provisions in the proposal. Lastly, the time to clear customs/immigration was addressed by refining the point where rest begins.

The FAA received over 2,500 comments from individuals who contend that the proposed 9 hour rest period was inadequate and did not allow sufficient time to eat, bathe, exercise or unwind, and still have an opportunity for 8 hours rest. The NTSB strongly encouraged the FAA to increase the duration of the required rest period to accommodate an opportunity for 8 hours of sleep. CAPA, APA, and SWAPA pointed to FAA Advisory Circular No. 120–FIT, which recognizes that 9 hours of rest typically does not yield 9 or 8 hours of sleep. Peninsula Airways, the Families of Continental Connection Flight 3407, APA, IPA, Southwest Airlines, SWAPA, AE and Delta Air Lines supported a 10 hour rest period for domestic operations.

Approximately 150 individual commenters believe that the rest period for international operations should be 12 hours. Other commenters suggested varying times of 13, 14, and 20 hours respectively for operations that travel across multiple time zones. Pinnacle Airlines suggested a rest period of 48 hours. ALPA advocated a minimum of 13 hours rest period for flightcrew members that fly to a new theater—once they become acclimated, they go back to 10 hours rest. ATA commented that the terminology should be changed from ''domestic'' and ''international'' to ''in theater'' and ''in new theater'' (and use the term ''theater'' as defined in the NPRM). ATA argues that the distinction of domestic/international in this context is not relevant and provides the following example. A pilot completing a north-south flight between the U.S. mainland and Canada or the Caribbean that crosses no time zones should not be treated differently than one that makes the same north-south trip within the continental U.S. APA, CAPA, SWAPA and Kalitta Air endorsed a 12 hour rest period for non-acclimated flights.

Conversely, Hawaiian Airlines supported the single hour rest requirement of 9 hours, and commented that this provision is not competitively disadvantageous for its operations. CCIA supported a longer rest period than that provided under the present regulations. American Airlines supported the proposed 9 hours and Alaska Airlines simply argued that the proposed rest provisions should be withdrawn, reevaluated, and republished for comment.

For the NPRM, the FAA chose to begin the rest period at the time that the flightcrew member reached the hotel or suitable accommodation. The basis for this tentative decision largely rested on the premise that transportation is not rest and therefore, cannot be factored into the rest period. In addition, the time spent in transportation may vary widely.

Commenters were divided with respect to the proposal's measurement of when the rest period begins. Most commenters representing industry did not support measuring the rest period from the time the flightcrew member reached the hotel or suitable accommodation. These commenters described this aspect as wholly unworkable, and open to too many variables that would be beyond the certificate holder's control, *e.g.* vehicular breakdowns, accidents, unexpectedly heavy traffic and lost or overbooked facility reservations. In addition, they state that the certificate holder would be responsible to account for the flightcrew member's whereabouts throughout the rest period. They argue that the certificate holder's responsibility is to control the scheduling of compliant rest periods, not to control an individual's private life and activities when off duty.

The labor organizations and the Families of Continental Connection Flight 3407 supported the proposed beginning measurement of the rest period. These entities were concerned with being able to ''get 9 hours behind the door,'' which would provide a better opportunity for a meaningful 8 hour sleep opportunity. APA also recommended, in addition to the proposal, that the FAA add language that to be compliant with this rest requirement, the hotel room must be available for immediate occupancy upon arrival. A number of pilot groups commented that rest time can be spent waiting for check-in or delay in getting room keys. Conversely, a number of certificate holders stated that check-in sometimes occurs in the vehicle on the way to the hotel, or that hotels offer separate check-in counters for flightcrew members.

As discussed above, the FAA was not persuaded at the NPRM stage to pursue a separate rest period for international operations. The agency concluded that an additional two hours of rest was not warranted to address potential fatigue from communicating with air traffic controllers in foreign airspace, nor did it support added rest due to time to clear customs and immigration. A number of airports have custom and immigration queues devoted to processing flightcrew members quickly.

The adopted regulations providing FDP limits for augmented and unaugmented operations address acclimation. For an unacclimated flightcrew member, the maximum flight duty period in Table B is reduced by 30 minutes and the flightcrew member enters the applicable FDP table based on the local time at the theater in which the flightcrew member was last acclimated. Under these provisions, the determined FDP limits take into account the flightcrew member's WOCL and general circadian rhythm. As long as the flightcrew member is receiving an 8 hour sleep opportunity, the nature of whether the FDP was international is not relevant. The FAA has decided to retain a single standard rest period provision that applies to all FDPs and reserve periods.

Based on the comments received from the certificate holders, the FAA agrees that using the time when a flightcrew member reaches the hotel or other suitable accommodation would present more issues for implementation than it actually solved. The FAA's main objective with this provision was to ensure that flightcrew members have an 8 hour sleep opportunity. Building from that and mindful of the comments received, the FAA has decided to adopt a 10 consecutive hour rest requirement that immediately precedes the beginning of a reserve or FDP measured from the time the flightcrew member is released from duty. At this point, if the flightcrew member cannot have 8 uninterrupted hours of rest opportunity, the flightcrew member cannot report for the assigned FDP until he/she receives that rest. If the reason for the shortened rest opportunity is travel delays, reservation confusion, or the flightcrew member's actions, the certificate holder is free to address the root cause. However, it must provide the required 8-hour rest opportunity.

The FAA finds that the modifications adopted in this rule address concerns raised by the labor organizations, the NTSB and the Families of Continental Connection Flight 3407 concerning an actual 8 hour opportunity devoted to sleep. Furthermore, it provides reasonable time for travel to the hotel, check-in, and meals. The FAA acknowledges there will be unforeseen circumstances that are beyond the control of either the certificate holder or the flightcrew member and these situations are difficult to capture in a regulatory standard. In situations such as this, where the flightcrew member ultimately is not provided with the necessary rest period and/or sleep opportunity, the flightcrew member must notify the certificate holder that he/she will be unable to obtain the required rest. It is advisable that the flightcrew member alert the certificate holder as soon as possible in order for the certificate holder to make alternative arrangements that may include adjusting the next FDP or flight departure time, or calling in a reserve crew.

NACA, Kalitta Air, NAA and Atlas disagree with the proposed rest requirement for a flightcrew member that crosses more than four different time zones and is away from home base for more than 168 consecutive hours. These commenters specifically state that three physiological nights' rest is excessive, not based on science, and that only a 30 hour rest period is necessary because fatigue has been mitigated throughout the flightcrew member's trip. They also commented that there is no justification for a different standard for rest at home and that rest at home generally is more fatigue mitigating than rest at operating locations. UPS also objected to the use of three physiological nights' rest upon return to home base. UPS contends that rest at home should be treated the same as rest in layover cities and that off-duty time between pairings ''is traditionally, and correctly, addressed via the collective bargaining process.'' [83]

NACA and Kalitta Air also recommended a reduced rest period of 30 hours, instead of the proposed 36 consecutive hours of rest, in any 168 consecutive hours for flightcrew members operating in a new theater.

The FAA adopts as proposed the requirement that a flightcrew member must be given at least 30 consecutive hours free from duty in any 168 consecutive hour period. The NPRM included two exceptions to this requirement. The first exception was a longer rest period upon return to home base after a flightcrew member has been away for more than 168 consecutive hours and has crossed at least four time zones. The second exception was for flightcrew members operating in a new theater to receive 36 hours of rest.

In the NPRM, the FAA stated that it was ''proposing to require a greater rest opportunity when a flightcrew member has been away from his or her home base for more than 168 hours. In this instance, the FAA proposes to require a rest period that includes 3 physiological nights, rather than 36 hours free from duty or permitting the flightcrew member to fly during that approximately 72 hour period.'' 75 Fed. Reg. 55862. The corresponding regulatory text proposed three physiological nights' rest. By using three physiological nights' rest, the FAA intended this provision to provide for a minimum 56-hour rest period, as indicated in the NPRM preamble discussion. As proposed, the regulatory text would permit a flightcrew member, upon return to home base after 168 hours away from home and crossing numerous time zones, to be assigned to FDPs that would occur during the day only, but require the flightcrew member to sleep at home for three nights. The intention was for that flightcrew member to receive a minimum of 56 consecutive hours of rest.[84]

The FAA does not agree with the commenters that a 30 consecutive hour rest period is adequate for flightcrew members that have flown a schedule that has the flightcrew member crossing several time zones and is away from home for more than 168 hours. This longer rest period serves an important purpose. The longer rest period provides a recovery period that facilitates the restoration of the flightcrew member's circadian rhythms. Sleep loss or sleep disturbance can significantly deteriorate performance. Moreover, performance impairment can occur when the sleep-wake cycle has only been phase-advanced by 2–4 hours and maintaining a normal sleep period. These results suggest that performance deterioration can directly result from circadian rhythm disturbance and not only solely from sleep loss that would occur with time zone changes. The onset of sleep and the duration of that sleep can ''* * * depend upon the circadian body temperature phase and provides a physiological basis for the performance deterioration or circadian desynchronization.'' [85] Typically, flights

[83] The FAA notes that not all pilot groups are organized and therefore, do not have a collective bargaining process.

[84] If a flightcrew member begins this rest at 1 a.m. on day 1 and concludes this rest at 7 a.m. on day 3, this provides a minimum of 56 hours of rest.

[85] Winget CM, Deroshia CW, Markley CL, Holley DC. (1984). A review of human physiological and

Continued

across multiple time zones involve a differential restructuring in an internal circadian desynchronization and associated symptoms.[86]

Flightcrews routinely deal with multiple time zone adjustments and work schedule changes. Flight operations involve night and ''shift work'' in general and exposures to different social and environmental cues can vary after both the outbound and inbound segments of flights, which can make the prediction of an individual's resynchronization very difficult. ''Advances'' in rhythms occur with eastward travel and ''delays'' with westward travel. Flights of multiple time zones involve circadian adjustments that vary in length depending on the direction of travel. Physiological, performance, and subjective measures are also found to adjust at different rates to changes in time zones.[87]

Some studies also indicate that a complete adjustment following six time zone transitions was found to take up to 13 days after eastbound flights, and 10 days in westbound flights.[88] Other research indicates that there is considerable variation in the rates of resynchronization of individual rhythms. After a time shift, such as that experienced by pilots flying several days in a new theater, with all rhythms phase-adjusted, upon return to their domicile, a resynchronization process begins anew and is not complete until each rhythm has rephrased back to the home time zone. ''The different rates of rhythm readjustment lead to transient internal dissociation, in which the normal phase relationships between rhythms are disrupted.'' [89]

Consequently, the FAA finds it critical to address the desynchronization/resynchronization of circadian rhythms that occurs when transiting multiple time zones. This recovery rest not only acclimates flightcrew members but also resets the circadian rhythms before the next assigned flight duty period. The FAA corrects the regulatory text to provide for a 56 consecutive hour rest instead of the three physiological nights' rest, as previously discussed. Depending upon when the rest period begins, this requirement provides for 2 to 3 physiological nights' rest.

With respect to the NACA and Kalitta's concern with using the higher value of 36 hours rest instead of 30 hours to acclimate, the FAA is not persuaded by the comment. The ARC members agreed that a flightcrew member should have at least 30 to 36 continuous hours free of duty (rest) in any 168 consecutive hours and that once a flightcrew member is given this rest, he or she is considered acclimated to the local time. As rest is critical, the FAA choose to propose the more conservative 36 hour rest period, given that adequate rest provides the most fatigue mitigation. NACA and Kalitta do not offer information supporting 30 hours instead of 36 hours. However, an approved FRMS may appropriately determine whether additional mitigations may permit the limited reduction in rest.

For clarity, the regulatory text in this section has been restructured. Paragraph (b) of this section adopts the 30 consecutive hour minimum rest requirement per week as proposed. Under paragraph (c), if a certificate holder gives a flightcrew member operating in a new theater 36 consecutive hours of rest, then that flightcrew member is acclimated and must enter the FDP Table for his/her next assignment as acclimated to the local time in that new theater. A certificate holder does not need to provide the 36 hour rest once a flightcrew member is in a new theater unless the carrier wants to acclimate that flightcrew member. The flightcrew member may be given a 10 hour rest period in accordance with paragraph (e) of this section and then be assigned a subsequent FDP based on the home base time. However, if the flightcrew member has received 36 consecutive hours of rest, that flightcrew member is acclimated at that point to the new theater, and subsequent FDP assignments must be made according to the acclimated time. The text also specifies that if a flightcrew member has received 36 consecutive hours of rest under this paragraph, then that rest meets the requirements of paragraph (b) for the required rest in any 168 hour period and that resets the 168 hour period. Paragraph (d) now contains that provision that requires at least 56 consecutive hours of rest if a flightcrew member traverses 60° longitude [90] during an FDP or a series of FDPs that require him or her to be away from home base more than 168 consecutive hours. This rest must encompass three physiological nights' rest based on local time.

ALPA, APA, CAPA, and SWAPA argued that where flightcrew members are not acclimated, a recovery period must be provided upon return to home base to ensure a flightcrew member's body clock has recovered home base local time before the start of the next day. They propose that Table F, provided below, be used to determine the number of nights required to re-acclimate. They also propose that Table F be used to provide ''recovery rest'' for time away from home when operating in a different theater for less than 168 consecutive hours away from home. They cite the current regulations [91] as providing this rest for international operations over a period less than 168 consecutive hours.

performance changes associated with desynchronosis of biological rhythms. Aviat. Space Envion. Med. 1984; 55:1085–96, p. 1090.

[86] *Id.* at p. 1085.

[87] Wegmann HM, Klein KE. Jet lag and aircrew scheduling. In: Folkard S, Monk TH, eds. Hours of work. Chichester; John Wiley & Sons Ltd., 1985; 263–76.

[88] Wegmann HM, Gundel A, Naumann M, Samel A, Schwartz E, Vejvoda M. Sleep, sleepiness, and circadian rhythmicity in aircrews operating on transatlantic routes. Aviat. Space Environ. Med. 1986; 57(12, Suppl.); B53–64.

[89] Winget *et al.* (1984) at page 1087.

[90] This change is consistent with the modification to the term theater in the definitions section, discussed earlier.

[91] *See* 14 CFR 121.483, 121.485, 121.523 and 121.525.

Table F – Number of Local Nights for Recovery on Return to Home Base

Elapsed Time Since Leaving Home base (h)	Maximum Time Difference from Home Base (h)					
	4	5	6	7	8-9	10-12+
60-84h	1*	2*	2*	2*	2*	3
84-108h	2*	2*	3	3	3	3
108-132h	3	3	3	3	3	3
132-156h	3	3	3	3	3	3
156+h	3	3	3	3	3	3

Note 1: The values in Table F refer to eastward transitions (eastward outbound/westward homebound) only. * denotes that for westward transitions (westward outbound/eastward homebound) one extra day is required to be added to the value depicted.

Note 2 : When the elapsed time away from home base is less than 60 hours one full physiological night's recovery rest should be provided on return to base, except when the returning flight duty period encroaches the WOCL, then an additional physiological nights rest will be added.

The FAA cannot support the inclusion of Table F. First and as a practical matter, it is not clear that the Table could be accommodated given the rest period that was proposed without seriously constraining the certificate holder's ability to schedule operations. As discussed previously, the FAA agrees and adopts a provision that specifically addresses the resynchronization of circadian rhythms. That rest however, must also be balanced with the certificate holder's flexibility to schedule operations, particularly those carriers conducting supplemental operations. The FAA used 168 hours as the minimum trigger point for when this rest must be provided for flightcrews returning home after completing FDPs that crossed multiple time zones. Under Table F, flightcrew members would have to be provided a minimum of two nights' rest at home every week. This is an unrealistic constraint on the certificate holder's ability to set and maintain a schedule. Under the concept furthered by this rulemaking, the cumulative limits on FDP during the same 168 hour period, coupled with cumulative rest requirement, should adequately mitigate the effect of cumulative fatigue.

Not unexpectedly, the provisions proposed in the NPRM permitting a limited reduction in rest generally were opposed by the entities representing labor groups and either supported or expanded by the industry groups. ALPA accepted the proposal. SWAPA commented that reduced rest should never be permitted since science supporting reduced rest assumes that one is starting from a full sleep bank, which is not always the case. SWAPA further commented that reduced rest is likely to follow an extended FDP and that if the FAA retains a reduced rest provision it should never be permitted after an FDP has been extended past the maximum provided in Table B. APA only supports reduced rest if restorative rest is provided. In addition, APA argues that if the FAA allows a reduction in rest it should be limited to only once in a 168 consecutive hour period, due to unforeseen circumstances subject to pilot in command concurrence, and never if associated with an extended FDP. FedEx ALPA argued that only a one-hour reduction in rest be permitted and only in cases of unforeseen circumstances. AE supports a permitted one-hour reduction in rest. AA supports the one-hour reduction but never on consecutive nights. Delta commented that the once in 168 consecutive hour period be reset after a 30-hours rest is given.

Conversely, UPS supported multiple reductions in rest without concurrence by the pilot in command. UPS contends that one reduction in a 168 consecutive hour window simply is not feasible. UPS also argues that requiring PIC concurrence will complicate the certificate's holder ability to utilize the reduced rest provisions and its ability to return a disrupted system back to a more normal state.

In view of the comments, the FAA has decided to remove the provisions that would permit a reduction in rest. As one of the stated goals of this rulemaking was to ensure that flightcrew members had an eight hour sleep opportunity, the FAA has reconsidered incorporating criteria in the regulations to permit a reduction in this sleep opportunity. While it is reasonable to anticipate that unforeseen circumstances may warrant a limited extension of an FDP, particularly for situations that arise after takeoff, the flightcrew members at this point have already had the benefit of an eight hour rest opportunity. The FDPs limits implemented by this rule were derived under the premise that flightcrew members were reporting for duty with a full rest. Permitting reduced rest undercuts that premise. This rule includes provisions for extensions of FDPs and flight time, as necessary to accommodate the situations that cannot be planned. Otherwise, certificate holders should not be scheduling FDPs to the point that a rest period needs to be reduced.

P. Deadhead Transportation

In the NPRM, the FAA proposed that all time spent in deadhead transportation is duty. The FAA further proposed that time spent in deadhead transportation would be considered part of an FDP if it occurred before a flight segment without an intervening required rest period. Lastly, the proposal provided a rest requirement for deadheading flightcrew members: the time spent in deadhead transportation during a duty period may not exceed the flight duty period in Table B for the applicable start time plus 2 hours unless the flightcrew member is given a rest period equal to the length of the deadhead transportation but not less than the required rest in § 117.25 upon completion of such transportation.

Several commenters contend that this proposed rest requirement should be deleted because it is punitive and not supported by science. They argue that this provision implies that the certificate holder should prevent a flightcrew member from deadheading home at the end of an FDP, even if the flightcrew member requests to do so.

The FAA has made changes to the section addressing deadhead transportation. Paragraphs (a) and (b) of proposed § 117.31 have been moved. Paragraph (a) provided that all time spent in deadhead transportation is duty and that statement is relocated to the definition for deadhead transportation. Paragraph (b), which provided that deadhead transportation is part of an FDP if it occurred before a flight segment without an intervening required rest period, is deleted as that information is already contained in the definition of the term ''flight duty period.''

The FAA agrees with the commenters that the proposed text for § 117.29(c), Deadhead transportation, does not correctly articulate the purpose of rest relative to deadhead transportation. The rest is appropriate if the deadhead transportation occurs prior to the FDP. The situation that FAA sought to address in the NPRM was a flightcrew member deadheading on a long flight and then going onto a FDP without the appropriate rest. The language as proposed would require a rest period for a flightcrew member who is deadheading home after completion of an FDP. The FAA has corrected the regulatory text to provide that before beginning a flight duty period, if a flightcrew member has engaged in deadhead transportation that exceeds the applicable flight duty period in Table B, the flightcrew member must be given a rest period equal to the length of the deadhead transportation but not less than 10 consecutive hours.

Q. Emergency and Government Sponsored Operations

This rulemaking also addresses various supplemental operations that require flying into or out of hostile areas, and politically sensitive, remote areas that do not have rest facilities. These operations range from moving armed troops for the U.S. military, conducting humanitarian relief, repatriation, Air Mobility Command (AMC), and State Department missions.[92] The discussions during the ARC recognized that these operations are unique and need to be specifically addressed in this rulemaking. Flights operated by a certificate holder under contract with a U.S. Government agency must comply with the flight and duty regulations in parts 121 and 135, as appropriate, unless the Administrator has granted a deviation under 14 CFR 119.55 or 14 CFR 112.57.

The FAA proposed that certificate holders may extend the applicable maximum FDPs to the extent necessary to allow flightcrew members to fly to a destination where they can safely be relieved from duty by another flightcrew or can receive the required rest before beginning the next FDP. Upon reaching the destination, the flightcrew members will receive the required rest, which would be equal to the length of the actual FDP or 24 hours, whichever is less. Furthermore, the proposal would not permit extensions of the cumulative FDP or cumulative flight time limits. In the event that an FDP was extended pursuant to this section, the NPRM provided reporting requirements.

A number of commenters disagreed with the FAA's use of the title ''Operations in unsafe areas'' as the title of this section. Commenters, including UPS, Atlas Air, NAA, NACA, and NAC recommended various terms instead such as ''Unique areas,'' ''Enhanced Security Consideration Area: Prescriptive Exemption,'' and ''Designated Areas.''

In addition, Atlas questioned the FAA's statement that under this section, the flightcrew members' FDP can be extended to permit them to continue the flight operation and land at the nearest suitable airport. *See* FAA Response to Clarifying Questions at page 24. Atlas commented that this airport may not be operationally feasible or economically viable.

RAA commented that operations may need to use this section to rapidly remove or recover aircraft and crews from an airport about to be impacted by a heavy storm, hurricane, or blizzard.

In the NPRM, the preamble discussion for this proposed section was titled ''Exception for Emergency and Government Sponsored Operations.'' The FAA regrets that the title was not carried over to regulatory text. Introducing the term ''unsafe areas'' could be subject to differing interpretations within the industry. Section 117.29 is now titled ''Emergency and government sponsored operations,'' which is an accurate depiction of the operations addressed in this section and is consistent with the discussion of the proposal.

The purpose of this section is to address true emergency situations and operations that are being conducted under contract with the U.S. Government that pose exceptional circumstances that would otherwise prevent a flightcrew member from being relieved from duty or safely provided with rest at the end of the FDP. This section is not meant to address self-induced emergencies that arise from inadequate planning. Certificate holders must be responsible for having appropriate onboard rest facilities or the proper number of flightcrew members available for the length of the duty day, if necessary.

The FAA reviewed the regulatory text and determined that this clarification warrants certain modifications. First, the applicability provision of this section now specifically articulates the two categories of operations that are affected. This section applies to operations conducted pursuant to contracts with the U.S. Government department and agencies. A number of these types of flights are conducted under contract with the Departments of Defense, State, Homeland Security, Justice, FEMA, and Customs and Immigration. This provision is not limited to operations conducted pursuant to § 119.55, which permits certificate holders to deviate from the requirements of parts 121 and 135, as authorized by the Administrator in order to conduct operations pursuant to a military contract. Rather, this provision could apply to multiple government agencies depending on the mission. The FAA also recognizes that there are operations in which the Department of Defense may need relief from the flight and duty regulations even though the circumstances do not meet the certification requirements of § 119.55.

This section also applies to operations conducted pursuant to a deviation issued by the Administrator under § 119.57 that authorizes an air carrier to deviate from the requirements of parts 121 and 135 to perform emergency operations. For example, under this section the FAA issued operations specifications for emergency operations

[92] This could also apply to the Civil Reserve Air Fleet (CRAF). However CRAF is only activated by presidential order in a time of war. The last time CRAF was activated was in 2003. Currently no operations are being conducted under the CRAF program.

during Hurricane Katrina to allow humanitarian flights into and out of New Orleans. This authority is issued on a case-by-case basis during an emergency situation as determined by the Administrator.

Upon review, the FAA concludes that these two categories are the only types of operations that warrant separate consideration because of the unique operating circumstances that otherwise limit a certificate holder's flexibility to deal with unusual circumstances. Therefore, unless a certificate holder's operations fall under either category, the ability to extend an FDP under this section does not apply.

In response to RAA's comment as to this section regarding moving aircraft and crews from an airport about to be impacted by a blizzard or hurricane, these certificate holders have recourse to extend an FDP as necessary under § 117.19. The FAA's modifications to this section are to allow for true emergency situations and to address the uniqueness of certain government contract operations.

Second, this section adopts the provision permitting the FDP and the flight time for a particular operation to be extended if deemed necessary by the pilot-in-command. This provision was slightly modified to allow for an extension to the flightcrew members' flight time limitations if necessary. In addition, the pilot-in command is given the authority to determine the closest destination to safely land the aircraft and allow for the flightcrew to be relieved and afforded the proper rest. The FAA does not expect the flightcrew to extend the FDP simply to complete the next commercially scheduled leg.[93]

Third, the FAA has addressed the reporting requirements for situations when a FDP is extended. Under the NPRM, the FAA proposed two different reporting requirements depending upon whether the operation was conducted pursuant to a U.S. government contract. This section has been modified to incorporate the reporting requirements listed in § 117.19 Flight Duty Period Extensions. Therefore, the certificate holder must file within 10 days any extended FDP and flight time that exceed the maximum permitted under the adopted regulations. The report must contain a description of the extended FDP and flight time limitations and the circumstances surrounding the situation requiring the extension. In addition, if the circumstances surrounding the situation were within the certificate holder's control, the report must contain information on the certificate holder's intended course of corrective action. This action must be implemented within 30 days from the date that the FDP was extended.

The reporting of FDP extensions in this manner can facilitate the certificate holder and the FAA's determination as to whether the certificate holder is properly planning its operations and mitigating the chances of its flightcrews exceeding the FDP limits. If a certificate holder cannot restructure its operations so that very few of these operations need to take advantage of this provision, the certificate holder is advised to develop an FRMS to address these operations.

Several commenters were concerned with the proposal's prohibition on any extension of the cumulative FDP and flight time limits if an extension to a daily FDP was triggered under this section. The FAA partially agrees with the commenters. For operations conducted pursuant to a deviation authorized under § 119.57, the FAA agrees that these circumstances may necessitate the flightcrew member's ability to exceed the cumulative flight time and FDP limitations respectively found in §§ 117.23(b) and (c). Therefore, this section permits an extension of the flightcrew member's FDP and flight time limitation even if it exceeds the cumulative requirements in 117.23 for operations that are conducted pursuant to a deviation authorized under § 119.57.

The FAA does not make such finding with respect to other operations conducted pursuant to a U.S. government contract. Even though these operations may fly into and out of hostile areas or areas that preclude the flightcrew members from proper rest facilities, the certificate holder is well aware of the operating environments where it is agreeing to conduct such operations. Therefore, these situations must be taken into account during the planning stages. A certificate holder needs to have considered and planned for whether the operations under contract will necessitate staging crews at other airports or installing rest facilities onboard the aircraft to enable augmentation, in order to ensure that flightcrews will not exceed FDP limit. For these operations, the cumulative limits on FDP and flight time apply.

R. Miscellaneous Issues

The FAA has also received a number of comments raising other significant issues. These comments, and the associated responses, are discussed below.

Statutory Authority

ATA stated that this rule exceeds the FAA's statutory authority and that this rule cannot be promulgated pursuant to the authority delegated to the FAA in 49 U.S.C. 44701(a)(5) because this rule does not increase aviation safety or national security.

As the NPRM indicated, the authority for this rulemaking stems from 49 U.S.C. 44701(a)(5), which requires the Administrator to promulgate ''regulations and minimum standards for other practices, methods, and procedure the Administrator finds necessary for safety in air commerce and national security.'' Subsection 44701(a)(5) ''grants the FAA 'broad authority to regulate civil aviation.''' *Gorman* v. *National Transp. Safety Bd.,* 558 F.3d 580, 590 (DC Cir. 2009) (quoting *Ass'n of Flight Attendants-CWA* v. *Chao,* 493 F.3d 155, 157 (D.C. Cir. 2007)).[94]

Here, the FAA finds that this rulemaking is necessary for safety in air commerce. As discussed in other portions of this preamble, the existing flight, duty, and rest regulations permit flightcrew members to accumulate unsafe amounts of fatigue. This unsafe accumulation of fatigue undermines aviation safety by increasing the risk of an accident.[95] This rulemaking addresses this issue by imposing limits that will ensure that flightcrew members' fatigue stays within safety-acceptable bounds. This will decrease the risk of an aviation accident, and thus, this rulemaking will increase safety in air commerce. Because this rulemaking will increase safety in air commerce, it is authorized by 49 U.S.C. 44701(a)(5).

As the NPRM also notes, additional authority for this rulemaking stems from 49 U.S.C. 44701(a)(4). Subsection 44701(a)(4) requires the Administrator to promulgate ''regulations in the interest of safety for the maximum hours or periods of service of airmen and other employees of air carriers.'' This rule reduces the fatigue experienced by flightcrew members during flight by limiting the maximum FDP and flight-time hours of airmen and other covered

[93] FAA Response to Clarifying Questions.

[94] *See Drake* v. *Laboratory Corp. of America Holdings,* 458 F.3d 48, 56 (2d Cir. 2006) (stating that ''Congress granted the FAA broad authority over aviation safety''); *Kraley* v. *National Transp. Safety Bd.,* 165 F.3d 27 (6th Cir. 1998) (unpublished opinion) (stating that ''Congress vested the Administrator of the FAA with broad power to prescribe regulations, standards, and procedures relating to aviation safety'').

[95] *See, e.g.,* Goode, *supra* note 17, at 311 (stating that 16-hour unaugmented FDPs, which are permissible under the existing regulations, result in an accident rate that is over five times higher than the accident rate for shorter FDPs).

employees of air carriers. Because this reduction in fatigue will increase aviation safety, the flight, duty, and rest limits that make up this rule are also authorized by subsection 44701(a)(4).

Constitutional Due Process

UPS argued that this rule is unconstitutional because its provisions substantially impair the collective bargaining agreement between UPS and IPA. Although UPS conceded that the Contracts Clause is not applicable to the federal government, UPS argued that ''similar principles apply [to the federal government] under the Due Process Clause.'' UPS concluded that this rule violates the Fifth Amendment's Due Process Clause because, UPS alleged, there is no justification for the contractual impairment imposed by this rule.

The FAA agrees with UPS that the Contracts Clause is not applicable to actions, such as this rulemaking, that are undertaken by the federal government. *Pension Ben. Guar. Corp.* v. *R.A. Gray & Co.,* 467 U.S. 717, 732 n.8 (1984). With regard to UPS' Fifth Amendment argument, the Supreme Court has explicitly rejected the premise that the Fifth Amendment's Due Process Clause is ''coextensive'' with the Contracts Clause. *Id.* at 733. The Court emphasized that ''to the extent that recent decisions of the Court have addressed the issue, we have contrasted the limitations imposed on States by the Contract Clause with the less searching standards imposed on economic legislation by the Due Process Clauses.'' *Id.* Thus, under the standard set out by the Supreme Court, a federal regulation does not offend the Due Process Clause so long as that regulation is not ''arbitrary and irrational.'' *Id.*

This rule is neither arbitrary nor irrational. While the FAA initiated this rulemaking by establishing an ARC, we subsequently received a Congressional directive, which came about because the existing flight, duty, and rest regulations allowed flightcrew members to accumulate dangerous levels of fatigue. To address this issue and keep flightcrew-member fatigue within reasonable bounds, this rule: (1) Limits daily FDP and flight-time hours based on a flightcrew member's circadian rhythm, (2) sets minimum rest requirements, and (3) encourages fatigue-mitigating measures such as split-duty rest and augmentation. This rule also contains a number of other provisions, which are based on specific fatigue and operational concerns and which are discussed in other parts of this preamble. In addition, each of the proposed provisions in this rule was amended, where possible, to respond to the specific concerns raised by the commenters. Because each provision in this rule has been carefully calibrated to mitigate flightcrew-member fatigue while providing air carriers with as much scheduling flexibility as possible, this rule is neither arbitrary nor irrational. Accordingly, this rule does not violate the Fifth Amendment's Due Process Clause.

Administrative Procedure Act

ATA and a number of other industry commenters criticized the timetable used for this rulemaking. These commenters stated that the ARC for this rulemaking met on an unreasonably compressed schedule that did not provide it with sufficient time to carefully consider the pertinent issues and come to a consensus as to the proper resolution of those issues. CAA stated that, rather than provide the ARC with sufficient time to come up with a comprehensive set of recommendations, ''the overwhelming majority of all regulatory activity has focused exclusively on reductions to the current limitations on hours of duty and flight time limits without ever determining whether such hours of service considerations are in fact the underlying cause of any fatigue.'' CAA concluded that ''[a]s a result, the proposals contained in the NPRM are, on the whole, simply designed to reduce the flightcrew hours of service.''

The industry commenters also stated that the NPRM was an ''incomplete and ambiguous document'' that did not provide them with sufficient detail to make meaningful comments. A number of commenters argued that the regulatory impact analysis used to develop the NPRM omitted important information, and thus, precluded the commenters from providing meaningful critique of this analysis.

CAA also stated that the FAA should have waited to publish an NPRM until the National Research Council's Committee on the Effects of Commuting on Pilot Fatigue provided a final report on the fatigue-related effects of pilot commuting. CAA stated that commuting is the primary cause of pilot fatigue, and that an understanding of pilot commuting is a necessary part of any flight, duty, and rest rule.

In addition, the industry commenters argued that the FAA did not provide them with sufficient time to evaluate the NPRM and submit their comments. They stated that the FAA unreasonably refused their requests to extend the 60-day comment period and provided responses to their numerous clarification questions with less than 30 days left in the comment period. Some commenters also stated that the FAA did not release a technical document that was used in the regulatory evaluation until there were only 23 days left in the comment period. The commenters pointed out that when the FAA conducted a similar rulemaking in 1995, it extended the comment period, citing ''the scope and complexity of the proposal.'' The commenters also stated that an analogous rulemaking conducted by the Department of Transportation Federal Motor Carrier Safety Administration to establish rules on hours of service for commercial motor vehicles permitted an extension of the comment period for that rulemaking. The industry commenters stated that the existence of the ARC was not a sufficient justification for the short comment period because this rule includes a number of provisions that the ARC never considered.

RAA suggested that the FAA issue a supplemental NPRM instead of finalizing this rule. RAA emphasized that the FAA received a large number of comments asking that substantial changes be made to this rule, and to account for the number and breadth of the comments, the FAA should issue a supplemental NPRM setting out its proposed resolution to the issues raised by the comments.

In response to the above comments, the FAA notes that while it began this rulemaking by establishing an ARC, we subsequently received a Congressional directive contained in the Airline Safety and Federal Aviation Extension Act (ASFAEA). Section 212 of ASFAEA required the FAA to issue new flight, duty, and rest regulations. This section, in subsection 212(a)(3), set a deadline of 180 days for the FAA to publish an NPRM and 1 year for the FAA to issue a final rule.

Under normal circumstances, the FAA has broad discretion to extend the timeframe for some parts of the rulemaking process. As the above commenters correctly pointed out, the FAA has used this discretion in the past to extend the timeframe for parts of other rulemakings. However, in this case, the FAA has recognized that implicit within the shortened statutory deadline that Congress set for completing this rulemaking was a presumption against extending the timeframe for any part of this rulemaking.

The FAA limited the ARC's schedule to approximately six weeks. The ARC actually met on a weekly basis for at least 2 days per week. The FAA recognizes the tremendous amount of effort expended by the ARC members during this time. At the six-week point, the FAA found that the ARC had achieved its goal of highlighting issues for the FAA to consider as part of the FAA's subsequent rulemaking deliberations. Because most of these issues elicited strong divergent opinions from the labor and industry ARC members and because these divergent opinions could not be reasonably reconciled, the FAA concluded that extending the ARC's timeframe would not result in a consensus set of ARC recommendations.

The FAA disagrees with CAA's assertion that the ARC's timeframe was not extended because the FAA wanted to design a rule that ''reduce[s] the flightcrew hours of service.'' While some parts of this rule reduce flightcrew members' hours of service, other parts increase those hours in a way that is consistent with safety considerations. Thus, for example, this rule increases the existing 8-hour unaugmented daily flight-time limit to 9 hours for periods of peak circadian alertness.

Turning to the length of the comment period that was used for this rulemaking, the FAA chose not to extend this rule's comment period due to the detailed comments that it received and the implicit statutory presumption against extensions in this rulemaking. At the end of the 60-day comment period, the FAA examined the comments that were submitted in response to the NPRM, and determined it was unlikely that an extension of the comment period would have a significant effect on comment quality. During the 60-day comment period, thousands of comments were submitted in response to this rulemaking, and many of those comments contained lengthy comprehensive analyses of every single part of the NPRM, as well as a critique of the regulatory evaluation. A number of commenters hired their own experts to provide detailed substantive reports on the NPRM, and these reports were submitted to the FAA during the 60-day comment period. Based on the comprehensive and detailed comments received during the 60-day comment period, the FAA determined that it had received sufficient information to proceed with this rulemaking. In light of this fact and the need to comply with the statutory deadline for this rulemaking, the FAA chose not to extend the comment period.

The FAA also notes that, as the NPRM pointed out, the FAA has a policy of considering comments that are ''filed after the comment period has closed if it is possible to do so without incurring expense or delay.'' 75 FR 55884. Thus, for example, as part of its consideration of augmented FDPs, the FAA took into account Continental and ALPA's comments about ULR flights, even though those comments were filed four months after the comment period closed. Because the FAA has a very liberal late-filed-comments policy, if the affected parties had important new comments that they wanted to file after the 60-day comment period closed, those parties had ample opportunity to file their comments after the closure of the comment period.

As the commenters pointed out, about halfway through the comment period, the FAA provided answers to clarifying questions that the commenters submitted, as well as a technical report that was referred to by the regulatory evaluation. While this information, which was provided with over 23 days left in the comment period, was important, it was not a central component of the NPRM. Moreover, the commenters appear to have fully incorporated this information into their filed comments, as the comments contained a comprehensive analysis of both the clarifying answers and the regulatory evaluation.

Turning to the sufficiency of the NPRM, the FAA finds that the NPRM provided enough detail for the commenters to provide the FAA with meaningful comments. The NPRM set out the regulatory provisions that the FAA proposed for the new flight, duty, and rest regulations, and the NPRM also explained the rationale for each of those provisions. After reading the NPRM and the accompanying regulatory evaluation, the affected parties provided the FAA with thousands of comments, many of which analyzed in detail every provision of the NPRM and provided a critique of the FAA's rationale for each of those provisions. While many of the commenters disagreed with parts of the NPRM, most of them appear to have had a clear understanding of the NPRM. The affected parties also submitted very detailed critiques of the regulatory evaluation that accompanied the NPRM which showed an understanding of the regulatory evaluation.

As a result of the comprehensive and detailed analyses that were submitted by the commenters, the FAA incorporated many of the commenters' suggestions into the final rule and the final Regulatory Impact Analysis. This process improved the final rule and accomplished the requirements of the Administrative Procedure Act.

Turning to CAA's comment, the FAA notes that since commencing this rulemaking activity, the National Research Council has completed its report. The authors of the report independently determined that it is premature to initiate rulemaking related to commuting. See *The Effects of Commuting on Pilot Fatigue,* National Research Council, July 6, 2011.[96] While pilot commuting is an important fatigue-related issue, this rulemaking does not foreclose the FAA from conducting a rulemaking in the future to address pilot commuting issues should better and more complete information of the risks posed by commuting and methods to alleviate that risk become available.

The FAA has also decided not to issue a supplemental NPRM as part of this rulemaking. As discussed above, the FAA received numerous thorough and high-quality comments in response to the original NPRM. Many of the comments have been incorporated into the final rule. We have made no changes that were not either originally contemplated in the NPRM or a logical outgrowth of that document.

Information Quality Act and OMB Bulletin M–05–03

ATA asserted that the NPRM violated the Information Quality Act (IQA), as applied by the Department of Transportation's (DOT) Information Dissemination Quality Guidelines (Guidelines).[97] ATA argued that the Guidelines require FAA rulemakings to meet defined standards of quality, objectivity, utility and integrity. ATA then argued that ''[d]espite the IQA's clear mandate and DOT's guidance, however, the present NPRM contains no accurate, clear, objective and unbiased information supporting the FAA's proposed overhaul of the existing flightcrew member flight and duty time limitations and rest requirements.'' ATA stated that the scientific information used to support the provisions of the NPRM could not meet the standards set out in the Guidelines because it was not validated in the aviation context. CAA added that the FAA's failure to provide additional regulatory-impact information requested by CAA was also a violation of the IQA. UPS argued that the scientific information used in this rulemaking violated OMB Bulleting M–

[96] In addition to reviewing the possibility of regulating pilot commuting, the National Research Council determined that fatigue mitigation needed to take into account multiple factors, including the duration of work periods within a single day and over time; the time of day that work occurs; duration of sleep on work days and non-work days, the volume and intensity of the work; and the different vulnerabilities of individuals to these factors (among others). This assessment is consistent with the FAA's assessment of fatigue risk.

[97] Citing 67 FR 61719 (Oct. 1, 2002).

05–03 because it was not subjected to peer review.

The DOT Guidelines state that, in the context of a rulemaking, the method by which an agency should correct alleged violations of the IQA is by responding to the pertinent public comments in the preamble to the final rule. Guidelines section VIII. In this case, a number of commenters argued that certain provisions of the NPRM were not supported by scientific information. A significant number of scientific studies were referenced in the NPRM. However, in response to the commenters' scientific concerns, the FAA has included either additional scientific information supporting the studies cited in the NPRM or an explanation for why the scientific information and operational experience cited in the NPRM is sufficient to justify the pertinent regulatory provision.

The FAA notes that, while some of the studies used in the final rule have not been validated in the aviation context, the major provisions of this rule are based on uncontroversial scientific findings that apply to all human beings. As the NPRM pointed out, sleep science, while still evolving, is clear in several important respects:

> Most people need eight hours of sleep to function effectively, most people find it more difficult to sleep during the day than during the night, resulting in greater fatigue if working at night; the longer one has been awake and the longer one spends on task, the greater the likelihood of fatigue; and fatigue leads to an increased risk of making a mistake.

75 FR 55857. These uncontroversial scientific findings form the basis for almost all of the major provisions in this rule. The FAA has concluded that, even though some of these findings were not based on aviation data, flightcrew members have the same fatigue concerns as other human beings, and as such, there is no reason to believe that these findings would not apply to flightcrew members.

However, in the process of considering the comments, the FAA found that some of the provisions of the NPRM, such as portions of the proposed fitness-for-duty section and the cumulative duty-period limit, were not justified by scientific studies and operational experience. Consequently, these provisions were removed from the final rule. Because, in this preamble, the FAA responded to comments questioning the scientific basis for the NPRM and removed regulatory provisions that could not be justified through scientific findings or operational experience, this rule does not violate the IQA and the DOT Guidelines.[98]

Turning to OMB Bulletin M–05–03, this Bulletin requires that ''[t]o the extent permitted by law, each agency shall conduct a peer review on all influential scientific information that the agency intends to disseminate.'' OMB Bulletin M–05–03, section II(1). The studies cited in this document were not conducted on behalf of the FAA and only generally note trends in sleep science. As noted earlier in this document, sleep science does not now, and likely never will, reach the level of certainty that would allow an agency to make public policy decisions based solely on scientific studies. While the science is informative, final decisions will necessarily be based on a balancing of interests in the real world rather than on rigid adherence to scientific studies. This rule complies with this Bulletin because almost all of the scientific information cited in this preamble comes from peer-reviewed scientific journals. Two notable exceptions are the TNO Report and the SAFTE/FAST modeling that was used in parts of this rule. However, the FAA has determined that both the TNO Report and the SAFTE/FAST model have been evaluated sufficiently to provide useful information to the agency in making policy decisions on how best to balance the needs of carriers to maximize their operations while still providing sufficient and meaningful rest opportunities to mitigate the risk of fatigue to those operations. The TNO Report's findings were reviewed by the Scientific Review Board of the Netherlands Organization for Applied Scientific Research, Department of Behavioral and Social Sciences (which complies with ISO 9001:2000 certification standards) and the review board of the Directorate General Transport and Aviation of the Netherlands Ministry of Transport. Turning to the SAFTE/FAST model, as the NPRM pointed out ''[t]his model is widely used, with approximately 14 major carriers and sixteen governmental agencies world-wide having used the model to evaluate fatigue in aviation and other industrial settings.'' 75 FR 55867 n.35. The NPRM also noted that a copy of the technical report evaluating this model has been placed on the docket, and, in addition, the NPRM cited a number of studies that either evaluated or utilized the SAFTE/FAST model. *See id.* n.34.

[98] The FAA also notes that the DOT Guidelines are simply the ''policy views of DOT.'' Guidelines section III. These Guidelines ''are not intended to be, and should not be construed as, legally binding regulations or mandates.'' *Id.*

Executive Order 12866

A number of industry commenters stated that this rulemaking does not comply with Executive Order 12866 because: (1) Its benefits do not justify its costs, (2) it is not based on scientific information, (3) the FAA has not assessed alternatives, and (4) the rule is unduly burdensome.

The commenters stated that the FAA admitted that sleep science has not been validated in the aviation context and portions of this rule, such as cumulative duty-period limits and lower unaugmented FDP limits for additional flight segments, are not based on scientific evidence. ATA and UPS argued that this rule also violated Section 212 of the Airline Safety and Federal Aviation Extension Act because, according to ATA and UPS, this rule is not based on the best science.

ATA and RAA criticized the FAA's approach to this rulemaking. RAA stated that the ARC members whose recommendations were used in this rulemaking have considerable operational experience, and that the less conservative, air carrier ARC recommendations were based on this experience and did not undermine safety. RAA added that some of the specific limits set out in this rule could have been increased due to the fact that this rule contains significant safety oversight provisions.

The industry commenters also stated that the FAA has not considered alternatives to this rule because its ''one-size fits all'' proposal does not take into account ''the unique needs of individual carriers or types of operations.'' ATA stated that this rule is unduly burdensome because the NPRM ''improperly treats passenger, cargo, short-haul, long-haul, domestic, and international carriers and operations the same despite their crucial, differing operational demands and crew scheduling requirements.''

NACA asserted that the FAA never considered the alternative proposals submitted by supplemental air carriers. NACA added that the FAA never explained why it excluded part 135 operators from this rule, but did not exclude other small business entities such as supplemental air carriers. ATA stated that the FAA did not carefully consider the impact that maintaining the status quo would have on small business entities, and that this violated the Regulatory Flexibility Act.

Executive Order 12866 requires, among other things, that a federal agency: (1) ''propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs;'' (2) base its decision on the best available scientific information; (3) consider alternatives to the proposed regulation; and (4) ''tailor its regulations to impose the least burden on society, including individuals, businesses of differing sizes.''

The FAA has determined that the benefits of this rule justify its costs. A detailed discussion explaining the FAA's basis for this determination is contained in the Regulatory Impact Analysis. The FAA has also used the best available scientific information as the basis for this rule. As discussed in the preceding section, most of the provisions in this rule are supported by the latest peer-reviewed scientific studies. While some of these peer-reviewed studies have not been validated in the aviation context, as discussed above, the major provisions of this rule are based on uncontroversial scientific findings that apply to all human beings.

The FAA acknowledges that the proposed cumulative duty-period limits were largely unnecessary, which is why they have been removed from the final rule. With regard to lower unaugmented FDP limits for additional flight segments, as the pertinent section of this preamble points out, a number of scientific studies support the premise that an increase in the number of flight segments leads to an increase in flightcrew member fatigue.[99] The FAA also acknowledges that certain provisions of the NPRM were unduly conservative, and these provisions have been amended in response to concerns expressed by the commenters. For example, the unaugmented FDP limits, which were based on the most conservative ARC recommendation, have been amended in accordance with higher FDP-limit alternatives that were proposed by industry commenters.

The FAA has also considered alternatives to the provisions set out in the NPRM. As the NPRM stated, the FAA has considered the alternative of maintaining the status quo, but rejected that alternative because the status quo subjects society to an ''unacceptably high aviation accident risk.'' 75 FR 55882. For example, as discussed in the Applicability section of this preamble, some of the FDPs permitted by the existing regulations can result in a five-fold increase to accident risk.

The FAA has also considered the alternative of differentiating between different types of part 121 operations. As a result, the FAA has decided to make the provisions of this rule voluntary for all-cargo operations, as subjecting all-cargo operations to the same mandatory flight, duty, and rest regulations as passenger operations would result in costs that far outweigh the commensurate societal benefit.

The FAA also considered differentiating between the different types of part 121 passenger operations. However, the FAA ultimately decided against this approach because, as discussed in the Applicability section, the factors that lead to fatigue are universal and, unlike all-cargo operations, imposing this rule on passenger operations is cost-justified. A flightcrew member who is working on a 16-hour unaugmented FDP will feel the same level of fatigue regardless of the type of operation that he or she is participating in. Accordingly, this rule uniformly regulates the universal fatigue factors in passenger operations regardless of the specific part 121 passenger operation that is involved.

The FAA has also considered the impact that this rule would have on supplemental passenger operations, and it has incorporated a number of suggestions from carriers who conduct supplemental operations and organizations that represent those carriers, into the final rule. The reason that the FAA excluded part 135 businesses regardless of size, but did not exclude air carriers who conduct supplemental operations from this rule, is that the air carriers who conduct supplemental operations operate under part 121 which contains more stringent safety standards than those found in part 135. Pursuant to the Regulatory Flexibility Act, the FAA also considered the impact of this rule on small businesses, and the pertinent discussion can be found below.

Throughout this rulemaking, the FAA has attempted to impose the least possible burden on air carriers, consistent with the need to improve safety. As many commenters pointed out, some provisions of this rule are complex because the FAA has consistently decided against imposing across-the-board flight, duty, and rest limitations, which would have been more stringent than necessary. Instead, this rule imposes stringent limits in safety-critical areas, such as the WOCL, and less stringent limits in other areas, such as unaugmented FDPs that begin in the morning.

The FAA also notes that the uniform approach used in this rulemaking provides additional scheduling flexibility to air carriers. For example, because this rule does not differentiate between international and domestic flights (aside from acclimation and time-zone-crossing issues), this rule permits augmentation on domestic flights, which existing regulations do not allow. In addition, because this rule does not differentiate between supplemental passenger operations and other part 121 passenger flights, this rule does not require supplemental passenger operations to provide flightcrew members with additional compensatory rest that is mandated by existing regulations. Accordingly, this rule complies with Executive Order 12866 because it: (1) Has benefits that justify its costs, (2) is based on the best available scientific information, (3) was finalized after the FAA considered a number of other alternatives, and (4) is tailored to impose the least burden on society.

Voluntary Consensus

ATA argued that this rule should have used a voluntary consensus standard instead of a government-unique standard. ATA stated that OMB Circular A–119 requires agencies to use voluntary standards whenever possible, and that the short time span given to the ARC was not sufficient for the ARC to address the complex issues present in this rulemaking.

As an initial matter, the FAA notes that there is no voluntary consensus standard for the issues addressed by this rulemaking. The FAA disagrees with ATA's assertion that OMB Circular A–119 requires the FAA to use a voluntary consensus standard in this rulemaking. Subsection 6(c) of OMB Circular A–119 states that:

> This policy does not preempt or restrict agencies' authorities and responsibilities to make regulatory decisions authorized by statute. Such regulatory authorities and responsibilities include determining the level of acceptable risk; setting the level of protection; and balancing risk, cost, and availability of technology in establishing regulatory standards.

This rulemaking consists of the FAA exercising its regulatory responsibility and establishing the acceptable level of fatigue-related risk, setting the appropriate level of protection from fatigue, and balancing the risks of fatigue with the costs that will be borne by air carriers as a result of this rule. Because subsection 6(c) of OMB Circular A–119 excludes this type of agency action from the circular's requirements, OMB Circular A–119 does not preempt or restrict the FAA's statutory authority to conduct this rulemaking. *See id.*

---

[99] *See supra* notes 36–38.

Public Interest

ATA stated that this rule would also harm the public interest by: (1) Reducing the number of U.S. jobs by hurting the competitive nature of the U.S. air carrier industry; (2) harm the U.S. economy by imposing excessive costs on air carriers; (3) disrupt air travel and waste passengers' air time as a result of additional cancelled and delayed flights; and (4) disrupt critical air deliveries.

As discussed above, this rule does not hurt the competitive nature of the U.S. air carrier industry. This rule simply reflects a different conceptual approach that the FAA utilized in light of its significant operational experience with daily flight-time limits. With regard to the remaining concerns expressed in the comments, as discussed in the Regulatory Impact Analysis, the costs that are imposed by this rule are justified by the associated benefits of reducing the risk that passengers will be involved in an accident.

Two-Year Effective Date

RAA also stated that a two-year effective date for this rule may be too short given the magnitude of the changes being proposed, and the complex process, development, training, and system programming, testing and implementation that would be required to effect those changes cannot be properly accomplished in such a time period. RAA emphasized that the changes being proposed by this rule ''go to the very heart'' of an airline's operations.

The FAA understands that this rule imposes complex new requirements that go to the heart of an airline's operations. That is why this rule provides air carriers with two years to make changes to their existing flight schedules and operations and if necessary, to address any labor agreement issues. The FAA has determined that two years is a substantial period of time, and that a longer effective date is unwarranted in light of the fact that, as discussed above, existing regulations allow flightcrew members in passenger operations to accumulate unsafe amounts of fatigue.

Federal Motor Carrier Safety Administration Hours of Service Rulemaking

FMCSA has been engaged in long-term rulemaking related to its hours of service regulations for commercial truck drivers. Like the FAA, FMCSA is working to address the universality of factors that lead to fatigue. However, the FAA has taken a different approach in addressing fatigue risk among pilots than FMCSA has with respect to commercial truck drivers. This is because the two industries operate differently both in terms of the likely number of days the affected individuals work per month and the respective operating environments. For example, pilots regularly cross multiple time zones in a very short period of time—something that is simply not possible in other modes of transportation. Additionally, pilots may work several days that are very long, but then be off for an extended period of time, a practice that naturally imposes a non-regulatory restorative rest opportunity. Finally, the nature of commercial flying is such that under typical conditions, the actual operation is likely to require intense concentration primarily during take-offs and landings, with a constant, but generally predictable level of concentration required for other phases of flight.

In contrast, commercial truck drivers face an environment where they are required to share the highways with drivers who have not received specialized training and are not subject to any regulatory constraints that pilots are subject to. This environment could logically lead to a regulatory approach with different fatigue mitigators for daytime operations on congested highways, compared to nighttime operations, where the roads are less crowded but the risk of fatigue is greater.

IV. Regulatory Notices and Analyses

A. Regulatory Evaluation

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 and Executive Order 13563 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Pub. L. 96–354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Pub. L. 96–39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, the Trade Agreements Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation with base year of 1995). This portion of the preamble summarizes the FAA's analysis of the economic impacts of this proposed rule. The FAA suggests readers seeking greater detail read the full regulatory impact analysis, a copy of which the agency has placed in the docket for this rulemaking.

In conducting these analyses, the FAA has determined that this final rule: (1) Has benefits that justify its costs even though under the base case scenario the quantified costs are greater than the quantified benefits, (2) is not an economically ''significant regulatory action'' as defined in section 3(f) of Executive Order 12866, (3) is ''significant'' as defined in DOT's Regulatory Policies and Procedures; (4) will have a significant economic impact on a substantial number of small entities; (5) will not create unnecessary obstacles to the foreign commerce of the United States; and (6) will not impose an unfunded mandate on state, local, or tribal governments, or on the private sector by exceeding the threshold identified above. These analyses are summarized below.

Total Benefits and Costs Over a 10 Year Period

We have analyzed the benefits and the costs associated with the requirements contained in this Final Rule over a 10 year period. We provide a range of estimates for our quantitative benefits. Our base estimate is $376 million ($247 million present value at 7% and $311 million present value at 3%) and our high case estimate is $716 million ($470 million present value at 7% and $593 million at 3%). The total estimated cost of the Final Rule is $390 million ($297 million present value at 7% and $338 million at 3%).

Additionally, the FAA believes there are substantial, non-quantified health benefits associated with the final rule. The agency has not evaluated the effect of fatigue on the overall, long-term health of the pilot community because those health impacts are unlikely to have an impact on aviation safety in a quantifiable manner. However, as ALPA noted in one of its meetings with OMB under its E.O. 12866 procedures, the societal cost associated with long-term fatigued-related health problems can be substantial.[100] Decreasing these costs

[100] See OMB submission from ALPA dated October 28, 2011. *http://www.whitehouse.gov/omb/oira_2120_meetings/*.

represents a societal benefit. While we have not quantified these potential benefits, they may well exceed the projected costs of the rule when added to our base case estimate.

The actual benefits of the final rule will depend upon the type and size of accident that the rule averts. We have provided a base case estimate, based on historical accidents and the regulatory structure in place at the time those accidents occurred, and a high estimate, based on a projection of future accidents that broadly reflect the historical accident profile. Neither estimate assumes a catastrophic accident aboard a large passenger aircraft. This is because no large passenger aircraft were represented in the historical accident analysis rather than because there is no fatigue-related risk to those operations. We note that preventing a single catastrophic accident with 61 people on board would cause this rule to be cost beneficial.

Total benefits over 10 years

Estimate	Nominal (millions)	PV at 7% (millions)	PV at 3% (millions)
Base	$376	$247	$311
High	716	470	593

Total costs over 10 years

Component	Nominal (millions)	PV at 7% (millions)	PV at 3% (millions)
Flight Operations	$236	$157	$191
Rest Facilities	138	129	134
Training	16	11	13
Total	390	297	338

Benefits of the Rule

The benefit analysis first examines the nature of fatigue, followed by its causes and how it relates to transportation. Second, it summarizes some recent findings on fatigue and occupational performance. Third, it looks at the magnitude of crew fatigue in Part 121 commercial aviation by briefly examining fatigue reports in the context of this final rule. We then re-analyze the likely effectiveness of the requirements contained in this final rule and the potential to decrease these types of accidents in the future. The FAA projects a likely number of preventable events that will occur in absence of this final rule. Finally, the agency estimates the benefits that will be derived from preventing such events and a range of benefits based upon likely scenarios.

Here the FAA provides a quantitative benefit estimate of historical-based accidents (base case), and a high case of expected benefits from future averted accidents once this rule is promulgated. Generally our benefit analysis begins using past history as an important reference from which to begin the benefit analysis. We believe the base case benefit estimate, which is based solely on the outcome of past accidents, may be low because today passenger load factors and aircraft size are already greater than they were in the past decade. We also note that this estimate may not fully take into account changes in regulatory requirements that postdate those accidents and that may mitigate the projected risk. As such, our base case estimate represents a snapshot of risk.

Airplane accidents are somewhat random both in terms of airplane size and the number of people on board. For these reasons, projections of future fatalities may be based on future risk exposure, and our projections are typically based on expected distributions around the mean. Our typical scenario incorporates increasing airplane size, expected load factors, and a breakeven analysis. However, our evaluation of the historical accidents showed a disproportionate risk among smaller, regional carriers. Accordingly, as we discuss below, the FAA has decided to base its high case estimate on preventing an accident in a regional jet airplane.

In response to comments, we have reduced the analysis period from the 20 years provided in the proposed regulatory analysis to 10 years here. We received comments disputing the use of a 20 year time frame for accidents stating the accident rate has declined over time. While noting the wide range of operations over the last 20 years, we shortened the accident history to the last ten years. A reduction in the length of the sample period introduces other problems, most importantly with less time there are fewer observations. Observations are important, as the nature of aviation accidents is that while they are rare events, very often these accidents result in severe, high consequences.

The FAA Office of Accident Investigation assessed the effectiveness of this rule to prevent the 6 fatigue-related accidents which occurred on passenger-carrying aircraft in a recent ten year period. This office used the Commercial Aviation Safety Team (CAST) methodology to assign a value to how effective the rule will be at preventing each accident. On average, we expect this rule would have been 52.5 percent effective in preventing the types of accidents had it been in effect over the last 10 years.

Base Case Estimate

The base case estimate only looks at the historical events as a specific reference point. In this estimate the exact number of fatalities for each past event is multiplied by the relative rule effectiveness score to obtain the historical number of deaths that would have been averted with the requirements contained in this final rule, had this rule been in effect at the time. The base case estimate supposes roughly six deaths will be averted annually. Multiplying six annual averted deaths by the $6.2 million value of statistical life equals $37 million annually. In addition, had the requirements been in place at the time of these historical accidents, $2 million in hull damage for each accident would have been averted, which equals $6 million for ten years or $0.6 million annually. When summed over the ten year period of analysis, the base case estimate is $376 million ($247 million present value at 7% and $311 million present value at 3%).

High Case Estimate

Because airplane accidents are relatively rare they are not necessarily representative of actual risk, especially with regard to airplane size and the number of people on-board. In addition, future conditions will be different than they were when the accident occurred. Thus, the base case represents a snapshot of the risk that fatigue introduces in the overall operating environment. It considers neither the forecasted increase in load factors nor the larger aircraft types. The future preventable events that this rule addresses will not exactly mirror the past events because the airplane types, utilization, and seating capacity have changed.

To quantify the expected benefits in the high case scenario, we narrowed the analysis to three of the six historic accidents which were catastrophic (all on board died). In this case the expected number of preventable catastrophic accidents equals the three accidents multiplied by the 52.5 percent effectiveness rate. Thus over a ten-year time period the expected number of preventable accidents is 1.575. Using the Poisson distribution there is roughly a 20 percent chance for no accident; however, there is also a 50 percent probability of two or more accidents.

While the 20 year accident history has a broader range of catastrophic accidents, in the shorter ten year historical period all the three catastrophic accidents were on regional airplanes. We recognize that as regional airplanes are smaller than the 'typical' passenger jet, assuming all future accidents would be on a regional jet may understate the relative risk across the fleet of aircraft affected by this rule. It does, however, represent historical accidents and may be somewhat representative actual future risk, since the mainline carriers typically have collective bargaining agreements that are already largely reflective of the requirements of this rule.[101]

The average size airplane in the forecast period is a B737/A320 with an expected number of passengers and crew of 123 given a forecasted 142 seat airplane and a load factor of 83 percent.[102] Even though there was a (relatively large) B757 passenger airplane accident in the 20 year history, if one looks at the past 10 years as truly representative of risk, the preventable accident would likely be on a regional airplane.

For the high case the FAA backed away from a benefit outcome based on mean fleet, flight hours, and occupant numbers because ultimately we were persuaded there was information which could not be ignored by the three regional passenger accidents occurring without a mainline passenger accident. For this reason, we selected an 88 seat regional jet (like an ERJ–175) to be the representative airplane for the high case. This size airplane is also consistent with the fact that regional operators are expected to fly somewhat larger airplanes in the future.

The expected benefit from this high case follows a simple methodology for estimating and then valuing the expected number of occupants in a prevented accident. With a total of 0.3 accidents per year over the ten year period multiplied by the 52.5 percent effectiveness rate, the analysis assumes 0.1575 average accidents per year. The estimated occupant value for each averted accident equals the average number of seats (88) multiplied by the load factor of 77% plus 4 crew members for a total of 72 averted fatalities. Each of these prevented fatalities is multiplied by a $6.2 million value of statistical life. The expected value of a preventable accident equals the sum of the averted fatalities at $446.4 million added to the value of the airplane hull loss ($8.15 million replacement value), for a prevented accident benefit of $454.6 million.[103] Over a ten year period the value of preventing the expected 1.575 accidents equals approximately $716 million ($470 million present value at 7% and $593 million present value at 3%).

Cost of the Rule

The total estimated cost of the Final Rule is $390 million ($297 million at 7% present value and $338 million at 3% present value). The FAA classified costs into three main components and estimated the costs for each component. Data was obtained from various industry sources; the sources of the data used in cost estimation are explained in each section. Flight operations cost accounts for 53 percent of the total present value cost of the rule. Rest facilities and fatigue training accounts for approximately 43 percent and 4 percent, respectively. Each of the main cost components is explained in-depth in the Regulatory Evaluation.

Cost component	Nominal cost (millions)	PV at 7% (millions)	PV at 3% (millions)
Flight Operations	$236	$157	$191
Rest Facilities	138	129	134
Training	16	11	13
Total	390	297	338

Alternatives Considered—The alternatives are shown in the section ''Final Regulatory Flexibility Analysis''

B. Final Regulatory Flexibility Analysis

The Regulatory Flexibility Act of 1980 (RFA) establishes ''as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation.'' To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule would have a significant economic impact on a substantial number of small entities. If the determination is that it would, the agency must prepare a

[101] It is unusual that collective bargaining agreements would closely mirror regulatory requirements. However, flight and duty limitations are unique because they address both safety considerations, which are regulatory in nature, and lifestyle considerations, which are properly addressed in collective bargaining agreements. Because of the impact of collective bargaining agreements on the number of hours that pilots work, those agreements were considered by the FAA in calculating both the costs and benefits of this rule.

[102] Table 6, FAA Aerospace Forecasts Fiscal Years 2011.

[103] In contrast, the value of an averted all-cargo fatal accident would range between $20.35 million (loss of hull and 2 crewmembers) and $32.55 million (loss of hull and 4 crewmembers).

regulatory flexibility analysis as described in the RFA.

The FAA believes that this final rule will have a significant economic impact on a substantial number of small entities and therefore has performed final regulatory flexibility analysis in accordance with section 604(a)(1)–(5), highlighted below:

1. A succinct statement of the need for, and objectives of, the rule.

2. A summary of the significant issues raised by the public comments in response to the IRFA, a summary of the assessment of the agency of such issues, and a statement of any changes made in the proposed rule as a result of such comments.

3. A description and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available.

4. A description of the projected reporting, recordkeeping, and other compliance requirements of the rule, including an estimate of the classes of small entities that will be subject to the requirement and the types of professional skills necessary for preparation of the report or record.

5. A description of the steps the agency has taken to minimize the significant adverse economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why each of the other significant alternatives to the rule considered by the agency were rejected. We address each requirement.

1. A Succinct Statement of the Need for, and Objectives of, the Rule

This final rule amends the FAA's existing flight, duty and rest regulations applicable to certificate holders and their flightcrew members operating under 14 CFR Part 121. The rule recognizes the universality of factors that lead to fatigue in most individuals. Fatigue threatens aviation safety because it increases the risk of pilot error that could lead to an accident. The new requirements eliminate the current distinctions between domestic, flag and supplemental operations as they apply to passenger operations. The rule provides different requirements based on the time of day, whether an individual is acclimated to a new time zone, and the likelihood of being able to sleep under different circumstances. The objective of the proposed rule is to increase the margin of safety for passengers traveling on U.S. part 121 air carrier flights. Specifically, the FAA wants to decrease diminished flight crew performance associated with fatigue or lack of alertness brought on by the duty requirements for flightcrew members.

2. A Summary of the Significant Issues Raised by the Public Comments in Response to the IRFA, a Summary of the Assessment of the Agency of Such Issues, and a Statement of Any Changes Made in the Proposed Rule as a Result of Such Comments

NAA, NJASAP, Southern Air, Lynden Air Cargo, NACA and U.S. Chamber of Commerce stated that RFA of the proposed rule failed to address the full burden to be borne by small entities, such as nonscheduled air carriers, and that the FAA did not follow RFA requirements in addressing alternative means of compliance that would lessen the economic burden on small entities.

Since the NPRM, the FAA has made substantial changes to the duty and rest requirements that will significantly reduce the cost to small entities.

3. A Description and an Estimate of the Number of Small Entities to Which the Rule Will Apply or an Explanation of Why No Such Estimate Is Available

The final rule applies to all certificate holders operating under part 121 who conduct passenger operations. There are 67 such operators, of which 55 operators have fewer than 1,500 employees.

4. A Description of the Projected Reporting, Recordkeeping, and Other Compliance Requirements of the Rule, Including an Estimate of the Classes of Small Entities That Will Be Subject to the Requirement and the Types of Professional Skills Necessary for Preparation of the Report or Record

As described in the Paperwork Reduction Analysis, there are additional compliance requirements for reporting and recordkeeping.

5. A Description of the Steps the Agency Has Taken To Minimize the Significant Adverse Economic Impact on Small Entities Consistent With the Stated Objectives of Applicable Statutes, Including a Statement of the Factual, Policy, and Legal Reasons for Selecting the Alternative Adopted in the Final Rule and Why Each of the Other Significant Alternatives to the Rule Considered by the Agency was Rejected.

Current crew schedules vary by operator, labor contract, and size of pilot pools. As such, the impact to small entity operators will vary. The agency understands that many smaller operators have maximized their pilot time in the cockpit and may have little flexibility with potential new flight and duty regulations and we have taken steps to minimize the economic impact on small entities. In response to several comments from small entities, the FAA has made significant changes from the proposal in this final rule which will minimize the economic impact on small entities. In addition, the FAA has largely removed schedule reliability from this rule. The FAA has instead adopted provisions that limit extensions of the FDP and requires reporting of FDP extensions and activities that were not otherwise permitted by the provisions of § 117.11, § 117.19 and § 117.29 in the Final Rule. Under this amendment, costs to airline carriers are limited to reporting exceptional activities by sending electronic mails to the FAA.

Alternative—Require Four Hours' Mid-duty Rest To Work on Give Consecutive Nighttime FDPs

This final rule reduces (to two hours) the amount of mid-duty rest necessary to work on five consecutive nighttime FDPs. The FAA rejected the higher mid-duty rest requirement proposed in the NPRM because of the potential negative impact on small businesses and the safety risks that are discussed in the pertinent part of the preamble.

Alternative—Different Limitations on Supplemental Passenger Operations

The FAA has considered imposing different limitations on small supplemental passenger operations but has rejected this alternative. The FAA has decided to impose the same FDP limits on passenger supplemental operations as other part 121 operations. While there are relatively few supplemental passenger operations, the FAA has determined that these pilots should be as rested as those in scheduled service since the numbers of passengers onboard the aircraft are similar to those on board an aircraft operating as a scheduled service. Furthermore, a significant number of these operations involve the transport of troops. The United States government believes these passengers should not be exposed to a level of risk different from if they were transported via a scheduled service operation.

Alternative—Exclude/Exempt Supplemental Passenger Operations

The FAA has also considered excluding supplemental passenger operations from this rule but rejected this alternative for the same reasons that it rejected the alternative of imposing different limitations on supplemental passenger operations. In addition, the FAA has noted that its decision to include supplemental operations in this rule was not specifically targeted at small businesses because many large air carriers also have supplemental authority.

Alternative—Require All-Cargo Operators To Comply With the Final Rule

The FAA has also considered requiring all-cargo operators to comply with part 117. However, the FAA decided to make compliance with this part voluntary for all-cargo operations because their compliance costs significantly exceed the quantified safety benefits.

C. International Trade Impact Assessment

A number of industry commenters argued that finalizing the NPRM as written would undermine the ability of U.S. air carriers to compete with foreign air carriers. These commenters stated that 49 U.S.C. 40101(a)(15) and (e)(1) require the Secretary of Transportation to ensure that U.S. air carriers compete on equal terms with foreign carriers. The commenters then pointed out that this rule contains provisions, such as daily flight-time limits, that are not a part of analogous foreign regulations, and that these provisions hurt the international competitive position of U.S. air carriers who are subject to this rule.

The industry commenters added that the imposition of daily flight-time limits, which are not contained in foreign aviation regulations, creates an unnecessary obstacle to the foreign commerce of the United States, and thus violates the Trade Agreements Act of 1979 (TAA) (codified at 19 U.S.C. sections 2531–2533). The commenters also argued that by imposing daily flight-time limits, the FAA did not properly consider other international standards, and thus violated the TAA, OMB Circular A–119, and Executive Order 12866, all of which require the FAA to consider international standards.

The Trade Agreements Act of 1979 (Pub. L. 96–39), as amended by the Uruguay Round Agreements Act (Pub. L. 103–465), prohibits Federal agencies from establishing standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Pursuant to these Acts, the establishment of standards is not considered an unnecessary obstacle to the foreign commerce of the United States, so long as the standard has a legitimate domestic objective, such the protection of safety, and does not operate in a manner that excludes imports that meet this objective. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards.[104] The FAA has assessed the potential effect of this final rule and determined that it would enhance safety and is not considered an unnecessary obstacle to trade.

The flight-time limits in this rule do not undermine the international competitive position of U.S. air carriers. While this rule sets daily flight-time limits that many foreign aviation rules do not contain, the additional fatigue mitigation created by the daily flight-time limits permits the FAA to set less stringent requirements in other parts of this rule. For example, this rule only requires a 10-hour rest period between FDPs instead of the 12-hour rest period required by many foreign flight, duty, and rest regulations. This rule also permits 14-hour FDPs for periods of peak circadian alertness while some foreign regulations, such as EU Rules, Subpart Q, only permit FDPs that do not exceed 13 hours.[105]

As the above examples demonstrate, the imposition of daily flight-time limits is simply the result of a different conceptual approach that was utilized by the FAA. The FAA chose this approach because it has significant operational experience administering daily flight-time limits, and the FAA chose to employ this experience to better calibrate the specific provisions of this rule. This difference in approach does not undermine the competitive position of U.S. air carriers because the imposition of daily flight-time limits permitted the FAA to make other parts of this rule less stringent than the analogous provisions of foreign flight, duty, and rest regulations.

D. Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a ''significant regulatory action.'' The FAA currently uses an inflation-adjusted value of $143.1 million in lieu of $100 million. This final rule does not contain such a mandate; therefore, the requirements of Title II do not apply.

[104] As discussed in the International Compatibility section, there are no ''international standards'' to consider.

[105] *See* EU Rules, Subpart Q, OPS 1.1100, section 1.3 and OPS 1.1110, section 1.1.

E. Paperwork Reduction Act

The paperwork burden comprises of five areas, fatigue risk management system § 117.7, fatigue training § 117.9, flight time limitation § 117.11, and flight duty period extension reporting § 117.19 and Emergency and government sponsored operations § 117.29. The following analyses were conducted under Paperwork Reduction Act of 1995 (44 U.S.C. 3501).

(1) PRA analysis for reporting fatigue risk management system (FRMS) § 117.7 provision

The final rule will allow each air carrier to develop a Fatigue Risk Management System (FRMS) if it wishes. FRMS is a voluntary program in the final rule. It will result in an annual recordkeeping and reporting burden if some of industry carriers eventually adopt the system so that they need to report the related activities to the FAA. Total FRMS annualized paperwork burden is determined by the numbers of FRMS to be developed and FRMS reporting cost per responders. FAA estimated that FRMS will incur the paperwork burden about $14,950 annually, $149,500 nominal cost for 10 years or $99,186 present value at 7%. FAA took steps to arrive the estimate as follows.

a. Number of respondents (air carriers): the FAA estimated approximately 20 carriers or respondents;

b. Estimated time of paperwork: about 11.5 hours per air carrier and 230 hours in total for data collection, annual FRMS record-keeping and reporting required by the FAA;

c. Average hourly wage rate of a FRMS information respondent (manager level): $65 per hour for reporting and analyzing FRMS data;

d. FRMS paperwork hour estimation: total 230 hours (11.5 hours × 20 estimated carriers);

e. Total annualized cost of FRMS paperwork is about $14,950 ($1,253.50 × 20) for the estimated 20 carriers.

f. The nominal cost for 10-year is $149,500 or $99,186 present value at 7%.

(2) PRA analysis for fatigue training § 117.9 provision

The fatigue training requirement in the final rule will also result in an annual recordkeeping and reporting burden. Total fatigue training annualized paperwork burden costs are determined by the numbers of responders and fatigue training reporting cost per responders. FAA estimated that the fatigue training will incur the paperwork burden approximately 2,345 hours, $152,425 for the first year, $1.5 million nominal cost for 10 years or $1 million present value at 7%. FAA took steps to arrive the estimate as follows.

a. Number of responders (dispatchers and managers): 67 operators;

b. Estimated time needed for each responder: 35 hours, or 2,345 hours incurred by 67 responders;

c. Average hourly wage rate of trainee: $65 per hour;

d. Fatigue training paperwork cost: $152,425 per annum ($65 hourly wage rate × 2,345 hours);

(3) PRA analysis for § 117.11, § 117.19 and § 117.29 provisions

The FAA combined the cost estimates in one PRA analysis for three provisions of the final rule (§ 117.11, § 117.19 and § 117.29), since paperwork burdens for carriers to report activities that were not otherwise permitted by § 117.11, § 117.19 and § 117.29 are the same. Reporting and recordkeeping by carriers can be done electronically by addressing the facts of events. Under the above provisions, carriers do not need to conduct complicated analyses, so that there will be no paperwork burden of analyses. In this analysis, the estimate of paperwork burden will be determined by the numbers of respondents, the frequencies of their reporting, hours required and the reporter's wage rate. The FAA estimated the final annual paperwork burden for three provisions is $92,250, and $0.9 million for the 10-years nominal cost, or the present value of $0.6 million at 7%, by taking steps to arrive the estimate as follows.

a. Number of respondents (air carriers): there are 67 carriers or respondents;

b. Estimated frequencies for reporting requirements under each provision: Although a definitive frequency is unknown and will decrease as certificate holders adapt the changes, the FAA assumes an average of 6 times per year for each provision;

c. Estimated total frequencies of annual responses: 18 times (6 × 3) per carrier and 1,206 times (67 × 18) by 67 carriers for these three provisions of the final rule;

d. Estimated time needed for each report for each occurrence: 30 minutes, one hundred percent of these responses will be collected electronically. The time needed for each carrier to report is about 9 hours (18 × 30 minutes), and 603 hours in total by 67 carriers for these three provisions of the final rule;

e. Estimated hourly wage rate of reporting staff: $65 per hour;

f. The estimated total annual cost of reporting is about $39,195 (603 hours × $65);

g. The nominal cost for 10-years is about $0.4 million or the present value of $0.24 million at 7%.

Summarizing the above, the annualized cost is approximately $194,950 and the total nominal cost for 10-years about $2.1 million ($0.15 million + $1.5 million + $0.4 million) or the present value of approximately $1.3 million at 7% ($0.1 + $1 million + $0.2 million). The public reporting burden is estimated to be an average of 47 hours for each Part 121 certificate holder and 3,178 hours, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The total annual cost burden is approximately $204,950 in total for 67 carriers. There will be no additional annualized cost to the Federal Government, because FAA will not add additional staff or pay additional contractors for collecting, viewing and keeping electronic report-emails.

F. International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to conform to International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has determined that there are no ICAO Standards and Recommended Practices that directly correspond to these regulations.[106]

G. Environmental Analysis

FAA Order 1050.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this rulemaking action qualifies for the categorical exclusion identified in paragraph 312f and involves no extraordinary circumstances.

V. Executive Order Determinations

A. Executive Order 12866 and 13563

See the ''Regulatory Evaluation'' discussion in the ''Regulatory Notices and Analyses'' section elsewhere in this preamble.

B. Executive Order 13132, Federalism

The FAA has analyzed this final rule under the principles and criteria of Executive Order 13132, Federalism. The agency determined that this action will not have a substantial direct effect on the States, or the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, does not have Federalism implications.

C. Executive Order 13211, Regulations That Significantly Affect Energy Supply, Distribution, or Use

The FAA analyzed this final rule under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). The agency has determined that it is not a ''significant energy action'' under the executive order and it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

VI. How To Obtain Additional Information

A. Rulemaking Documents

An electronic copy of a rulemaking document may be obtained by using the Internet—

1. Search the Federal eRulemaking Portal (*http://www.regulations.gov*);

2. Visit the FAA's Regulations and Policies Web page at *http://www.faa.gov/regulations_policies/* or

3. Access the Government Printing Office's Web page at *http://www.gpoaccess.gov/fr/index.html.*

Copies may also be obtained by sending a request (identified by notice, amendment, or docket number of this rulemaking) to the Federal Aviation Administration, Office of Rulemaking, ARM–1, 800 Independence Avenue SW., Washington, DC 20591, or by calling (202) 267–9680.

B. Comments Submitted to the Docket

Comments received may be viewed by going to *http://www.regulations.gov* and following the online instructions to search the docket number for this action. Anyone is able to search the electronic form of all comments received into any of the FAA's dockets by the name of the individual submitting the comment (or signing the

[106] Chapter 4 of ICAO 6, Amendment 33, section 4.2.10.2 states the following:

Fatigue management. An operator shall establish flight time and duty period limitations and a rest scheme that enable it to manage the fatigue of all its flight and cabin crew members. This scheme shall comply with the regulations established by the State of the Operator, or approved by that State and shall be included in the operations manual.

This provision of ICAO is not inconsistent with this rule. Moreover, because the ICAO provision defers to the regulations promulgated by the State of the Operator, it does not even directly correspond to this rule.

comment, if submitted on behalf of an association, business, labor union, *etc.*).

C. Small Business Regulatory Enforcement Fairness Act

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires FAA to comply with small entity requests for information or advice about compliance with statutes and regulations within its jurisdiction. A small entity with questions regarding this document, may contact its local FAA official, or the person listed under the **FOR FURTHER INFORMATION CONTACT** heading at the beginning of the preamble. To find out more about SBREFA on the Internet, visit *http://www.faa.gov/regulations_policies/rulemaking/sbre_act/.*

List of Subjects

14 CFR Part 117

Airmen, Aviation safety, Reporting and recordkeeping requirements, Safety.

14 CFR Part 119

Air carriers, Aircraft, Aviation safety, Reporting and recordkeeping requirements.

14 CFR Part 121

Air carriers, Aircraft, Airmen, Aviation safety, Reporting and recordkeeping requirements, Safety.

The Amendment

In consideration of the foregoing, the Federal Aviation Administration amends chapter I of title 14, Code of Federal Regulations as follows:

■ 1. Part 117 is added to read as follows:

PART 117—FLIGHT AND DUTY LIMITATIONS AND REST REQUIREMENTS: FLIGHTCREW MEMBERS

Authority: 49 U.S.C. 106(g), 40113, 40119, 44101, 44701–44702, 44705, 44709–44711, 44713, 44716–44717, 44722, 46901, 44903–44904, 44912, 46105.

§ 117.1 Applicability.

(a) This part prescribes flight and duty limitations and rest requirements for all flightcrew members and certificate holders conducting passenger operations under part 121 of this chapter.

(b) This part applies to all operations directed by part 121 certificate holders under part 91, other than subpart K, of this chapter if any segment is conducted as a domestic passenger, flag passenger, or supplemental passenger operation.

(c) This part applies to all flightcrew members when participating in an operation under part 91, other than subpart K of this chapter, on behalf of the part 121 certificate holder if any flight segment is conducted as a domestic passenger, flag passenger, or supplemental passenger operation

(d) Notwithstanding paragraphs (a), (b) and (c) of this section, a certificate holder may conduct under part 117 its part 121 operations pursuant to 121.470, 121.480, or 121.500.

§ 117.3 Definitions.

In addition to the definitions in §§ 1.1 and 110.2 of this chapter, the following definitions apply to this part. In the event there is a conflict in definitions, the definitions in this part control.

Acclimated means a condition in which a flightcrew member has been in a theater for 72 hours or has been given at least 36 consecutive hours free from duty.

Airport/standby reserve means a defined duty period during which a flightcrew member is required by a certificate holder to be at an airport for a possible assignment.

Augmented flightcrew means a flightcrew that has more than the minimum number of flightcrew members required by the airplane type certificate to operate the aircraft to allow a flightcrew member to be replaced by another qualified flightcrew member for in-flight rest.

Calendar day means a 24-hour period from 0000 through 2359 using Coordinated Universal Time or local time.

Certificate holder means a person who holds or is required to hold an air carrier certificate or operating certificate issued under part 119 of this chapter.

Deadhead transportation means transportation of a flightcrew member as a passenger or non-operating flightcrew member, by any mode of transportation, as required by a certificate holder, excluding transportation to or from a suitable accommodation. All time spent in deadhead transportation is duty and is not rest. For purposes of determining the maximum flight duty period in Table B of this part, deadhead transportation is not considered a flight segment.

Duty means any task that a flightcrew member performs as required by the certificate holder, including but not limited to flight duty period, flight duty, pre- and post-flight duties, administrative work, training, deadhead transportation, aircraft positioning on the ground, aircraft loading, and aircraft servicing.

Fatigue means a physiological state of reduced mental or physical performance capability resulting from lack of sleep or increased physical activity that can reduce a flightcrew member's alertness and ability to safely operate an aircraft or perform safety-related duties.

Fatigue risk management system (FRMS) means a management system for a certificate holder to use to mitigate the effects of fatigue in its particular operations. It is a data-driven process and a systematic method used to continuously monitor and manage safety risks associated with fatigue-related error.

Fit for duty means physiologically and mentally prepared and capable of performing assigned duties at the highest degree of safety.

Flight duty period (FDP) means a period that begins when a flightcrew member is required to report for duty with the intention of conducting a flight, a series of flights, or positioning or ferrying flights, and ends when the aircraft is parked after the last flight and there is no intention for further aircraft movement by the same flightcrew member. A flight duty period includes the duties performed by the flightcrew member on behalf of the certificate holder that occur before a flight segment or between flight segments without a required intervening rest period. Examples of tasks that are part of the flight duty period include deadhead transportation, training conducted in an aircraft or flight simulator, and airport/standby reserve, if the above tasks occur before a flight segment or between flight segments without an intervening required rest period:

Home base means the location designated by a certificate holder where a flightcrew member normally begins and ends his or her duty periods.

Lineholder means a flightcrew member who has an assigned flight duty period and is not acting as a reserve flightcrew member.

Long-call reserve means that, prior to beginning the rest period required by § 117.25, the flightcrew member is notified by the certificate holder to report for a flight duty period following the completion of the rest period.

Physiological night's rest means 10 hours of rest that encompasses the hours of 0100 and 0700 at the flightcrew member's home base, unless the individual has acclimated to a different theater. If the flightcrew member has acclimated to a different theater, the rest must encompass the hours of 0100 and 0700 at the acclimated location.

Report time means the time that the certificate holder requires a flightcrew member to report for an assignment.

Reserve availability period means a duty period during which a certificate holder requires a flightcrew member on short call reserve to be available to receive an assignment for a flight duty period.

Reserve flightcrew member means a flightcrew member who a certificate holder requires to be available to receive an assignment for duty.

Rest facility means a bunk or seat accommodation installed in an aircraft that provides a flightcrew member with a sleep opportunity.

(1) *Class 1 rest facility* means a bunk or other surface that allows for a flat sleeping position and is located separate from both the flight deck and passenger cabin in an area that is temperature-controlled, allows the flightcrew member to control light, and provides isolation from noise and disturbance.

(2) *Class 2 rest facility* means a seat in an aircraft cabin that allows for a flat or near flat sleeping position; is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation; and is reasonably free from disturbance by passengers or flightcrew members.

(3) *Class 3 rest facility* means a seat in an aircraft cabin or flight deck that reclines at least 40 degrees and provides leg and foot support.

Rest period means a continuous period determined prospectively during which the flightcrew member is free from all restraint by the certificate holder, including freedom from present responsibility for work should the occasion arise.

Scheduled means to appoint, assign, or designate for a fixed time.

Short-call reserve means a period of time in which a flightcrew member is assigned to a reserve availability period.

Split duty means a flight duty period that has a scheduled break in duty that is less than a required rest period.

Suitable accommodation means a temperature-controlled facility with sound mitigation and the ability to control light that provides a flightcrew member with the ability to sleep either in a bed, bunk or in a chair that allows for flat or near flat sleeping position. Suitable accommodation only applies to ground facilities and does not apply to aircraft onboard rest facilities.

Theater means a geographical area where local time at the flightcrew member's flight duty period departure point and arrival point differ by more than 60 degrees longitude.

Unforeseen operational circumstance means an unplanned event of insufficient duration to allow for adjustments to schedules, including unforecast weather, equipment malfunction, or air traffic delay that is not reasonably expected.

Window of circadian low means a period of maximum sleepiness that occurs between 0200 and 0559 during a physiological night.

§ 117.5 Fitness for duty.

(a) Each flightcrew member must report for any flight duty period rested and prepared to perform his or her assigned duties.

(b) No certificate holder may assign and no flightcrew member may accept assignment to a flight duty period if the flightcrew member has reported for a flight duty period too fatigued to safely perform his or her assigned duties.

(c) No certificate holder may permit a flightcrew member to continue a flight duty period if the flightcrew member has reported him or herself too fatigued to continue the assigned flight duty period.

(d) As part of the dispatch or flight release, as applicable, each flightcrew member must affirmatively state he or she is fit for duty prior to commencing flight.

§ 117.7 Fatigue risk management system.

(a) No certificate holder may exceed any provision of this part unless approved by the FAA under a Fatigue Risk Management System that provides at least an equivalent level of safety against fatigue-related accidents or incidents as the other provisions of this part.

(b) The Fatigue Risk Management System must include:

(1) A fatigue risk management policy.

(2) An education and awareness training program.

(3) A fatigue reporting system.

(4) A system for monitoring flightcrew fatigue.

(5) An incident reporting process.

(6) A performance evaluation.

§ 117.9 Fatigue education and awareness training program.

(a) Each certificate holder must develop and implement an education and awareness training program, approved by the Administrator. This program must provide annual education and awareness training to all employees of the certificate holder responsible for administering the provisions of this rule including flightcrew members, dispatchers, individuals directly involved in the scheduling of flightcrew members, individuals directly involved in operational control, and any employee providing direct management oversight of those areas.

(b) The fatigue education and awareness training program must be designed to increase awareness of:

(1) Fatigue;

(2) The effects of fatigue on pilots; and

(3) Fatigue countermeasures

(c) (1) Each certificate holder must update its fatigue education and awareness training program every two years and submit the update to the Administrator for review and acceptance.

(2) Not later than 12 months after the date of submission of the fatigue education and awareness training program required by (c)(1) of this section, the Administrator shall review and accept or reject the update. If the Administrator rejects an update, the Administrator shall provide suggested modifications for resubmission of the update.

§ 117.11 Flight time limitation.

(a) No certificate holder may schedule and no flightcrew member may accept an assignment or continue an assigned flight duty period if the total flight time:

(1) Will exceed the limits specified in Table A of this part if the operation is conducted with the minimum required flightcrew.

(2) Will exceed 13 hours if the operation is conducted with a 3-pilot flightcrew.

(3) Will exceed 17 hours if the operation is conducted with a 4-pilot flightcrew.

(b) If unforeseen operational circumstances arise after takeoff that are beyond the certificate holder's control, a flightcrew member may exceed the maximum flight time specified in paragraph (a) of this section and the cumulative flight time limits in 117.23(b) to the extent necessary to safely land the aircraft at the next destination airport or alternate, as appropriate.

(c) Each certificate holder must report to the Administrator within 10 days any flight time that exceeded the maximum flight time limits permitted by this section. The report must contain the following:

(1) A description of the extended flight time limitation and the circumstances surrounding the need for the extension; and

(2) If the circumstances giving rise to the extension were within the certificate holder's control, the corrective action(s) that the certificate holder intends to take to minimize the need for future extensions.

(d) Each certificate holder must implement the corrective action(s) reported in paragraph (c)(2) of this section within 30 days from the date of the extended flight time limitation.

§ 117.13 Flight duty period: Unaugmented operations.

(a) Except as provided for in § 117.15, no certificate holder may assign and no flightcrew member may accept an assignment for an unaugmented flight operation if the scheduled flight duty period will exceed the limits in Table B of this part.

(b) If the flightcrew member is not acclimated:

(1) The maximum flight duty period in Table B of this part is reduced by 30 minutes.

(2) The applicable flight duty period is based on the local time at the theater in which the flightcrew member was last acclimated.

§ 117.15 Flight duty period: Split duty.

For an unaugmented operation only, if a flightcrew member is provided with a rest opportunity (an opportunity to sleep) in a suitable accommodation during his or her flight duty period, the time that the flightcrew member spends in the suitable accommodation is not part of that flightcrew member's flight duty period if all of the following conditions are met:

(a) The rest opportunity is provided between the hours of 22:00 and 05:00 local time.

(b) The time spent in the suitable accommodation is at least 3 hours, measured from the time that the flightcrew member reaches the suitable accommodation.

(c) The rest opportunity is scheduled before the beginning of the flight duty period in which that rest opportunity is taken.

(d) The rest opportunity that the flightcrew member is actually provided may not be less than the rest opportunity that was scheduled.

(e) The rest opportunity is not provided until the first segment of the flight duty period has been completed.

(f) The combined time of the flight duty period and the rest opportunity provided in this section does not exceed 14 hours.

§ 117.17 Flight duty period: Augmented flightcrew.

(a) For flight operations conducted with an acclimated augmented flightcrew, no certificate holder may assign and no flightcrew member may accept an assignment if the scheduled flight duty period will exceed the limits specified in Table C of this part.

(b) If the flightcrew member is not acclimated:

(1) The maximum flight duty period in Table C of this part is reduced by 30 minutes.

(2) The applicable flight duty period is based on the local time at the theater in which the flightcrew member was last acclimated.

(c) No certificate holder may assign and no flightcrew member may accept an assignment under this section unless during the flight duty period:

(1) Two consecutive hours in the second half of the flight duty period are available for in-flight rest for the pilot flying the aircraft during landing.

(2) Ninety consecutive minutes are available for in-flight rest for the pilot performing monitoring duties during landing.

(d) No certificate holder may assign and no flightcrew member may accept an assignment involving more than three flight segments under this section.

(e) At all times during flight, at least one flightcrew member qualified in accordance with § 121.543(b)(3)(i) of this chapter must be at the flight controls.

§ 117.19 Flight duty period extensions.

(a) For augmented and unaugmented operations, if unforeseen operational circumstances arise prior to takeoff:

(1) The pilot in command and the certificate holder may extend the maximum flight duty period permitted in Tables B or C of this part up to 2 hours.

(2) An extension in the flight duty period under paragraph (a)(1) of this section of more than 30 minutes may occur only once prior to receiving a rest period described in § 117.25(b).

(3) A flight duty period cannot be extended under paragraph (a)(1) of this section if it causes a flightcrew member to exceed the cumulative flight duty period limits specified in 117.23(c).

(4) Each certificate holder must report to the Administrator within 10 days any flight duty period that exceeded the maximum flight duty period permitted in Tables B or C of this part by more than 30 minutes. The report must contain the following:

(i) A description of the extended flight duty period and the circumstances surrounding the need for the extension; and

(ii) If the circumstances giving rise to the extension were within the certificate holder's control, the corrective action(s) that the certificate holder intends to take to minimize the need for future extensions.

(5) Each certificate holder must implement the corrective action(s) reported in paragraph (a)(4) of this section within 30 days from the date of the extended flight duty period.

(b) For augmented and unaugmented operations, if unforeseen operational circumstances arise after takeoff:

(1) The pilot in command and the certificate holder may extend maximum flight duty periods specified in Tables B or C of this part to the extent necessary to safely land the aircraft at the next destination airport or alternate airport, as appropriate.

(2) An extension of the flight duty period under paragraph (b)(1) of this section of more than 30 minutes may occur only once prior to receiving a rest period described in § 117.25(b).

(3) An extension taken under paragraph (b) of this section may exceed the cumulative flight duty period limits specified in 117.23(c).

(4) Each certificate holder must report to the Administrator within 10 days any flight duty period that exceeded the maximum flight duty period limits permitted by Tables B or C of this part. The report must contain a description of the circumstances surrounding the affected flight duty period.

§ 117.21 Reserve status.

(a) Unless specifically designated as airport/standby or short-call reserve by the certificate holder, all reserve is considered long-call reserve.

(b) Any reserve that meets the definition of airport/standby reserve must be designated as airport/standby reserve. For airport/standby reserve, all time spent in a reserve status is part of the flightcrew member's flight duty period.

(c) For short call reserve,

(1) The reserve availability period may not exceed 14 hours.

(2) For a flightcrew member who has completed a reserve availability period, no certificate holder may schedule and no flightcrew member may accept an assignment of a reserve availability period unless the flightcrew member receives the required rest in § 117.25(e).

(3) For an unaugmented operation, the total number of hours a flightcrew member may spend in a flight duty period and a reserve availability period

may not exceed the lesser of the maximum applicable flight duty period in Table B of this part plus 4 hours, or 16 hours, as measured from the beginning of the reserve availability period.

(4) For an augmented operation, the total number of hours a flightcrew member may spend in a flight duty period and a reserve availability period may not exceed the flight duty period in Table C of this part plus 4 hours, as measured from the beginning of the reserve availability period.

(d) For long call reserve, if a certificate holder contacts a flightcrew member to assign him or her to a flight duty period that will begin before and operate into the flightcrew member's window of circadian low, the flightcrew member must receive a 12 hour notice of report time from the certificate holder.

(e) A certificate holder may shift a reserve flightcrew member's reserve status from long-call to short-call only if the flightcrew member receives a rest period as provided in § 117.25(e).

§ 117.23 Cumulative limitations.

(a) The limitations of this section include all flying by flightcrew members on behalf of any certificate holder or 91K Program Manager during the applicable periods.

(b) No certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total flight time will exceed the following:

(1) 100 hours in any 672 consecutive hours and

(2) 1,000 hours in any 365 consecutive calendar day period.

(c) No certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total Flight Duty Period will exceed:

(1) 60 flight duty period hours in any 168 consecutive hours and

(2) 190 flight duty period hours in any 672 consecutive hours.

§ 117.25 Rest period.

(a) No certificate holder may assign and no flightcrew member may accept assignment to any reserve or duty with the certificate holder during any required rest period.

(b) Before beginning any reserve or flight duty period a flightcrew member must be given at least 30 consecutive hours free from all duty in any 168 consecutive hour period.

(c) If a flightcrew member operating in a new theater has received 36 consecutive hours of rest, that flightcrew member is acclimated and the rest period meets the requirements of paragraph (b) of this section.

(d) If a flightcrew member travels more than 60° longitude during a flight duty period or a series of flight duty periods that require him or her to be away from home base for more than 168 consecutive hours, the flightcrew member must be given a minimum of 56 consecutive hours rest upon return to home base. This rest must encompass three physiological nights' rest based on local time.

(e) No certificate holder may schedule and no flightcrew member may accept an assignment for any reserve or flight duty period unless the flightcrew member is given a rest period of at least 10 consecutive hours immediately before beginning the reserve or flight duty period measured from the time the flightcrew member is released from duty. The 10 hour rest period must provide the flightcrew member with a minimum of 8 uninterrupted hours of sleep opportunity.

(f) If a flightcrew member determines that a rest period under paragraph (e) of this section will not provide eight uninterrupted hours of sleep opportunity, the flightcrew member must notify the certificate holder. The flightcrew member cannot report for the assigned flight duty period until he or she receives a rest period specified in paragraph (e) of this section.

(g) If a flightcrew member engaged in deadhead transportation exceeds the applicable flight duty period in Table B of this part, the flightcrew member must be given a rest period equal to the length of the deadhead transportation but not less than the required rest in paragraph (e) of this section before beginning a flight duty period.

§ 117.27 Consecutive nighttime operations.

A certificate holder may schedule and a flightcrew member may accept up to five consecutive flight duty periods that infringe on the window of circadian low if the certificate holder provides the flightcrew member with an opportunity to rest in a suitable accommodation during each of the consecutive nighttime flight duty periods. The rest opportunity must be at least 2 hours, measured from the time that the flightcrew member reaches the suitable accommodation, and must comply with the conditions specified in § 117.15(a), (c), (d), and (e). Otherwise, no certificate holder may schedule and no flightcrew member may accept more than three consecutive flight duty periods that infringe on the window of circadian low. For purposes of this section, any split duty rest that is provided in accordance with § 117.15 counts as part of a flight duty period.

§ 117.29 Emergency and government sponsored operations.

(a) This section applies to operations conducted pursuant to contracts with the U.S. Government and operations conducted pursuant to a deviation under § 119.57 of this chapter that cannot otherwise be conducted under this part because of circumstances that could prevent flightcrew members from being relieved by another crew or safely provided with the rest required under § 117.25 at the end of the applicable flight duty period.

(b) The pilot-in-command may determine that maximum applicable flight duty periods must be exceeded to the extent necessary to allow the flightcrew to fly to the closest destination where they can safely be relieved from duty by another flightcrew or can receive the requisite amount of rest prior to commencing their next flight duty period.

(c) A flight duty period may not be extended for an operation conducted pursuant to a contract with the U.S. Government if it causes a flightcrew member to exceed the cumulative flight time limits in § 117.23(b) and the cumulative flight duty period limits in § 117.23(c).

(d) The flightcrew shall be given a rest period immediately after reaching the destination described in paragraph (b) of this section equal to the length of the actual flight duty period or 24 hours, whichever is less.

(e) Each certificate holder must report within 10 days:

(1) Any flight duty period that exceeded the maximum flight duty period permitted in Tables B or C of this part, as applicable, by more than 30 minutes; and

(2) Any flight time that exceeded the maximum flight time limits permitted in Table A of this part and § 117.11, as applicable.

(f) The report must contain the following:

(1) A description of the extended flight duty period and flight time limitation, and the circumstances surrounding the need for the extension; and

(2) If the circumstances giving rise to the extension(s) were within the certificate holder's control, the corrective action(s) that the certificate holder intends to take to minimize the need for future extensions.

(g) Each certificate holder must implement the corrective action(s) reported pursuant to paragraph (e)(2) of this section within 30 days from the date of the extended flight duty period.

TABLE A TO PART 117—MAXIMUM FLIGHT TIME LIMITS FOR UNAUGMENTED OPERATIONS TABLE

Time of report (acclimated)	Maximum flight time (hours)
0000–0459	8
0500–1959	9
2000–2359	8

TABLE B TO PART 117—FLIGHT DUTY PERIOD: UNAUGMENTED OPERATIONS

Scheduled time of start (acclimated time)	Maximum flight duty period (hours) for lineholders based on number of flight segments						
	1	2	3	4	5	6	7+
0000–0359	9	9	9	9	9	9	9
0400–0459	10	10	10	10	9	9	9
0500–0559	12	12	12	12	11.5	11	10.5
0600–0659	13	13	12	12	11.5	11	10.5
0700–1159	14	14	13	13	12.5	12	11.5
1200–1259	13	13	13	13	12.5	12	11.5
1300–1659	12	12	12	12	11.5	11	10.5
1700–2159	12	12	11	11	10	9	9
2200–2259	11	11	10	10	9	9	9
2300–2359	10	10	10	9	9	9	9

TABLE C TO PART 117—FLIGHT DUTY PERIOD: AUGMENTED OPERATIONS

Scheduled time of start (acclimated time)	Maximum flight duty period (hours) based on rest facility and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 pilots	4 pilots	3 pilots	4 pilots	3 pilots	4 pilots
0000–0559	15	17	14	15.5	13	13.5
0600–0659	16	18.5	15	16.5	14	14.5
0700–1259	17	19	16.5	18	15	15.5
1300–1659	16	18.5	15	16.5	14	14.5
1700–2359	15	17	14	15.5	13	13.5

PART 119—CERTIFICATION: AIR CARRIERS AND COMMERCIAL OPERATORS

■ 2. The authority citation for part 119 continues to read as follows:

Authority: 49 U.S.C. 106(g), 1153, 40101, 40102, 40103, 40113, 44105, 44106, 44111, 44701–44717, 44722, 44901, 44903, 44904, 44906, 44912, 44914, 44936, 44938, 46103, 46105.

■ 3. In § 119.55, revise paragraph (a) to read as follows:

§ 119.55 Obtaining deviation authority to perform operations under a U.S. military contract.

(a) The Administrator may authorize a certificate holder that is authorized to conduct supplemental or on-demand operations to deviate from the applicable requirements of this part, part 117, part 121, or part 135 of this chapter in order to perform operations under a U.S. military contract.

* * * * *

PART 121—OPERATING REQUIREMENTS: DOMESTIC, FLAG, AND SUPPLEMENTAL OPERATIONS

■ 4. The authority section for part 121 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 40119, 44101, 44701–44702, 44705, 44709–44711, 44713, 44716–44717, 44722, 46901, 44903–44904, 44912, 46105.

■ 5. In § 121.467, revise paragraphs (c) introductory text and (c) (1) to read as follows:

§ 121.467 Flight attendant duty period limitations and rest requirements: Domestic, flag, and supplemental operations.

* * * * *

(c) Notwithstanding paragraph (b) of this section, a certificate holder conducting domestic, flag, or supplemental operations may apply the flightcrew member flight time and duty limitations and requirements of part 117 of this chapter to flight attendants for all operations conducted under this part provided that—

(1) The flightcrew is subject to part 117;

* * * * *

Subpart Q [Amended]

■ 6. Revise § 121.470 to read as follows:

§ 121.470 Applicability.

This subpart prescribes flight time limitations and rest requirements for domestic all-cargo operations, except that:

(a) Certificate holders conducting operations with airplanes having a passenger seat configuration of 30 seats or fewer, excluding each crewmember seat, and a payload capacity of 7,500 pounds or less, may comply with the applicable requirements of §§ 135.261 through 135.273 of this chapter.

(b) Certificate holders conducting scheduled operations entirely within the States of Alaska or Hawaii with airplanes having a passenger seat configuration of 30 seats or fewer, excluding each crewmember seat, and a payload capacity of 7,500 pounds or less, may comply with the applicable requirements of subpart R of this part for those operations.

(c) A certificate holder may apply the flightcrew member flight time and duty limitations and requirements of part 117 of this chapter. A certificate holder may choose to apply part 117 to its—

(1) Cargo operations conducted under contract to a U.S. government agency.

(2) All-cargo operations not conducted under contract to a U.S. Government agency,

(3) A certificate holder may elect to treat operations in paragraphs (c)(1) and (c)(2) of this section differently but, once having decided to conduct those operations under part 117, may not segregate those operations between this subpart and part 117.

■ 7. Add § 121.473 to read as follows:

§ 121.473 Fatigue risk management system.

(a) No certificate holder may exceed any provision of this subpart unless approved by the FAA under a Fatigue Risk Management System.

(b) The Fatigue Risk Management System must include:

(1) A fatigue risk management policy.

(2) An education and awareness training program.

(3) A fatigue reporting system.

(4) A system for monitoring flightcrew fatigue.

(5) An incident reporting process.

(6) A performance evaluation.

Subpart R—[Amended]

■ 8. Revise § 121.480 to read as follows:

§ 121.480 Applicability.

This subpart prescribes flight time limitations and rest requirements for flag all-cargo operations, except that:

(a) Certificate holders conducting operations with airplanes having a passenger seat configuration of 30 seats or fewer, excluding each crewmember seat, and a payload capacity of 7,500 pounds or less, may comply with the applicable requirements of §§ 135.261 through 135.273 of this chapter.

(b) A certificate holder may apply the flightcrew member flight time and duty limitations and requirements of part 117 of this chapter. A certificate holder may choose to apply part 117 to its—

(1) All-cargo operations conducted under contract to a U.S. government agency.

(2) All-cargo operations not conducted under contract to a U.S. Government agency,

(3) A certificate holder may elect to treat operations in paragraphs (b)(1) and (b) (2) of this section differently but, once having decided to conduct those operations under part 117, may not segregate those operations between this subpart and part 117.

■ 9. Add § 121.495 to read as follows:

§ 121.495 Fatigue risk management system.

(a) No certificate holder may exceed any provision of this subpart unless approved by the FAA under a Fatigue Risk Management System.

(b) The Fatigue Risk Management System must include:

(1) A fatigue risk management policy.

(2) An education and awareness training program.

(3) A fatigue reporting system.

(4) A system for monitoring flightcrew fatigue.

(5) An incident reporting process.

(6) A performance evaluation.

Subpart S—[Amended]

■ 10. Revise § 121.500, to read as follows:

§ 121.500 Applicability.

This subpart prescribes flight time limitations and rest requirements for supplemental all-cargo operations, except that:

(a) Certificate holders conducting operations with airplanes having a passenger seat configuration of 30 seats or fewer, excluding each crewmember seat, and a payload capacity of 7,500 pound or less, may comply with the applicable requirements of §§ 135.261 through 135.273 of this chapter.

(b) A certificate holder may apply the flightcrew member flight time and duty limitations and requirements of part 117 of this chapter. A certificate holder may choose to apply part 117 to its—

(1) All-cargo operations conducted under contract to a U.S. Government agency.

(2) All-cargo operations not conducted under contract to a U.S. Government agency,

(3) A certificate holder may elect to treat operations in paragraphs (b)(1) and (b)(2) of this section differently but, once having decided to conduct those operations under part 117, may not segregate those operations between this subpart and part 117.

■ 11. Add § 121.527 to read as follows:

§ 121.527 Fatigue risk management system.

(a) No certificate holder may exceed any provision of this subpart unless approved by the FAA under a Fatigue Risk Management System.

(b) The Fatigue Risk Management System must include:

(1) A fatigue risk management policy.

(2) An education and awareness training program.

(3) A fatigue reporting system.

(4) A system for monitoring flightcrew fatigue.

(5) An incident reporting process.

(6) A performance evaluation.

12. In § 121.583, revise paragraph (a) introductory text to read as follows:

§ 121.583—Carriage of persons without compliance with the passenger-carrying requirements of this part and part 117.

(a) When authorized by the certificate holder, the following persons, but no others, may be carried aboard an airplane without complying with the passenger-carrying airplane requirements in §§ 121.309(f), 121.310, 121.391, 121.571, and 121.587; the passenger-carrying operation requirements in part 117 and §§ 121.157(c) and 121.291; and the requirements pertaining to passengers in §§ 121.285, 121.313(f), 121.317, 121.547, and 121.573:

* * * * *

Issued in Washington, DC, on December 21, 2011.

Michael P. Huerta,

Acting Administrator.

[FR Doc. 2011–33078 Filed 12–23–11; 4:15 pm]

BILLING CODE P

TAB 2

September 9, 2009

Ms. Margaret Gilligan
Associate Administrator for Aviation Safety
Aviation Safety
Federal Aviation Administration
800 Independence Avenue SW.
Washington, DC 20571

Dear Ms. Gilligan:

On behalf of the Flight and Duty Time Limitations and Rest Requirements Aviation Rulemaking Committee (ARC), we are pleased to provide you with a copy of the ARC's recommendations on updated flight and duty time limitations and rest requirements. The recommendations are in the format of a draft notice of proposed rulemaking, as required by the ARC's charter.

These recommendations reflect diligent work by the ARC on an accelerated timeline, and represent careful deliberation by the members, combining the best available science and their collective experience in the air carrier industry. We are confident that the recommendations represent a substantial improvement over current regulations and will be effective in helping to achieve the FAA's goal of reducing fatigue and increasing alertness among flightcrew members.

We trust these recommendations will be helpful in your decisionmaking process. We and our fellow ARC members stand ready to assist the FAA in prioritizing implementation of the ARC's recommendations.

Sincerely,

Jim Mangie
Co-Chair

Don Wykoff
Co-Chair

Enclosure

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part XXX

Docket No. FAA-YYYY- ; Notice No.

RIN 2120-

Flightcrew Member Flight and Duty Time Limitations and Rest Requirements

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This proposal would establish flightcrew member flight and duty time limitations and rest requirements, taking into account current fatigue science and approaches to addressing fatigue. This proposal would set a single standard for all certificate holders and flightcrew members operating under parts 121 and 135 of Title 14, Code of Federal Regulations (14 CFR). This proposal is needed to address the current international approaches concerning fatigue. The intended effect of this proposal is to ensure the continued safety of the national airspace system (NAS) for all users by enhancing flightcrew member alertness and mitigating fatigue.

DATES: Send your comments on or before [Insert date 30/45/60/90/120 days after date of publication in the Federal Register].

ADDRESSES: You may send comments identified by Docket Number [insert docket number] using any of the following methods:

- Federal eRulemaking Portal: Go to http://www.regulations.gov and follow the online instructions for sending your comments electronically.

- Mail: Send comments to Docket Operations, M–30; U.S. Department of Transportation, 1200 New Jersey Avenue SE., Room W12–140, West Building Ground Floor, Washington, DC 20590–0001.
- Hand Delivery or Courier: Take comments to Docket Operations in Room W12–140 of the West Building Ground Floor at 1200 New Jersey Avenue SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.
- Fax: Fax comments to Docket Operations at 202–493–2251.

For more information on the rulemaking process, see the SUPPLEMENTARY INFORMATION section of this document.

Privacy: We will post all comments we receive, without change, to http://www.regulations.gov, including any personal information you provide. Using the search function of our docket Web site, anyone can find and read the electronic form of all comments received into any of our dockets, including the name of the individual sending the comment (or signing the comment for an association, business, labor union, etc.). You may review the U.S. Department of Transportation's (DOT) complete Privacy Act Statement in the Federal Register published April 11, 2000 (65 FR 19477), or you may visit http://DocketsInfo.dot.gov.

Docket: To read background documents or comments received, go to http://www.regulations.gov at any time and follow the online instructions for accessing the docket, or the Docket Operations in Room W12–140 of the West Building Ground Floor at 1200 New Jersey Avenue SE., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: For technical questions concerning this proposed rule contact [Insert the name, Division/Branch, Routing Symbol], Federal Aviation Administration, 800 Independence Avenue SW., Washington, DC 20591; telephone (XXX) XXX-XXXX; facsimile (XXX) XXX-XXXX, email XXXX.XXXX@faa.gov. For legal questions concerning this proposed rule contact [Insert the name, Division/Branch, Routing Symbol], Federal Aviation Administration, 800 Independence Avenue SW., Washington, DC 20591; telephone (XXX) XXX-XXXX; facsimile (XXX) XXX-XXXX, email XXXX.XXXX@faa.gov.

SUPPLEMENTARY INFORMATION:

Later in this preamble under the Additional Information section, we discuss how you can comment on this proposal and how we will handle your comments. Included in this discussion is related information about the docket, privacy, and the handling of proprietary or confidential business information. We also discuss how you can get a copy of related rulemaking documents.

Authority for this Rulemaking

[Insert]

Table of Contents

D. International Standards

1. Amendment No. 33 to the International Standards and Recommended Practices, Annex 6 to the Convention on International Civil Aviation, Part I, International Commercial Air Transport—Aeroplanes (International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARP))

2. United Kingdom Civil Aviation Authority Publication 371 (CAP 371)

3. Annex III, Subpart Q to the Commission of the European Communities Regulation No. 3922/91, as amended (EU OPS subpart Q)

E. Scientific Expert Presentations

1. Fatigue

2. Fatigue Factors in Aviation

3. Preventing and Mitigating Sleep Debt

4. Fatigue Modeling

5. Preventing Fatigue and Fatigue Risk Management Systems

III. General Discussion of the Proposal

A. Applicability

1. Single Approach

2. Unique Supplemental Operations

B. Definitions

C. Responsibilities

1. Certificate Holder Responsibilities

a. Schedule

b. Nonretribution Policy

I. Executive Summary

[To be completed]

II. Background

A. Statement of the Problem

On June 10, 2009, FAA Administrator J. Randolph Babbitt testified before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Aviation Operations, Safety, and Security on Aviation Safety regarding the FAA's role in the oversight of certificate holders. He addressed issues regarding flightcrew member training and qualifications, flightcrew fatigue, and consistency of safety standards and compliance among air transportation certificate holders. He also committed to assess the safety of the air transportation system and to take appropriate steps to improve it.

B. Aviation Rulemaking Committee Tasking

To carry out the Administrator's goal, the FAA chartered an aviation rulemaking committee (ARC) to recommend rulemaking on flight time limitations, duty period limits, and rest requirements for flightcrew members in operations under parts 121 and 135. The ARC was chartered to provide a forum for the U.S. aviation community to discuss current approaches to mitigate fatigue found in international standards, and recommend how the United States should modify its regulations. The ARC consisted of 18 members representing air carrier and union associations. The members were selected based on their extensive certificate holder management and/or direct operational experience.

The FAA recognizes that the effects of fatigue are universal. The profiles of operations under parts 121 and 135 are similar enough that the same fatigue mitigations should be applied to all flightcrew members operating under these parts. Therefore, the FAA asked the ARC to consider and address the following:

(1) A single approach to addressing fatigue that consolidates and replaces existing regulatory requirements in parts 121 and 135.

(2) Generally accepted principles of human physiology, performance, and alertness based on the body of fatigue science.

(3) Information on sources of aviation fatigue.

(4) Current approaches to fatigue mitigation in international standards.

(5) Fatigue risk management systems (FRMS).

The ARC met over a 6-week period beginning July 7, 2009, and provided the FAA the results of their meeting discussions in the form of a record of each meeting, and a draft NPRM, including the preamble and regulatory text. A writing committee, a subgroup of the ARC, drafted this preamble using the records of meeting, which are attached in their entirety to this NPRM as attachment III.

(NOTE: Because of time constraints, the full ARC did not review this preamble. However, as mentioned, the language was developed from the records of meeting, which were reviewed for accuracy by the full ARC.)

The ARC's goal was to reach as much agreement as possible on the prospective regulation. The ARC noted that it would most likely not achieve consensus on all issues. Several of the ARC members proposed rule sections include alternative schemes and/or limits to reflect the range of ARC member positions; these are bracketed and highlighted in gray. In addition, the Cargo Air Carrier Association (CAA) presented a separate proposal, for FAA consideration, that addresses the unique operations of its members. (See attachment I to this NPRM.) According to the CAA, cargo operations are subject to different operational and competitive factors than scheduled passenger air carrier operations, including flight delays and schedule changes outside the control of the certificate holder. Several ARC members opposed establishing a separate rule for cargo operations and stressed that they support establishing one level of safety for all operations. These ARC members believed that fatigue mitigation elements for the various types of operations discussed during the ARC meetings can be addressed under the ARC's proposed scheme.

The National Air Carrier Association (NACA) also submitted an alternate proposal to the ARC. (See attachment II to this NPRM.) NACA proposed that the regulations contained in subpart S of part 121 continue to apply to certificate holders conducting unscheduled supplemental operations; however, the regulations should include a requirement that such operators develop and implement FRMSs. NACA also requested that the FAA establish a supplemental air carrier working group in the near future to discuss the most effective fatigue mitigation elements for certificate holders conducting supplemental operations.

The FAA informed the ARC that it may not accept all of the ARC's proposals, but it would explain any decisions in the published NPRM's preamble. The FAA clarified to ARC members that their ARC participation in no way precluded them from submitting comments critical of the final NPRM to the public docket when it is eventually published.

C. National Transportation Safety Board (NTSB) Recommendations

The NTSB has long been concerned about the effects of fatigue in the aviation industry. The first aviation safety recommendations, issued in 1972, involved human fatigue. Aviation safety investigations continue to identify serious concerns about the effects of fatigue, sleep, and circadian rhythm disruption. Currently, the NTSB's list of Most Wanted Transportation Safety Improvements includes safety recommendations regarding pilot fatigue. These recommendations are based on two accident investigations and an NTSB safety study on commuter airline safety.

In February 2006, the NTSB issued safety recommendations after a BAE–J3201 operated under part 121 by Corporate Airline struck trees on final approach and crashed short of the runway at Kirksville Regional Airport in Kirksville, Missouri. The captain, first officer, and 11 of the 13 passengers were fatally injured. The NTSB determined the probable cause of the accident was the pilots' failure to follow established procedures and properly conduct a nonprecision instrument approach at night in instrument meteorological conditions. The NTSB concluded that fatigue likely contributed to the pilots' performance and decisionmaking. This conclusion was based on (1) the less than optimal overnight rest time available to the pilots, (2) the early reporting time for duty, (3) the number of flight legs, and (4) the demanding conditions encountered during the long duty day.

As a result of the accident, the NTSB issued the following safety recommendations on flight and duty time limitations: (1) modify and simplify the flightcrew hours-of-service regulations to consider factors such as length of duty day, starting time, workload, and other factors shown by recent research, scientific evidence, and current industry experience to affect crew alertness (recommendation No. A–06–10); and (2) require all part 121 and part 135 certificate holders to incorporate fatigue-related information similar to the information being developed by the DOT Operator Fatigue Management Program into initial and recurrent pilot training programs. The recommendation notes that this training should address the detrimental effects of fatigue and include strategies for avoiding fatigue and countering its effects (recommendation No. A–06–11).

The NTSB's list of Most Wanted Transportation Safety Improvements also includes a safety recommendation on pilot fatigue and ferry flights conducted under 14 CFR part 91. Three flightcrew members died after a Douglas DC–8–63 operated by Air Transport

International was destroyed by ground impact and fire during an attempted three engine takeoff at Kansas City International Airport in Kansas City, Missouri. The NTSB noted that the flightcrew conducted the flight as a maintenance ferry flight under part 91 after a shortened rest break that followed a demanding round trip flight to Europe that crossed multiple time zones. The NTSB further noted that the international flight conducted under part 121 involved multiple legs flown at night following daytime rest periods; this caused the flightcrew to experience circadian rhythm disruption. In addition, the NTSB found that the captain's last rest period before the accident was repeatedly interrupted by the certificate holder.

In issuing its 1995 recommendations, the NTSB stated that the flight time limits and rest requirements under part 121 that applied to the flightcrew before the ferry flight did not apply to the ferry flight operated under part 91. The NTSB found that the regulations permitted a substantially reduced flightcrew rest period for the nonrevenue ferry flight. As a result of the investigation, the NTSB reiterated earlier recommendations to (1) finalize the review of current flight and duty time limitations to ensure the limitations consider research findings on fatigue and sleep issues and (2) prohibit certificate holders from assigning a flightcrew to flights conducted under part 91 unless the flightcrew met the flight and duty time limits under part 121 or other applicable regulations (recommendation No. A–95–113).

In 1994 the NTSB issued a safety study on commuter airline safety. The NTSB noted that most of the pilots surveyed for the study had flown fatigued. The NTSB concluded that the practice of scheduling part 135 pilots for training, check flights, or other nonrevenue flights at the end of a full day of scheduled revenue flying increases the potential for fatigue-related accidents. The NTSB recommended that the FAA revise part 135 to require that pilot flight time accumulated in all company flying conducted after revenue operations, such as training and check flights, ferry flights, and repositioning flights, be included in the flightcrew member's total flight time accrued during revenue operations.

In addition to recommending a comprehensive approach to fatigue with flight duty limits based on fatigue research, circadian rhythms, and sleep and rest requirements, the NTSB has also stated that FRMSs may hold promise as an approach to dealing with fatigue in the aviation environment. However, the NTSB noted that it considers fatigue management plans to be a complement to, not a substitute for, regulations to prevent fatigue.

D. International Standards

There are a number of international standards addressing flight and duty time limitations and rest requirements. In developing this proposal, the ARC reviewed the following standards to determine if the FAA should adopt any of the international philosophies or structures. The ARC recognized the importance of harmonization with the international community and, where possible, used those standards in developing its proposals. However, the ARC tailored the proposed flight and duty time limitations and rest requirements to more accurately reflect the type of flying U.S. certificate holders conduct, which differs from operations by European Union certificate holders. The following is a summary of the basic provisions of the international standards.

1. Amendment No. 33 to the International Standards and Recommended Practices, Annex 6 to the Convention on International Civil Aviation, Part I, International Commercial Air Transport—Aeroplanes (International Civil Aviation Organization (ICAO) Standards and Recommended Practices (SARP))

U.S. certificate holders are increasingly concerned with compliance with ICAO standards, as they form the basis for regulation in foreign states where U.S. certificate holders often operate.

The ICAO SARPs for Contracting States (States) provide that a certificate holder establish flight time and duty period limitations and rest requirements that enable the certificate holder to manage the fatigue of its flightcrew members. The ICAO SARPs do not provide specific numerical values for these provisions; rather they set forth a regulatory framework for member States to use as guidelines in establishing prescriptive limitations for fatigue management. Member States are required to base their regulations on scientific principles and knowledge, with the goal of ensuring that flightcrew members perform at an adequate level of alertness for safe flight operations. The ICAO SARPs currently do not address fatigue risk management programs. However, these programs are currently under development.

The ICAO SARPs define fatigue as a physiological state of reduced mental and physical performance capacity resulting from sleep loss or extended wakefulness and/or physical activity. The ICAO SARPs address both transient and cumulative fatigue. They recognize the importance of limiting (1) the additional tasks flightcrew members perform before flights, and (2) the total flight time and duty periods over specified timeframes. In establishing flight time and duty period limitations, member States are to consider factors that affect fatigue, including the (1) number and direction of time zones crossed, (2) time a scheduled flight duty period is to begin, (3) number of planned and/or actual sectors, (4) pattern of resting and sleeping relative to the flightcrew member's circadian rhythm, (5) scheduling of days, (6) sequence of early reporting times and late releases from duty, and (7) flight operations characteristics.

ICAO states that a flight duty period (FDP) begins when a flightcrew member is required to report for duty that includes flight and ends when the airplane comes to rest and the engines are shutdown after the last flight on which that person is a flightcrew member. Basic FDP limitations may be extended through the use of flightcrew augmentation depending on the composition and number of flightcrew members carried to provide relief and the type of rest facility. The ICAO SARPs provide that positioning (that is, transferring a nonoperating flightcrew member from place to place as required by the certificate holder) is part of an FDP if the time spent positioning immediately precedes an FDP in where that person participated as a flightcrew member. However, commuting (traveling from home to the point where the flightcrew member reports for duty) is not included in an FDP.

The ICAO SARPs recognize the necessity of providing flightcrew members with an adequate rest opportunity, free from all duties, to recover from fatigue before beginning the next FDP. The flightcrew member is responsible for reporting for duty in an adequately rested condition. The ICAO SARPs provide that rest periods should not include standby if the conditions of standby do not allow the flightcrew member to recover from fatigue. In addition, suitable accommodations are required to allow flightcrew members to recover from fatigue. The ICAO SARPs also provide that the pilot in command has the discretion, within limits, to extend an FDP and reduce rest if unforeseen circumstances arise.

Finally, the ICAO SARPs provide that a certificate holder should maintain records for its flightcrew members, including records of flight time, FDPs, duty periods, and rest periods, and retain those records for a specified period of time for inspection by the State. The certificate holder also should maintain records when the pilot in command has exercised his discretion as described above. If this discretion has to be applied on more than a specified percentage of occasions on a particular route or pattern, the certificate holder should make arrangements to prevent undue fatigue; this can be accomplished by revising the schedule or flightcrew member composition to reduce the frequency of such events.

2. United Kingdom Civil Aviation Authority Publication 371 (CAP 371)

Air Navigation Order 2000, Part VI, as amended, requires a certificate holder to have a civil aviation authority (CAA)-approved scheme for regulating the flight time of aircrews. CAP 371 provides guidance on this requirement and recognizes that the prime objective of a flight limitation scheme is to ensure flightcrew members are adequately rested at the beginning of each FDP and are flying sufficiently free from fatigue so they can operate efficiently and safely in normal and abnormal situations. When establishing maximum FDPs and minimum rest periods, certificate holders must consider the (1) relationship between the frequency and patterns of scheduled FDPs and rest periods and time off, and (2) effects of working long hours with minimum rest.

Similar to the ICAO SARPs, CAP 371 states that an FDP begins when the flightcrew member is required to report for duty that includes a flight and ends with "on-chocks," that is, shutting down the aircraft engines on the final flight sector (commonly referred to in the United States as a flight segment or a flight leg). However, CAP 371 sets specific maximum FDP limitations in a series of tables for different flightcrew compositions.

For an acclimatized flightcrew with two or more pilots, the limitations are based on the local start time of the FDP and the number of sectors to be flown. (An acclimatized flightcrew member is an individual who has spent 3 consecutive local nights on the ground within a time zone that is 2 hours wide.) Under this scheme, the number of hours in an FDP that begins between 0800 and 1259 is greater than the number of hours in an FDP beginning earlier or later in the day for the same number of sectors flown.

For a nonacclimatized flightcrew with two pilots, the FDP limitations are based on the length of the preceding rest period and the number of sectors flown. FDP limitations may be extended by use of in-flight relief (augmentation) or split duty, or at the commander's (pilot in command's) discretion. CAP 371 requires that when in-flight relief is used to extend an FDP, the flightcrew members must have a comfortable reclining seat or bunk separated from the flight deck and passengers.

To prevent cumulative fatigue, CAP 371 provides for maximum cumulative duty hours and flight time hours. Maximum cumulative duty hours must not exceed 55 hours in any 7 consecutive days (with limited extension to 60 hours); 95 hours in any 14 consecutive days; and 190 hours in any 28 consecutive days. In addition, CAP 371 precludes an individual from acting as a flightcrew member if at the beginning of the flight the aggregate of all flight times exceeds (1) 100 hours, during the period of 28 days expiring at the end of the day on which the flight begins; or (2) 900 hours, during the period of 12 months expiring at the end of the previous month.

Under CAP 371, a certificate holder must provide a rest period before a flightcrew member begins an FDP. The minimum rest period must be (1) at least as long as the preceding duty period or (2) 12 hours, whichever is greater. In limited circumstances, the rest periods may be reduced by 1 hour. When away from home base, the certificate holder must provide the flightcrew member with suitable accommodations for rest. All flightcrew members must make optimum use of the opportunities and facilities provided for rest; the individual flightcrew member is responsible for being sufficiently rested before undertaking a flight.

CAP 371 requires each certificate holder to maintain the following records and reports for at least 12 calendar months: (1) each flightcrew member's flight and duty time performed and rest periods received and (2) commander discretion reports for extended FDPs and reduced rest periods as described above. The CAA audits these records and reports to determine if the certificate holder's planning of flight schedules and duty is compatible with the limitations provided in the certificate holder's scheme.

3. Annex III, Subpart Q to the Commission of the European Communities Regulation No. 3922/91, as amended (EU OPS subpart Q)

EU OPS subpart Q prescribes limitations on FDPs, duty periods, block (flight) time, and rest requirements. Like the previous standards discussed, EU OPS subpart Q recognizes the importance of enabling flightcrew members to be sufficiently free from fatigue so they can operate the aircraft satisfactorily in all circumstances. In establishing their flight and duty limitation and rest schemes, EU OPS subpart Q requires certificate holders to consider (1) the relationship between the frequencies and pattern of FDPs and rest periods, and (2) the cumulative effects of long duty hours with interspersed rest. Certificate holders must revise a schedule when an actual operation exceeds the maximum scheduled FDP on more than 33 percent of the flights in that schedule during a specified period.

EU OPS subpart Q limits the maximum scheduled daily FDP to 13 hours. This limitation does not apply to single pilot operations or emergency medical service operations. However, for each sector (flight segment) flown, this 13-hour limitation is reduced by 30 minutes after three sectors, with a maximum reduction of 3 hours. In addition, EU OPS subpart Q recognizes the fatigue effect of flight during a flightcrew member's window of circadian low (WOCL). The WOCL is the period between 0200 and 0559. If the FDP starts in the WOCL, the FDP is reduced by 100 percent of its encroachment on the WOCL, up to a maximum of 2 hours. When the FDP ends in or fully encompasses the WOCL, the maximum FDP is reduced by 50 percent of its encroachment.

Under EU OPS subpart Q, the maximum daily FDPs can be extended up to 1 hour, depending on the number of sectors flown and whether an FDP encroaches on the WOCL. In addition, the use of augmented flightcrews is permitted to extend the maximum FDP limit of 13 hours. The commander (pilot in command) also may extend an FDP after consultation with the other flightcrew members in the event of unforeseen circumstances. However, any such extensions must not exceed 2 hours, unless the flightcrew is augmented; then the FDP may not be extended by more than 3 hours. If circumstances arise after takeoff during the final sector, the flight may continue to the destination or an alternate destination.

EU OPS subpart Q also addresses cumulative duty and total block (flight) time limits. Cumulative duty periods, including airport standby, cannot exceed 190 duty hours in any 28 consecutive days, and must be spread as evenly as possible throughout the 28 consecutive days. In addition, a flightcrew member's cumulative duty hours cannot exceed 60 duty hours in any 7 consecutive days. A flightcrew members total block (flight) time cannot exceed 900 block (flight) hours in a calendar year and 100 block (flight) hours in any 28 consecutive days.

EU OPS subpart Q defines rest as an uninterrupted and defined period of time when a flightcrew member is free from all duties and airport standby. Certificate holders are required to ensure that rest periods provide sufficient time for flightcrew members to overcome the effects of the previous duties and be well-rested for the next FDP. In addition, a certificate holder must ensure that the effects on a flightcrew of passing through different time zones are compensated for with additional rest. Flightcrew members are required to make optimum use of rest opportunities and facilities.

Specifically, EU OPS subpart Q requires that minimum rest for an FDP, beginning at home base, must be at least as long as the preceding duty period or 12 hours, whichever is greater. If the FDP begins away from home base, the rest period must be as long as the preceding duty period or 10 hours, whichever is greater. Within this rest period, EU OPS subpart Q requires that a certificate holder provide at least 8 hours of opportunity for sleep. EU OPS subpart Q also requires certificate holders to increase the minimum rest periodically to a weekly rest period. The commander (pilot in command) also may reduce rest in the event of unforeseen circumstances.

Certificate holders must record and preserve each flightcrew member's block and duty time and rest period records for at least 15 calendar months. In addition, certificate holders must separately retain aircraft commander discretion reports of extended FDPs and flight hours and reduced rest periods for at least 6 months after the event.

E. Scientific Expert Presentations

To assist the ARC with its goal of developing proposed rules to enhance flightcrew member alertness and employ fatigue mitigation strategies, the ARC reviewed scientific information presented by the following scientific experts in sleep, fatigue, and human performance research:

- Information on sleep, fatigue, and human performance presented by Mr. Gregory Belenky, M.D., Sleep and Performance Research Center, Washington State University and Mr. Steven R. Hursh, Ph.D., president, Institutes for Behavior Resources, Professor, Johns Hopkins University, School of Medicine.
- An overview of the current FAA fatigue studies. Mr. Thomas Nesthus, Ph.D., FAA Civil Aeromedical Institute (CAMI).

Drs. Belenky, Hursh, and Nesthus addressed questions from ARC members. In addition, Mr. Peter Demitry, M.D., 4d Enterprises, addressed questions from the ARC but did not make a presentation.

Below is a summary of the scientific presentations. The information from responses to ARC member questions are contained under the appropriate subject headings in the preamble.

1. Fatigue

Fatigue is characterized by a general lack of alertness and degradation in mental and physical performance. The scientific experts identified three types of fatigue: transient, cumulative, and circadian. Transient fatigue is acute fatigue brought on by extreme sleep restriction or extended hours awake within 1 to 2 days. Cumulative fatigue is fatigue brought on by repeated mild sleep restriction or extended hours awake across a series of days. Circadian fatigue refers to the reduced performance during nighttime hours, particularly during the WOCL.

The scientific experts explained that there is no direct measure or physiological marker that establishes when a person is fatigued, although biomedical data may indicate physiological conditions favorable to fatigue. Fatigue is often accompanied by drowsiness but is more than just being sleepy or tired.

Common symptoms of fatigue include the following:

- Measurable reduction in speed and accuracy of performance,
- Lapses of attention and vigilance,
- Delayed reactions,
- Impaired logical reasoning and decisionmaking, including a reduced ability to assess risk or appreciate consequences of actions,
- Reduced situational awareness, and
- Low motivation to perform optional activities.

A variety of factors contribute to whether an individual experiences fatigue, and the severity of fatigue experienced. The major factors affecting fatigue include the following:

- *Time of day*. Fatigue is, in part, a function of circadian rhythms. Human waking and sleep cycles follow a 24-hour cyclical wave pattern, which is known as the internal body clock (circadian rhythm). The circadian rhythm is closely correlated to core body temperatures. All other factors being equal, fatigue is most likely, and, when present, most severe, during the WOCL, when body temperatures are at their lowest, between the hours of 0200 and 0600. Studies have found that subjects remaining awake through the WOCL and into the daytime hours experience improvements in performance once past the WOCL, relative to their performance during the WOCL.
- *Amount of recent sleep.* If a person has had significantly less than 8 hours of sleep in the past 24 hours, he or she is more likely to be fatigued.
- *Time awake.* A person who has been continually awake for more than 17 hours since his or her last major sleep period is more likely to be fatigued.
- *Cumulative sleep debt.* Sleep debt refers to the impact of receiving less than a full night's sleep for multiple days. For the average person, cumulative sleep debt is the difference between the amount of sleep a person has received over the past several days, and the amount of sleep they would have received if they obtained 8 hours of sleep per night. For example, a person who has received a total of 10 hours of sleep over the past 2 nights has a cumulative sleep debt of 6 hours. A person with a cumulative sleep debt of more than 8 hours since his or her last full night of sleep is more likely to be fatigued.

- *Time on task.* The longer a person has continuously been doing a job without a break, the more likely he or she is to be fatigued.
- *Individual variation*. Different individuals will respond to fatigue factors differently. Individuals may also become fatigued at different times, and to different degrees of severity, under the same circumstances.

There often is interplay between various factors contributing to fatigue. For example, the performance of a person working night and early morning shifts is impacted by the time of day. Additionally, because of the difficulty in obtaining normal sleep during other than nighttime hours, this person is more likely to have a cumulative sleep debt and/or to not have obtained a full night's sleep within the past 24 hours.

2. Fatigue Factors in Aviation

It was noted that fatigue was a contributing factor in 9.3 percent of all Flight Safety Awareness Program reports from one air carrier. Reported events included procedural errors, unstable approaches, lining up with the incorrect runway, and landing without clearances.

The following work schedule factors[1] were cited as affecting sleep, circadian rhythms, and alertness:

- Early start times,
- Extended work periods,
- Insufficient time off between work periods,
- Insufficient recovery time off between consecutive work periods,
- Amount of work time within a shift or duty period,

[1] Rosekind MR. *Managing work schedules: an alertness and safety perspective.* In: Kryger MH, Roth T, Dement WC, editors. Principles and practice of sleep medicine; 2005:682.

- Insufficient time off between work periods,
- Number of consecutive work periods,
- Night work through WOCL,
- Daytime sleep periods, and
- Day-to-night or night-to-day transitions (lack of schedule stability).

3. Preventing and Mitigating Sleep Debt

Scientific research and experimentation has consistently demonstrated that adequate sleep sustains performance. For most people, 8 hours of sleep in each 24-hour period sustains performance indefinitely. Sleep opportunities during the WOCL (0200 and 0559) are preferable, although some research indicates that the total amount of sleep obtained is more important than the timing of sleep within the day. Within limits, shortened periods of nighttime sleep augmented by additional sleep periods, such as naps before evening departures, during flights with augmented flightcrews, and during layovers, may be nearly as beneficial as a single consolidated sleep period. Sleep should not be fragmented with interruptions and environmental conditions, such as temperature, noise, and turbulence. Such conditions can impact how beneficial sleep is and how performance is restored.

In addition to scheduled rest in dedicated onboard rest facilities, the scientific experts also endorsed the concept of controlled napping on the flight deck. Under a carefully designed and approved controlled napping program, one flightcrew member at a time remains seated at his or her flight deck station, but is relieved from flight responsibilities, and may use the opportunity to nap. The other flightcrew member assumes responsibility for monitoring flight status. By taking controlled naps in turns during cruise, each flightcrew member may be more rested and alert for the more demanding approach and landing phases of flight. The scientific experts emphasized that controlled cockpit napping is a performance enhancing measure only. They recommended that it not be used to extend duty periods.

The scientific experts recommended crew resource management as an early step in identifying fatigue. Flightcrew members should be cognizant of the appearance and behavior of fellow flightcrew members. Signs of fatigue to watch for include slurred speech, droopy eyes, requests to repeat things, and attention to the length of time left in the duty period.

When a person has accumulated a sleep debt, recovery sleep is necessary. Recovery sleep requires an opportunity to obtain sufficient sleep to fully restore the person's "sleep reservoir." Recovery sleep should include at least 1 physiological night; that is, one sleep period during nighttime hours in the time zone in which the individual is acclimated. Recovery sleep does not require additional sleep equal to the cumulative sleep debt; that is, an 8-hour sleep debt does not require 8 additional hours of sleep. However, sleep on recovery days should be extended beyond the usual sleep amount. The average person requires in excess of 9 hours of sleep per night to recover from a sleep debt.

The scientific experts also addressed issues involved in layovers. It was noted that after long flights, a layover should permit at least 1 physiological night's sleep, and the value of additional layovers days would depend on circumstances of the particular operation. According to the scientific experts, if a person usually sleeps less on layovers than the normal amount at home, then additional layover days may lead to more sleep debt. However, when sleep is missed, an extra day can permit additional recovery. Finally, the benefits of layover sleep can depend on circadian factors.

4. Fatigue Modeling

The scientific experts noted that biomathematical modeling of fatigue and performance can assist in providing objective metrics, which are conspicuously lacking in fatigue science. The rationale for modeling is that conditions that lead to fatigue are well known. A model simulates specific conditions and determines if fatigue could be present. Models can estimate degradations in performance and provide an estimate of schedule-induced fatigue risk that considers many dynamically changing and interacting fatigue factors.

5. Preventing Fatigue and Fatigue Risk Management Systems

The scientific experts offered the following steps toward preventing fatigue:

- Consider fatigue a safety risk factor.
- Consider the conditions and consequences of fatigue.
- Apply modeling as a tool to assess fatigue potential for specific routes and schedules.
- Construct barriers in the scheduling process to reduce the safety risk.
- Use modeling as one tool to assess the success of fatigue reduction initiatives.

The scientific experts noted that these steps lead toward the concept of an FRMS. An FRMS is an evidence-based process of continuous performance improvement. One approach to an FRMS uses the five Ms, as follows:

- *Measure*. This step involves defining the operating environment, evaluating schedules, and gathering empirical data, such as actigraph recordings, that may correlate to fatigue risk.
- *Model*. This step includes modeling the fatigue problem, and analyzing factors and sources of fatigue.

- *Manage*. This step prescribes collaborating to identify solutions, and obtaining commitment from affected parties to solve the problem.
- *Mitigate*. This step includes implementing operating practices, labor agreements, and individual lifestyle choices to reduce fatigue risk to acceptable levels.
- *Monitor*. The final step includes assessing operational indicators, as well as individual self-evaluation. These data are fed back into the measurement process to evaluate the success of and continuously improve mitigation measures.

Following each presentation, the scientific experts cautioned the ARC not to base its proposals on any one scientific study because of the propensity for individuals to selectively interpret a study. Rather, they suggested considering an entire body of scientific studies on which to develop proposed limitations and requirements.

The ARC members considered the information presented by the scientific experts as well as other available scientific information, and used their substantial operational experience knowledge base to develop its proposals. The ARC noted that the flight and duty time rules and rest requirements will not eliminate fatigue; however, the ARC's proposals are focused on managing fatigue risk using mitigation strategies.

III. General Discussion of the Proposal

A. Applicability

1. Single Approach

The ARC initially discussed a single approach covering all part 121 and 135 operations, including certain flights conducted by part 121 and 135 certificate holders under part 91, such as ferry flights, maintenance flights, and training flights. The proposed flight and duty time limitation and rest requirement scheme is designed to enhance flightcrew member alertness and mitigate fatigue. Its concepts have broad applicability, therefore, it may not be necessary to distinguish between domestic, flag, supplemental, commuter, or ondemand operations. Some ARC members disagreed and suggested that certain operations might need to be addressed outside of mainstream operations.

2. Unique Supplemental Operations

The ARC discussed various types of supplemental operations that may not be adequately addressed by the ARC's proposed requirements and unduly restrictive to these certificate holders. These supplemental operations range from moving armed troops for the U.S. military and conducting humanitarian relief, repatriation, Civil Reserve Air Fleet (CRAF), Air Mobility Command (AMC), and State Department missions.
One ARC member noted that many types of supplemental operations fly into hostile areas. Another ARC member added that these flights are conducted into politically sensitive, remote areas without rest facilities. One ARC member proposed that the director of operations for the supplemental operator and the FAA's principal operations inspector be allowed to extend the FDP limits based on necessity. Another ARC member clarified that these supplemental operations need to be distinguished from tourism operations or

operations where cargo arrives late to the aircraft for loading. The ARC member added that the certificate holder needs to have performed adequate planning for the mission, such as having the appropriate onboard rest facilities or number of flightcrew members for the length of the duty day, and that the emergency should not be self-induced. If a certificate holder chooses not to equip an aircraft with adequate rest facilities, then the certificate holder should not be able to claim an inability to comply with requirements because of the lack of those rest facilities.

The ARC recognized the uniqueness of these operations and noted that today, AMC and emergency operations are conducted under a deviation authority contained in 14 CFR §§ 119.55 and 119.57. The ARC also noted that the proposed requirements establish a level of minimum risk, and added that the FAA should determine how to adjust this level of risk for these special operations. One ARC member emphasized that a certificate holder should be required to provide the flightcrew member adequate recovery rest after operating under a deviation authority described above.

B. Definitions

The ARC's proposed definitions are discussed under the appropriate topic headings.

C. Responsibilities

<u>1. Certificate Holder Responsibilities</u>

The ARC defined certificate holder as a person, organization, or enterprise operating an aircraft for compensation or hire. The ARC used the term certificate holder to reference domestic, flag, and supplemental air carriers and operators.

The ARC discussed the following issues regarding certificate holder responsibilities relating to flightcrew member flight and duty time limitations and rest requirements:

- Each certificate holder should consider the relationship between the frequencies and pattern of flight duty periods, flight time, and rest periods, and the cumulative effects of long duty hours; and
- Each certificate holder's culture should not inhibit flightcrew members from refusing to accept an assignment because of being in a state of fatigue.

a. Schedule

The ARC noted that a certificate holder should consider the following factors, which affect fatigue, in addition to the characteristics of its flight operations, when scheduling flightcrew members:

- Time of day a flight duty period is to begin and end,
- Number of flight segments,
- Time zones,
- Flightcrew member's circadian rhythm, and
- Days off.

The ARC also noted that a flightcrew member scheduling system needs to be robust. The ARC discussed that reliability of the FDP schedule is a key component to maintaining fatigue mitigation boundaries. The ARC defined schedule reliability as the accuracy of the length of a scheduled FDP, as compared to the actual FDP. The ARC proposed that each certificate holder ensure scheduling integrity by adjusting their system-wide FDP schedule if the total number of FDPs are shown to actually exceed the planned schedule 5 percent of the time. In addition, the ARC proposed that the certificate holder ensure flightcrew member scheduling reliability by adjusting any FDPs that are shown to actually exceed the planned schedule [15 to 30] percent of the time. The ARC also considered that planned schedule times should factor in all known and foreseeable circumstances such as seasonal wind changes and runway closures, and that certificate holders adjust schedules in the next cycle after any variations become known or forecasted. The ARC proposed that certificate holders report scheduling reliability data to the FAA every [1 month/ 2 months].

b. Nonretribution Policy

The ARC proposed that each certificate holder establish a policy of nonretribution toward a flightcrew member who may state that he or she is fatigued. This may be a separate policy or part of the company's overall fatigue policy discussed in section D.

2. Flightcrew Member Responsibilities

The ARC defined a flightcrew member as a certificated pilot or flight engineer assigned to duty in an aircraft during a flight duty period. The ARC discussed that flightcrew members should make the best use of sleep opportunities and rest facilities. The ARC noted that it is incumbent on a flightcrew member to be rested and prepared before beginning an FDP.

The ARC also noted that it would be a violation of § 91.13, Careless or reckless operations, not to do so. The ARC also considered whether the ARC proposal should contain a requirement for each flightcrew member to report to the certificate holder when they are too fatigued to complete a flight segment. Generally, the ARC members felt that such regulation would be overly restrictive. The ARC included a proposed requirement for a flightcrew member to report for an FDP adequately rested. In addition, the ARC defined fatigue as a physiological state of reduced mental and/or physical performance capability resulting from a lack of sleep and/or increased physical activity that can reduce a flightcrew member's alertness and ability to safely operate an aircraft or perform safety-related duties.

D. Fatigue Policy, Education, and Training

The ARC noted that to be effective, changes to flight and duty time limitations and rest requirements must be coupled with a robust education initiative. Flightcrew members must be aware of the relationships between fatigue, rest, and duty time, and must know how to plan their rest to best prepare for upcoming duty periods. The ARC proposed that each certificate holder develop a fatigue policy, and implement a fatigue education and training program for its flightcrew members and all flight operations employees in dispatch, crew scheduling, and systems operations control, including individuals with management oversight of those areas. This policy and training is required regardless of whether the certificate holder chooses to develop an FRMS. The fatigue education and training program must include information on the detrimental effects of fatigue and strategies for avoiding and countering fatigue. The ARC anticipated that the FAA will provide advisory material on these issues.

E. Fatigue Risk Management System

The ARC defined an FRMS as a comprehensive range of procedures that are both scientifically based and data-driven, allowing a cooperative and flexible means of managing fatigue.

The ARC noted that an FRMS is envisioned to bring relief on flight and duty time limits that may be overly prescriptive for particular operations, including those that experience has shown can be safely conducted even though the constructs of the operation may indicate a potential for inducing fatigue. The ARC discussed extended twin-engine overwater operations (ETOPS), the advanced qualification program (AQP), and area navigation/required navigation performance as examples of existing processes developed by the FAA and air carriers that could be benchmarked.

1. Simplified FRMS

The ARC noted that certificate holder development and FAA approval of a comprehensive, mature FRMS would be a lengthy process, but believes a simplified FRMS could be implemented relatively quickly to permit certificate holders the flexibility to increase maximum scheduled FDPs for limited operations, as necessary, if certain mitigations are present. As an example, the ARC speculated that the requirements would be similar to those in existing operations specifications (OpSpecs) A332, Ultra Long Range Operations. The ARC noted that the FAA envisioned a centralized FAA organization responsible for processing all such FRMS requests.

The ARC stated that an education and data collection component, a feedback process, and a review process be the minimum required in a simplified FRMS. Several ARC members expressed concern that education is not an adequate substitute for quality sleep, and that simplified FRMS approvals could be granted too easily. Further, some ARC members held personal beliefs that fatigue and rest education is an existing requirement for all certificate holders, so the education component of a simplified FRMS should include enhancements or increases, such as a required number of training hours.

The ARC members discussed the philosophy behind an FRMS, and some of the key concepts, from the standpoints of both certificate holders and flightcrew members. Some ARC members stated that the ARC's recommendations should include rule language enabling the development and approval of a basic FRMS process potentially under a certificate holder's operations specifications. In addition, the FAA could develop advisory circulars offering certificate holders guidance on creating an FRMS. The ARC envisioned that these would be interim steps in the development of a comprehensive, fully matured FRMS.

The ARC noted that an FRMS initially would be developed around long-range international operations, although scientific modeling shows that domestic operations pose a greater fatigue risk. From long-range operations, development for potential use would extend to all operations, and could eventually reach a point where all schedules are vetted through an FRMS.

The ARC discussed the following mitigations that can be described as a simplified FRMS. The ARC proposed that a simplified FRMS be approved by the FAA for the limited operation. The ARC presented how a simplified FRMS would be used for flights conducted by a four-pilot flightcrew with a Class 1 rest facility. The simplified FRMS would include the following:

- Scientifically based method to determine maximum duty times, preduty, layover, and post-duty rest requirements, and an in-flight prescriptive rest scheme to ensure adequate alertness is maintained during regular and irregular operations.
- Validation of the suitability of the onboard rest facility.
- Data gathering methodology to validate the scientific method used.
- A feedback process to assess actual operations.
- Specific qualification and staffing requirements.

- An FAA-approved training program for all stakeholders on fatigue and sleep education, including mitigation and countermeasures strategies.

2. Comprehensive FRMS

The ARC considered whether development and implementation of an FRMS would be voluntary or mandatory. One ARC member noted that developing and implementing an FRMS eventually should be mandatory, although expanded operational capability may be an incentive to early development.

The ARC discussed a comprehensive FRMS. Fatigue risk management includes development of a just culture, processes, and structures within the operation that are directed toward the effective mutual management of both potential opportunities. The scientifically validated effects those opportunities might pose on the operation from fatigue. Fatigue risk management also requires a cooperative effort at the highest level for the respective parties involved. The FRMS requires the certificate holder to—

- Identify a fatigue baseline for the population.
- Use scientific validation of respective work schedules.
- Implement education and management of the processes for the all stakeholders.
- Evaluate and validate the instituted policies at the highest level of the joint review team for future inclusion in the continuing process of fatigue management/mitigation on the property.

The ARC discussed some of the concepts that would be included in a comprehensive FRMS, such as high-level management involvement, feedback and continuous improvement, and an intrinsic safety culture. An FRMS would include the definition of baseline fatigue, identification and implementation of mitigation measures, and data collection to evaluate effectiveness, which would be fed back into the system in a repetitive process. The ARC envisioned a data collection effort similar to those used to support AQP and ETOPS would be necessary, and that the FRMS would be FAA-approved through a centralized FAA office. The ARC noted that three operators currently are gathering fatigue data under an independently funded voluntary program.

The ARC proposed an FRMS addressing the following elements:

- A fatigue risk management policy.
- A cooperative effort between management and labor (management and labor are co-owners of the program).
- Development of a baseline of fatigue.
- The use of scientific methodology for developing work schedules that includes—
  - Construction of rotations (pairings) and monthly schedules, and
  - Scientific modeling and filtering of actual operations.
- The development of processes and structures within the operation directed toward effective management of fatigue.
- Education and training of all stakeholders.
- A continuous process of fatigue management and mitigation.
- A fatigue review panel that includes management and labor representatives.
- A monthly reassessment process, including analysis of data.
- Audits (semiannual and annual).

The ARC envisioned that the FAA audit a certificate holder's FRMS annually.

F. Duty

1. Definitions

The ARC reviewed the definition of duty contained in the ICAO SARPs, CAP 371, and EU OPS subpart Q. The ARC noted that all three standards consider duty as any task associated with the business of the certificate holder. ICAO specifies duty as any task that flightcrew members are required by the certificate holder to perform, including, for example, flight duty, administrative work, training, deadheading, and standby when it is likely to induce fatigue. The ARC defined duty as any task where a certificate holder requires a flightcrew member to perform, including pre- and post-flight duties, administrative work, training, deadhead transportation, aircraft positioning on the ground, aircraft loading, and aircraft servicing. In addition, the ARC defined duty period as a period that begins when a certificate holder requires a flightcrew member to report for duty and ends when that person is free from all duties.

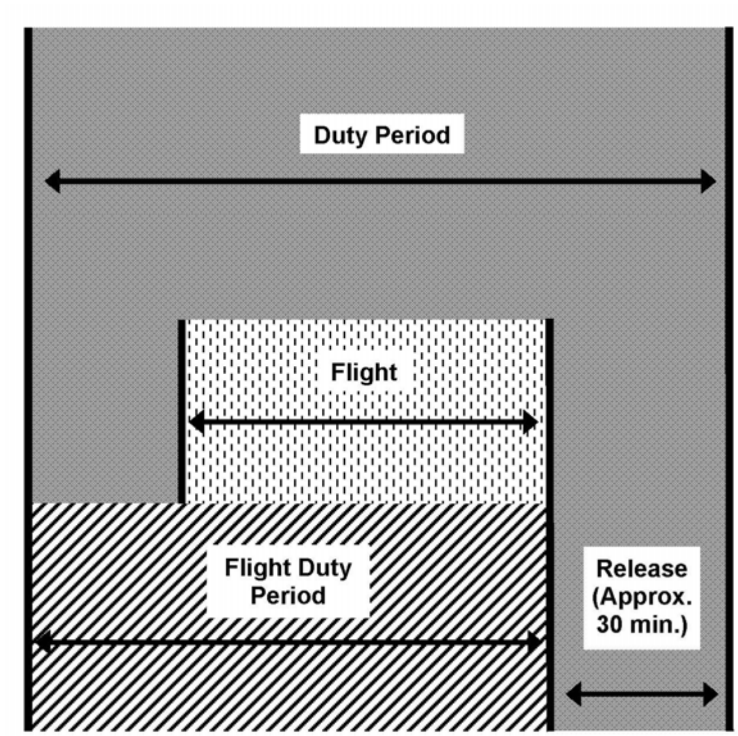
2. Scientific Considerations

In determining cumulative fatigue limits, the ARC considered whether a duty period, which encompasses duties not included in the FDP, such as post-flight checklists, debrief, and logbook write-ups, was necessary. The ARC asked the scientific experts how cumulative duty affects fatigue. The scientific experts responded that repeated infringement of duty into opportunity for sleep leads to sleep debt. The scientific experts noted that there also is a correlation between time awake and general performance, in that regardless of whether the person is doing work that requires little effort, there still is a drain on the body over time since awakening. The scientific experts ultimately decided that while low-level tasks, such as post-flight checklists and logbook write-ups, did not require the same level of alertness as that needed to safely operate an aircraft, there was good rationale for placing a cumulative limit on duty time. It was noted that some administrative tasks, such as logbook write-ups, can have safety implications on future operations.

3. ARC Considerations

The ARC noted that some certificate holders use the concept of a release time, which typically is 15 to 30 minutes after the end of an FDP, to address checklists, debrief, and logbook write-ups, essentially creating an ad hoc duty period limitation. The ARC considered whether such an approach was adequate, as opposed to creating a separate duty period. The ARC noted that a separate, total duty period limit was necessary to prevent flightcrew member fatigue because flightcrew members often are being required to carry out other duties, such as monitoring an aircraft that has an engine running because of station or aircraft limitations and engine run-ups for maintenance purposes that would not be captured by a set length of time for release. See figure 1 for depiction of duty period.

Figure 1—Duty Period



a. Ground Transportation

The ARC discussed whether transportation to and from an accommodation for a rest period should be included in a duty period, because time spent in transportation is not rest and could detract from a flightcrew member's opportunity for sleep during a rest period. The ARC defined transportation local in nature as transportation from the point of last duty to an accommodation for the purpose of a rest period, or from an accommodation to report for a duty period. This transportation does not exceed 30 minutes under normal circumstances. The ARC differentiated transportation local in nature from any transportation needed to travel from a remote airport or aircraft location to an accommodation. The ARC acknowledged that transportation was not rest, but elected to include an allotment for transportation time in the required rest period, rather than include it as part of a duty period. However, if the actual transportation time is known to exceed the allotted time in the rest period, the certificate holder should plan for that additional time period to protect the flightcrew member's opportunity for sleep on a rest period.

b. Deadhead Transportation

The ARC noted that deadhead transportation can be either by air or surface, and can occur before, after, or in between flight segments. The ARC defined deadhead transportation as transportation of a flightcrew member as a passenger, by air or surface transportation, as required by a certificate holder. The ARC considered how each of these situations would be addressed in either an FDP or duty period.

Discussion centered around whether deadheading was fatiguing or could actually mitigate fatigue because flightcrew members were not spending time on a task and may be able to obtain a restorative nap. Because of the various possibilities for deadhead transportation, which can include a minimally reclining coach seat in an aircraft to riding in a van in surface transportation, the ARC noted it is difficult to assume that a flightcrew member would receive any sort of sleep opportunity for fatigue mitigation during deadhead transportation. The ARC acknowledged that deadhead transportation preceding a flight segment was more critical, because the flightcrew member would begin their flight segment after potentially having spent several hours in an aircraft or vehicle in an upright sitting position. The ARC viewed deadhead transportation following a flight segment as potentially fatiguing for the previously listed reasons, but acknowledged that the transportation would allow the flightcrew member to reach either their home base or an accommodation for a rest period without requiring time on task. The ARC defined home base as the location designated by a certificate holder, where a flightcrew member normally begins and ends his or her duty period. Home base is also commonly known as domicile.

Based on this reasoning, the ARC noted that deadhead transportation that precedes a flight segment without an intervening required rest period or occurs between flight segments should be considered as part of an FDP. The ARC further noted that deadhead transportation following the final flight segment of an FDP or a flightcrew member's duty that consists entirely of deadhead transportation should be considered part of a duty period, and may not be considered part of a rest period.

One ARC member suggested that there be additional limitations on deadhead transportation other than the proposed cumulative fatigue duty limits. The ARC discussed whether there should be a daily duty day limit applicable to a flightcrew member in deadhead transportation. One ARC member commented that flightcrew members in deadhead transportation are not operating aircraft, so safety is not directly affected. Another ARC member suggested that that proposed weekly cumulative duty limits adequately address the issue; however, the ARC solicited alternative concepts. These alternatives are presented as follows:

- Time spent entirely in deadhead transportation during a duty period must not exceed the flight duty period in tables B(1) and B(2) of § 117.17 for the same start time as the deadhead transportation, plus 2 hours. [Option 1]
- A duty period that consists entirely of deadhead transportation cannot exceed 21 hours and the flightcrew member must travel in a Class 2 rest facility. [Option 2]
- The certificate holder must provide rest equal to the length of the deadhead transportation, but not less than the required rest in § 117.33 upon the completion of such transportation. [Option 3]

- If time is spent entirely in deadhead transportation, the certificate holder must provide a rest period equal to the length of the deadhead transportation multiplied by 1.5 but not less than the required rest in § 117.33 upon completion of such transportation. [Option 4]
- See attached September 1, 2009, CAA Proposal. [Option 5]]

These alternatives potentially would address the possible scenario of a flightcrew member in deadhead transportation for 30 hours who, as currently proposed, would receive only the 12 hours minimum required rest.

The ARC considered the following additional concepts for limiting deadhead transportation:

- A duty period that includes an FDP, followed by deadhead transportation in the same duty period may exceed the maximum FDP values by no more than the allowable extension.
- For a duty period that consists solely of deadhead transportation, the subsequent rest period should be based on the length of the deadhead transportation multiplied by 1.5 but not less than 10 hours for domestic operations or 12 hours for international operations.

c. Duties Before a Flight Duty Period

The ARC discussed duties that may be required of a flightcrew member before an FDP. For example, some flightcrew members working for smaller certificate holders may be required to be at the airport well before departure time to clean, load, or deice an aircraft. Some certificate holders take the position that, regardless of when a flightcrew member arrives to perform these tasks, duty does not begin until 1 hour before departure, which is the report time commonly used in the air carrier industry. The ARC defined report time as the time at which a flightcrew member is required by a certificate holder to report for a duty period. This time is typically 1 hour for domestic operations and 1 to 1.5 hours for international operations but can vary by certificate holder.

The ARC noted that with the increased use of electronic flight bags, flightcrew members may begin preparing for a flight before their report time at the airport. The ARC considered when duty begins, if a flightcrew member downloads and reviews flight planning paperwork before leaving his or her home or accommodations. The ARC noted that the difference is that the certificate holder required the duties to be performed versus the flightcrew member voluntarily performing the duties. The ARC proposed that if the certificate holder requires the duty, it should be included in the duty period. If the duty was a voluntary action by the flightcrew member, it should not be included in the duty period. The ARC stated that the purpose of the report time being a set time before departure is to allow for preflight planning and briefing.

d. Training

The ARC discussed various concerns related to training administered in close proximity to the beginning or end of an FDP. The ARC considered whether training should constitute a duty period or an FDP. The ARC noted that time in training cannot constitute rest, and that flightcrew members must have adequate rest following training before reporting for an FDP.

One ARC member suggested that training preceding actual flight operations be considered part of an FDP, while training following flight operations be considered part of a duty period. Some ARC members proposed that training conducted in an aircraft, [flight simulator or flight training device] would be considered as an FDP, while all other types of training, including ground school and distance learning would be considered as part of a duty period. Other ARC members proposed that training in [flight simulators or flight training devices] be considered duty but not part of an FDP. The ARC further discussed how distance learning would be counted against duty period limits, because many flightcrew members conduct this training at various times, including at home on days off or while on a lengthy layover. The ARC proposed to allow distance learning to be performed at the discretion of a flightcrew member. This would allow the flightcrew member to complete the training on their own schedule, without concern for whether or not they were exceeding a duty limit if they elected to do so while on a layover.

e. Aircraft Positioning

The ARC also considered whether on-airport aircraft positioning and similar activities should be included in a duty period or an FDP. The ARC noted that under the definition proposed by an earlier ARC addressing fatigue in part 135 operations, positioning an aircraft on the ground would be included in an FDP. However, one ARC member pointed out that it seems unnecessary to, for example, augment a flightcrew simply to cover the potential need to position an aircraft were the positioning to cause the flightcrew member to exceed an FDP. Several ARC members stated that under the above scenario aircraft positioning could be accomplished under a 2-hour extension for unforeseen circumstances. However, some ARC members noted that if positioning consistently was called for after flights, such as at a station where aircraft are parked in a hangar during winter months, that it could not be considered unforeseen and would have to be included in the FDP. Several ARC members suggested that any activities conducted after a flight is concluded, such as positioning or engine run-ups, should be considered part of a duty period, but not part of an FDP. The ARC did not reach general agreement on this issue. ARC members agreed that fatigue certainly could play a role in causing an error by a flightcrew member taxiing an aircraft on the airport, such as a runway incursion; however, some ARC members believed that an FDP ended as soon as there was no further intention for flight (that is, when the aircraft was parked following the final flight segment in an FDP).

G. Flight Time

1. Definition

The ARC noted that flight time also is referred to as block time. The ARC further noted that the FAA defines flight time in 14 CFR § 1.1 as time that commences when an aircraft moves under its power for the purpose of flight and ends when the aircraft comes to rest after landing. The ARC proposed the same definition for flight time to be consistent with § 1.1.

2. ARC Considerations

The ARC discussed the difference between flight or block time and flight duty time. The ARC noted that a flightcrew member flying pairings involving long, single-leg FDPs could fully comply with the FDP limitations of CAP 371 and still exceed current 14 CFR flight hour limitations. Many ARC members stated that flight time limitations are necessary and urged that these limitations be retained in addition to setting FDP limits. Some ARC members noted that duty time limits are intended to replace flight time limits as more accurate measures of fatigue, and proposed that there be no flight time limits. The

ARC discussed whether fatigue is induced by flight hours, duty time, or both, and whether flight time is more physically taxing than duty time.

The ARC noted that the NTSB has included a combination of duty time and flight time limitations in its safety recommendations. The ARC also noted that the ICAO standards contain flight time limitations. Therefore, removing flight time limitations from 14 CFR might require the filing of a difference from ICAO standards. Additionally, the ARC discussed that from a legal standpoint, reducing any safety standard requires a justification, and noted that an absence of scientific data supporting the existing standard is not sufficient justification to remove it. The ARC stated that it would have to show that the combination of proposed FDP limits and rest requirements in the new scheme provided an equivalent level of safety to that of the current flight time regulations, if it proposed the removal of flight time limits. Some ARC members expressed concern that the ARC did not have sufficient justification to remove flight time limits.

Several ARC members noted that the FDP limitations address concerns over transient fatigue, while flight time limitations address cumulative fatigue issues. The ARC determined that flight time limitations, if retained, could be variable like the proposed FDP limits, and based on factors such as report time and circadian rhythms. Ultimately, the ARC proposed two daily flight time limit schemes, as presented in tables A(1) and A(2). One ARC member proposed that the daily flight time limit for a nonaugmented flightcrew never exceed 8 hours because there is a lack of scientific evidence that exceeding the current limit is safe.

The ARC's first proposal, in table A(1), selected the scheduled maximum flight times to adjust workload during circadian cycles. The ARC's second proposal, in table A(2), using the same scientific principle as in table A(1), selected the scheduled maximum flight times for each time of start by reducing the maximum flight duty period proposed in table B(2) by 2 hours. Also see attached CAA and NACA proposed alternative flight time limits.

Table A(1)—Maximum Flight Time Limits, Option 1

Time of Start (Home Base)	Maximum Flight Time (hours)
0000-0459	7
0500-0659	8
0700-1259	9
1300-1959	8
2000-2359	7

Table A(2)—Maximum Flight Time Limits, Option 2

Time of Start (Home Base)	Maximum Flight Time (hours)
0000-0159	7
0200-0459	8
0500-0659	10
0700-1259	11
1300-1659	10
1700-2159	9
2200-2259	8.5
2300-2359	7.5

The ARC also proposed cumulative flight time limits. (See the discussion of Cumulative Fatigue Limits in section P of this document.)

H. Flight Duty Period

1. Scientific Considerations

The ARC considered the following considerations relevant to fatigue management and FDP limitations:

- Information presented by scientific experts on the relationship between fatigue, rest, time awake, time on task, and circadian rhythms.
- Science does not provide a hard and fast rule, but should be considered in establishing FDP limitations, as recommended by ICAO.
- Performance and sleep propensity follow the 24-hour circadian rhythm cycle. Sleep opportunities during the WOCL (0200 and 0559) are preferable.
- Scientific studies (referenced by the scientific experts during a question-and-answer session with the ARC members) demonstrate that a person will eventually adjust to a new time zone. The general thought in the scientific community is that acclimation requires 1 day for each time zone shifted, although there is significant individual variability. Full acclimation to a 6-hour time shift requires 6 days, depending on the person and light exposure. The scientific experts noted that there is still much discussion on this topic.

2. ARC Considerations

In establishing the specific maximum scheduled FDP limitations proposed for the various types of part 121 and 135 operations, the ARC considered the following:

- International standards in the ICAO SARPs, CAP 371, and the EU OPS subpart Q. Specifically, the ARC used CAP 371 as a starting point to determine maximum FDPs. The ARC noted that the FDP limits in CAP 371 were established 5 years ago or longer, and in some areas current scientific research warrants a more conservative approach. The ARC used operational experience and current, applicable science to modify CAP 371 limitations.

- Whether FDP limitations should take into account the number of flight segments, flightcrew member augmentations, irregular operations, and flightcrew member acclimation.
- Whether FDP reductions for the number of flight segments should be linear-based or whether ranges of flight segments could be treated equally.
- Whether, regardless of the flight segments and/or time of day, a maximum scheduled FDP should be established. Setting an absolute maximum FDP would prevent certificate holders from scheduling too close to the maximum FDP. The ARC did not establish an absolute maximum FDP, because it would reduce a certificate holder's ability to use its own operational judgment.
- Whether, in the case of continuous duty overnights (CDOs) (also referred to as split duty), the makeup of the pairing should be taken into account. Alternatively, should CDOs be treated differently with a separate maximum scheduled FDP table or should credit be given for actual sleep opportunity during split duty. (See discussion on Split Duty in section I of this document.)
- Whether FDP reductions should be eliminated, reduced, or increased after multiple flight segments if certain mitigating factors are demonstrated such as—
    - Details of previous and subsequent duties,
    - Amount and timing of sleep opportunities,
    - Time for nonrest physiological needs,

- Quality of flightcrew member rest facilities,
- Scheduling reliability, and
- Simplified FRMS process factors which include flightcrew member education, a safety reporting structure, data collection, feedback, and nonpunitive fatigue policy.

- Appropriate maximum scheduled FDP hour limitations, including a maximum scheduled limitation of 9 hours. However, some air cargo operator representatives opposed a 9-hour maximum scheduled FDP. It was noted that 16-hour duty periods are common in air cargo operations, and the 9-hour limitation would be unduly burdensome. In addition, some regional air carriers opposed a 9-hour limit because it would represent a significant reduction in their FDPs. Both felt that science does not support some of the proposal limitations.
- Longer FDPs might be appropriate for flightcrew members with more experience and better judgment, but this topic would be more appropriately addressed in an FRMS. The ARC determined that the regulations needed to prescribe specific hour limits and not rely solely on an FRMS to address lengthy FDPs.
- Maximum scheduled FDPs may have to be reduced in certain circumstances involving difficult flying, such as multiple legs, multiple category II approaches, and inclement weather, which can greatly increase fatigue.
- There is little data on overnight or ultra long-range operations to validate proposed FDP limitations for these types of operations. The ARC encouraged

air cargo operators conducing operations on the "backside of the clock" to collect and share the data with FAA.

3. Maximum Scheduled Flight Duty Period by Operations

Based on the considerations discussed above, the ARC established maximum scheduled FDP limitations for—

- Nonaugmented operations with an acclimated flightcrew.
- Acclimated augmented flightcrew operations.
- Nonacclimated augmented flightcrew operations.

4. Definitions

FDP means a period that begins when a flightcrew member is required to report for duty that includes a flight, a series of flights, and/or positioning flights, and ends when the aircraft is parked after the last flight and there is no intention for [further aircraft movement]/[further flight] by the same flightcrew member. An FDP includes deadhead transportation before a flight segment without an intervening required rest period, training conducted in an aircraft, [flight simulator, or flight training device], and airport standby reserve.

To define FDP, the ARC reviewed the definition of FDP in the ICAO SARPs and CAP 371. The ARC agreed that the FDP would begin when the flightcrew member reports for duty. The ARC considered what location should be used to determine where a flightcrew member reports, such as the flightcrew member's home base or the location of an aircraft. The ARC also considered the fatigue effects on a flightcrew member who is required to report in a different time zone from his or her home base. The ARC noted that the "time of start" used to determine an FDP should be the local time at the flightcrew member's home base. Therefore, a flightcrew member based at Los Angeles International Airport (LAX) would use LAX time when reporting for duty in another time zone (unless the flightcrew member became acclimated to that time zone). The ARC also considered the appropriate language for describing the end of an FDP. The ARC noted that a definition that described the end of an FDP as when engines shut down would be problematic. For a variety of reasons, the flightcrew may not shut the engines down at the termination of a flight. Therefore, the ARC proposed that an FDP includes—

- Flightcrew member sign-in, otherwise known as report time, is the time that the certificate holder requires a flightcrew member to report for duty;
- Deadhead transportation, if it precedes a flight segment without a required intervening rest period;
- Training conducted in an aircraft;
- [Training conducted in a flight simulator or flight training device]; and
- A positioning flight.

The ARC defined positioning flight as a flight conducted by a certificate holder that is not scheduled or a charter, for the purpose of ferrying, maintenance, or otherwise moving an aircraft between locations.

The ARC proposed that an FDP does not include—

- Release time and activities, such as post-flight check, debriefings, and logbook entries, because of the reduced level of skill required for the performance of these tasks. However, the ARC recognized that these activities may have safety implications for future operations and are included in a duty period.
- Deadhead transportation that follows the final flight segment in an FDP.

- Training that follows a flight segment.
- Commuting. (The ARC again noted that it is the flightcrew member's responsibility to report for duty rested.)

Some ARC members defined an acclimated flightcrew member as a flightcrew member who remains in a theater to allow 3 consecutive physiological nights' rest or [30 or 36] consecutive hours or greater free from all duty in the theater. The ARC defined theater as a geographical area where local time at the flightcrew member's FDP departure point and arrival point differ by no more than 4 hours.

5. Nonaugmented Operations With Acclimated Flightcrew

The ARC proposed four maximum scheduled FDP limitation schemes for nonaugmented operations with an acclimated flightcrew. These schemes are set forth in the tables B(1) and B(2), and the CAA and NACA attachments.

Tables B(1) and B(2) differentiate FDP limits for lineholders. The ARC defined lineholder as a flightcrew member that has a schedule and is not a reserve flightcrew member. This term differentiates flightcrew members who have a known schedule of flying from a reserve flightcrew member who must make themselves available for duty at the request of the certificate holder. (For reserve duty periods, see tables E(1) and E(2).)

Table B(1)—Flight Duty Period: Nonaugmented operations, Option 1

Time of Start (Home Base)	Maximum Flight Duty Period (hours) for Lineholders Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000-0359	9	9	9	9.	9	9	9
0400-0459	10	10	9	9	9	9	9
0500-0559	11	11	11	11	10	9.5	9
0600-0659	12	12	12	12	11.5	11	10.5
0700-1259	13	13	13	13	12.5	12	11
1300-1659	12	12	12	12	11.5	11	10.5
1700-2159	11	11	10	10	9.5	9	9
2200-2259	10.5	10.5	9.5	9.5	9	9	9
2300-2359	9.5	9.5	9	9	9	9	9

Table B(2)—Flight Duty Period: Nonaugmented operations, Option 2

Time of Start (Home Base)	Maximum Flight Duty Period (hours) for Lineholders Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000-0159	9	9	9	9	9	9	9
0200-0459	10	10	10	10	9	9	9
0500-0659	12	12	12	12	11.5	11	10.5
0700-1259	13	13	13	13	12.5	12	11.5
1300-1659	12	12	12	12	11.5	11	10.5
1700-2159	11	11	11	11	9	9	9
2200-2259	10.5	10.5	10.5	10.5	9	9	9
2300-2359	9.5	9.5	9.5	9.5	9	9	9

The maximum scheduled FDP limitation is 13 hours and applies to FDPs beginning at 0700 and ending by 1259, with a maximum of four flight segments. The number of hours in an FDP beginning earlier than 0700 or later than 1259 are less and vary depending on the time of start and the number of flight segments. The maximum number of hours in an FDP are the lowest for FDPs during and immediately preceding the WOCL. The ARC defined WOCL as a period of maximum sleepiness that occurs between 0200 and 0559 during a physiological night on a person's home base or acclimated time. (Also see the attached CAA and NACA alternative proposals.)

In establishing these limitations, the ARC considered that many certificate holders' flightcrew members' daily flight duty schedules can consist of four or more flight segments. This is especially true of regional air carriers and some air cargo operators. The proposed FDP tables seek to mitigate fatigue especially for regional air carrier flightcrew members, by recognizing the high workload involved in conducting multiple takeoff and landings and time of day as factors. Therefore, as the number of flight segments increase the FDP is reduced. In addition, the ARC noted that under the proposed duty limits, after four flight segments the number of flight segments essentially limit the number of available FDP hours. The ARC also proposed that if a flightcrew member is nonacclimated, the maximum FDP in tables B(1) and B(2) is reduced by 30 minutes. Some ARC members considered limiting the maximum FDP for a nonacclimated flightcrew member to 9 hours until the flightcrew member becomes acclimated. The ARC did not reach an agreement on this issue.

6. Delayed Departures

The ARC considered whether to address delayed departures, and their impact on an FDP and minimum rest. The ARC reviewed the following scheme for delayed departures. If the flightcrew member has not checked in, a certificate holder may reschedule a report time, provided the flightcrew member can obtain an intervening physiological night's rest. Otherwise, the maximum FDP limits apply based on the flightcrew member's originally scheduled report time. For delays occurring after a flightcrew member has checked in, the maximum FDP limit applies based on the report time. If the flightcrew member is released to rest, a minimum required rest period must be given in accordance with the required rest for the particular operation. In addition, no certificate holder may allow multiple consecutive minimum rest periods. The ARC noted that this is a difficult issue to regulate.

I. Flight Duty Period—Split Duty

1. Definitions

The ARC defined split duty as an FDP that has a break in duty that is less than a required rest period.

2. Scientific Considerations

The ARC discussed the concept of split sleep with the scientific experts to assess the value of the type of rest obtained on a split duty trip. The ARC asked if 4 hours of sleep at one time of day, and 4 hours of sleep at another time of day equal 8 hours of sleep. The scientific experts noted that split sleep is an area of intensive work. All other factors being equal, if the total amount of actual sleep is the same, split sleep is as valuable as continuous sleep. However, the scientific experts noted that the value of sleep is impacted by when in the circadian rhythm it falls. The scientific experts stated that split sleep with 4 hours during a circadian night is better than 8 hours of continuous sleep not during a circadian night. The scientific experts stressed that actual sleep is important, and noted that a 4-hour sleep opportunity may only net 2 hours of actual sleep. The scientific experts stated that it is less clear if a split sleep involving a 2-hour sleep segment and a 6-hour sleep segment is equivalent to 8 hours of continuous sleep.

The ARC also considered how best to position split sleep. The scientific experts stated that the larger portion of split sleep ideally would fall during the WOCL, and reiterated that split sleep with a component at night is better than consolidated sleep during the day. The scientific experts recommended protecting some sleep to take place at night, and not to discourage naps. The scientific experts noted that there is an overhead involved in getting to sleep, and that split sleep multiplies that overhead. Therefore, split sleep with 4 hours at night and 4 hours during the day would, over time, result in a cumulative sleep debt.

3. ARC Considerations

The ARC discussed extending the FDP based on the opportunity for sleep during the duty period and the mitigations needed to extend the FDP. These mitigations would apply to split duty trip pairings (including CDOs), in which a flightcrew member has a downtime of several hours between flights within the same FDP. The ARC identified factors affecting the level of mitigation to include the quality of the sleep facility (flat bed versus recliner, noise level, and temperature), and the duration of sleep available.

ARC members questioned whether this mitigation would be necessary to increase maximum scheduled FDP for a single-leg overnight pairing, because the flightcrew members would be expected to arrive adequately rested. One ARC member noted that for sleep opportunities to be valuable, they must coincide with times in a flightcrew member's circadian cycle when he or she actually is able to sleep. It was noted this could be problematic for daytime split duty scenarios, where the sleep opportunity would fall during the day. The ARC noted that providing a sleep opportunity in a sleep facility is equivalent to the concept of flightcrew augmentation in the air; therefore, with the appropriate mitigations extending the FDP would be possible. However, some ARC members disagreed with this principle because augmented flightcrews have an additional flightcrew member to provide rest in flight while there are no additional flightcrew members in a split duty scenario.

The ARC developed the following key concepts for split duty to extend the FDP:

- Rest must be obtained in a suitable accommodation, which means a single occupancy, temperature-controlled facility with sound mitigation that provides a flightcrew member with the undisturbed ability to sleep in a bed and to control light.
- The flightcrew member must be given an actual, not scheduled, sleep opportunity in the suitable accommodation (behind the door). Some ARC members believe this reconciles the split duty rest with in-flight rest flightcrew members receive when conducting augmented flightcrew operations.
- A feedback loop must be established between flightcrew members and the certificate holder to review and adjust for issues that develop in actual operations.
- The split duty operation should be FAA-approved.
- The certificate holder's FAA-approved training program must include—
    - Information on fatigue and sleep education, and
    - Mitigation and countermeasures strategies.

The ARC considered allowing a certificate holder to extend the FDP up to [50 or 75] percent of time that a flightcrew member spent resting in a suitable accommodation up to a maximum FDP of [12 or 13] hours contingent upon meeting the above mitigations.

The ARC also considered another split duty scheme. This scheme would allow a certificate holder to schedule up to four consecutive split duty periods, with a fifth possible under an FRMS. In addition, the FDP could be extended by [75] percent of the time spent by the flightcrew member behind the door at accommodations up to the maximum daytime FDP limit. Finally, a flightcrew member would be given a 30-hour rest period after a series of night split duty periods before shifting to daytime duty — denoted by whether or not the duty period encompasses the WOCL.

One ARC member suggested that the FDP be extended by 50 percent of the time spent by the flightcrew member at accommodations versus 75 percent, and that the proposed 30 hours rest requirement be revised to 2 physiological nights to better address cumulative sleep debt. Another ARC member commented that based on operational experience, five consecutive split duty periods is demanding. Another ARC member added that it cannot be guaranteed that flightcrew members obtain sleep during a split duty period because of delays. One ARC member responded that many certificate holders who conduct split duty operations find that flightcrew members normally obtain over 4 hours of sleep during split duty periods. The ARC then reconsidered the concept that split duty proposals involving sleep during the WOCL do not differ significantly from the concept of augmented flightcrew operations using onboard rest facilities to extend FDPs.
One ARC member reiterated that split duty cannot be compared to augmented flightcrew operations because there is no additional flightcrew member to provide in-flight relief.

J. Flight Duty Period—Consecutive Night Flights

The ARC considered that pre– and post–duty rest requirements be established for consecutive night duty operations. One ARC member suggested that night FDP operations be limited to 4 consecutive nights. The ARC discussed whether an FRMS would be necessary to operate 5 consecutive nights, and if split sleep or napping could effectively mitigate fatigue in this situation. The ARC reviewed presentations depicting the results of scientific modeling for 5 consecutive night FDPs.

The ARC then discussed limiting night FDP operations to 3 consecutive nights but allowing up to 5 consecutive nights with mitigations. The ARC noted that objective data validation is needed to allow operations beyond a prescriptive scheme if operating under an FRMS. One ARC member suggested limiting consecutive night patterns until objective validation is conducted, or place an intervening physiological night's sleep (defined alternatively as 2200 to 0600) between consecutive night periods.

The ARC also considered a proposal that after 3 consecutive duty periods during the WOCL, a flightcrew member would require a rest period of at least 14 hours before reporting for a fourth duty period during the WOCL. A fifth consecutive duty period during the WOCL would require the certificate holder to have an FRMS.

K. Flight Duty Period—Augmented Flightcrew

1. Definition

Augmented flightcrew means a flightcrew that has more than the minimum number required to operate the aircraft to allow a flightcrew member to be replaced by another qualified flightcrew member for in-flight rest.

2. ARC Considerations

In establishing the maximum scheduled FDP limitations for an augmented flightcrew, the ARC discussed the relative merits and safety of operations conducted with augmented flightcrews and in-flight rest, as compared to conventionally scheduled operations.

The ARC considered how augmented flightcrew accommodations could be included under the broader proposed FDP-based scheme and reviewed the following:

- The current 8 and 12 flight hours before augmentation currently used in domestic and international operations, which is not scientifically based.
- Whether flight time should continue to be a limiting factor for augmented flightcrews.
- The amount of time an FDP could be expanded based on the quality of rest facility (seat versus a lie flat bunk). The ARC defined rest facility as a bunk, seat, room, or other accommodation that provides a flightcrew member with a sleep opportunity. (Also see attached CAA September 1, 2009, alternative proposal.)

The ARC noted that the type of rest facility needs to be addressed in the proposed rule and in advisory material.

3. Scientific Discussions

The ARC members reviewed the scientific material regarding augmentation that was presented during its meetings. The following are key points made by the scientific experts during their presentations and follow up discussions.

- In-flight naps with augmented flightcrews are dramatically helpful in mitigating sleep debt.
- When extending the FDP with an augmented flightcrew, a quality opportunity for in-flight sleep becomes available; however, the flightcrew members must take advantage of this sleep opportunity because augmentation is of no value if the entire flightcrew is awake.

- The value of augmented flightcrew operations depends on the available sleep facility adding that a quiet, flat bunk is the most desirable.
- In-flight sleep has restorative value, and the flatter one is able to lie, the more beneficial the sleep is. Sitting in an upright position increases blood flow to the brain and causes emission of norephrenephrine, which stimulates the body and reduces relaxation.
- To divide in-flight duty and rest among the flightcrew appropriately, route guides for positioning of sleep should be developed for augmented flightcrews.

4. Flight Time Limitations To Determine Augmentation

In developing the proposed FDP augmentation scheme, the ARC reconsidered whether the current 8-hour flight time limitation will continue to be necessary with the ARC's proposed FDP limitations. Some ARC members again suggested that limiting FDPs noticeably reduces fatigue risk. ARC members further noted that CAP 371 contains no daily flight time restrictions.

The ARC members contemplated whether changing the flight time limitations variable could have unpredicted consequences. The ARC members noted that 12-hour flight operations with three-person flightcrews (two pilots and one flight engineer) used to be a common practice and questioned if fatigue mitigations would permit longer flight times for nonaugmented flightcrews. The ARC members also considered that fatigue is influenced by exposure to factors such as noise, vibration, and radiation, and that eliminating the 8-hour flight time limit would increase exposure to those factors.

The ARC members discussed whether the 8-hour flight time limitation in the current regulation was based on science, or was derived arbitrarily. The ARC considered that longer flights crossing multiple time zones or overnight flights instead of a flight time limit may prompt augmentation. For example, an 8-hour-and-45-minute flight during the day could be safely operated by a nonaugmented flightcrew, but a 7-hour-and-30 minute overnight flight should perhaps be augmented. This led the ARC to consider that required augmentation be driven by factors other than block time. One ARC member proposed that any planned pairing with greater than 6.5 block hours, where the FDP infringes on the normal sleep cycle, require augmentation.

The ARC noted that for certificate holders who would have difficulty augmenting their flightcrews to fly increased flight time or FDP hours, the solution would be an FRMS process.

The ARC reviewed CAP 371 as a baseline for its discussions on augmentation. CAP 371 determines the maximum FDP based on the number of planned block hours and the number of sectors (flight segments). The ARC also reviewed the CAP 371 methodology for determining the maximum FDP for an augmented flightcrew.

During the ARC's review, some members criticized CAP 371 requirements for not being scientifically based. ARC members suggested that CAP 371 does not appropriately account for acclimation and augmentation needed for the operations conducted by U.S. certificate holders.

The ARC then reviewed the TNO Report, Extension of Flying Duty Period by In-flight Relief, dated July 29, 2007. The TNO Report was prepared for the Dutch Government to provide science-based advice on the maximum permissible extension of the

FDP related to the quality of the available onboard rest facility and the augmentation of the flightcrew with one or two pilots. The TNO Report benchmarked existing research when arriving at its recommended values. Finally, the ARC created a comparison table combining the TNO Report and CAP 371 approaches, and generated sample pairings using the numbers in the table to evaluate both approaches.

The ARC also discussed whether augmentation could be used for domestic operations. The ARC considered that augmentation of domestic operations is a possibility. ARC members expressed concern that domestic operations that would appear to work on paper would require flightcrew members to obtain rest in unreasonably small amounts, or that certificate holders would use augmentation to schedule long, multiple-leg FDPs, rather than its current use, to permit long, single-leg operations that could not otherwise be operated.

5. Rest Facilities

The ARC noted that both the TNO Report and CAP 371, to varying degrees, assign value to in-flight rest opportunities that depend on the quality of the rest facility available on the aircraft. The TNO Report ranks the quality of the rest facility from 1 to 4, with 1 being the best quality (flat bunk separated from passenger cabin), and 4 being the worst quality (coach seat). No FDP may be extended using augmentation with a category 4 rest facility. Under the TNO Report, FDPs may be extended using augmentation, with the amount of the extension dependent on the length of the planned FDP and the quality of the rest facility available.

Several ARC members noted that the TNO Report does not account for all the types of rest facilities used by U.S. certificate holders. The ARC then discussed how to evaluate or rate rest facilities. The ARC determined that there are approximately 20 different combinations of rest facilities among various certificate holders. The ARC members developed a rating system dependent on the following variables:

- Horizontal, lie flat position.
- Amount of light.
- Noise.
- Temperature.
- Flightcrew member's time off task.

Depending on the amount of points assigned to these rest facilities, the amount of credit for receiving rest in a type of seat could be calculated. The ARC members suggested a type I, II, and III scheme. ARC members questioned how to address a situation if the flightcrew member was in a type II seat with all the positive factors but the chair does not recline. The ARC members noted that they reviewed various combinations, but the subject needed more study. Some ARC members liked the theory and found it easier to understand than the TNO Report scheme.

Other ARC members favored adopting the TNO Report scheme as the basis for its proposed augmentation recommendations, with the following suggestions:

- Account for factors such as noise, temperature, lighting, and proximity to activities by other persons (for example, passengers, flight attendants, or loadmasters).

- Have five sleep facility categories, rather than four, with the highest quality category being a flightcrew rest bunk compliant with FAA Advisory Circular (AC) 121–31, Flight Crew Sleep Quarters and Rest Facilities. The five categories would be—
    - Category 1: a separate, horizontal, overhead, or underneath bunk.
    - Category 2: a true, lie flat (horizontal) seat.
    - Category 3: a reclining seat that includes a foot rest.
    - Category 4: a traditional business class seat.
    - Category 5: a coach class seat.
- Credit as sleep a percentage of the time during which a flightcrew member occupies a rest facility to extend the FDP. The percentages proposed ranged from 65 percent of time occupied for the highest level sleep facility to 0 percent for the lowest level (coach seat in passenger cabin). The percentages are as follows:
    - Category 1: 65 percent.
    - Category 2: 20 to 50 percent, depending on the time of day.
    - Category 3: 33 percent.
    - Category 4: 25 percent.
    - Category 5: 0 percent.
- Certificate holders and flightcrew members should have flexibility in how they choose to arrange rest opportunities to address both foreseen and unforeseen circumstances, and ensure the best rested flightcrew at landing.
- Factor in the time of day of the departure into the augmentation scheme.

For simplicity, the ARC combined the reclining sleep facility and traditional business class facility (categories 3 and 4 above), resulting in the following classes of sleep facilities:

- *Class 1 rest facility*: a bunk or other surface that allows for a flat sleeping position, is separated from both the flight deck and passenger cabin to provide isolation from noise and disturbance, and provides controls for light and temperature.
- *Class 2 rest facility*: a seat in an aircraft cabin that allows for a flat or near flat sleeping position (approximately 80 degrees), is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation, and is reasonably free from disturbance by passengers and/or flightcrew members.
- *Class 3 rest facility*: a seat in an aircraft cabin or flight deck that reclines at least 40 degrees, provides leg and foot support, and is not located in the coach or economy section of a passenger aircraft.
- *Class 4 rest facility*: a coach seat.

Accordingly, the ARC revised the sleep credit for the class rest facility to more closely align the percentages with the TNO Report recommendations as follows:

- Class 1: 75 percent.
- Class 2: 56 percent.
- Class 3: 25 percent.
- Class 4: 0 percent.

6. Relief Flightcrew Member

The ARC defined flightcrew member as a certificated pilot or flight engineer assigned to duty in an aircraft during an FDP. The ARC discussed the qualifications of the relief flightcrew member used in augmented operations. Some ARC members emphasized that there must be one type-rated flightcrew member on the flight deck at all times. One ARC member noted that current regulations require only one type-rated flightcrew member on the aircraft. Another ARC member stated that under no circumstances should a flight engineer serve as a relief flightcrew member. The ARC proposed that at least one flightcrew member type rated in the aircraft be on the flight deck at all times.

7. Development of FDP Augmentation Table

The ARC considered applying a modifier to the standard FDP limit table when conducting augmented flightcrew operations or creating a separate table combining values from CAP 371 and the TNO Report for augmented operations. The ARC agreed to create a separate FDP table for augmented flightcrew operations.

The ARC reviewed a table that combined limits from the first (single flight segment) column of the proposed FDP table with principles from the TNO Report. The ARC placed an absolute limit of 16 or 18 hours (for a three or four pilot flightcrew, respectively) on the FDP, even though the TNO Report scheme results in a higher FDP. The ARC determined that higher FDPs could be achieved only by use of an FRMS process.

In developing the proposed FDP augmentation tables, several ARC members presented pairing scenarios to demonstrate how they would work under the TNO Report and CAP 371 approaches, respectively. It was noted that some extremely long flights, such as Washington Dulles International Airport to Beijing Capital International Airport, are close to exceeding the absolute 16- and 18-hour limits in the TNO Report approach. It was also noted that return trips on such long-leg pairings are problematic because of domicile time and acclimation issues. The ARC stated that its prescriptive approach could apply to most operations, but certificate holders engaged in ULR operations could use an FRMS process to develop an alternate means of fatigue mitigation tailored to their specific operations. ARC members noted that some types of operations, such as air cargo operations, which operate under different demands and circumstances, might approach augmentation and fatigue differently than other operations.

Finally, the ARC members considered an alternative FDP augmentation table that provided a block hour maximum for nonaugmented operations, where the flightcrew member is acclimated based on report time. If the planned block hours for a trip exceeds the block hours indicated in the table, augmentation is required. A separate table for augmented flightcrew operations must be consulted to determine the maximum FDP, which depends on the size of the flightcrew and the onboard flightcrew rest facilities available. The rest opportunity in the table is the maximum nonaugmented FDP minus 2.5 hours to account for climb and descent times and non-sleep rest time. The ARC reviewed several scenarios to see how FDP was affected by augmentation under the table.

8. Augmentation Triggers

The ARC determined that augmentation is required when the maximum scheduled FDP or flight time hour limit described, in sections G and H above, is insufficient for the planned operation. The ARC also considered intrusion into the WOCL as a potential trigger for augmentation. The length an FDP and the number of additional flightcrew members required is determined using the appropriate augmentation table. Augmentation is based on the length of the FDP and is not limited to international operations. The ARC noted that augmentation should be used strictly for long flights of not more than two to three flight segments and not to extend the FDP for multiple short flight segments.

9. Acclimation

The ARC discussed various approaches to determine whether a flightcrew member is acclimated before accepting an assignment for an FDP. Each approach discussed was interrelated with the following:

- Cumulative fatigue limits for rest ([30 or 36] consecutive hours free from all duty);
- Sleep required to acclimate (3 consecutive local nights' rest where the flightcrew member could also be working during this period, or [30 or 36] hours free from duty); and
- Minimum required rest after a duty period (12 consecutive hours) for flights conducted outside the 48 contiguous United States.

a. Scientific Considerations

During the question and answer session with ARC members, the scientific experts explained how an individual acclimates to time zones when flying long range operations. The scientific experts noted that an individual spending time in a new time zone will gradually acclimate to that time zone. Generally, an individual acclimates approximately 1 day per hour of time zone difference, depending on the individual's variation and amount of light exposure; however, the scientific experts noted there is still much discussion on this topic and considerable individual variability.

The scientific experts stated that having sleep opportunities during a physiological night is the most important fatigue mitigation strategy for global travel, and they recommended that certificate holders arrange flight schedules to permit that. The scientific experts suggested that an applicable regulation allow for flexibility and iterative adjustment.

b. Definitions

The ARC defined the following terms relevant to long-range flying and acclimation.

- *Acclimated* means when a flightcrew member remains in a theater and is given 3 consecutive physiological nights' rest, or at least [30 or 36] consecutive hours free from all duty.
- *Physiological night's rest* means the rest that encompasses the hours of 0100 and 0700 [2200 and 1000] local time.
- *Theater* means a geographical area where local time at the flightcrew member's FDP departure point and arrival point differ by no more than 4 hours.

The ARC members chose the 0100 to 0700 timeframe to define physiological night's rest to ensure to encompass rest during the WOCL. However, other ARC members provided an alternate definition, which states that the rest occurs between the hours of 2200 and 0600.

c. Acclimated versus Nonacclimated

The ARC assumed the following to determine that a flightcrew member is acclimated after travelling across multiple time zones:

- The United States is one time zone.
- The basic FDP table is used.
- The certificate holder has a designated flightcrew member base.

The ARC originally defined nonacclimated as flying more than 4 hours and across five time zones, and then developed a scheme for calculating FDP based on different amounts of rest. After reviewing these scenarios, the ARC concluded that to reset from nonacclimated to acclimated, a flightcrew member would require 3 consecutive local nights' sleep or a [30 or 36]-hour rest period.

The ARC members noted that a flightcrew member can be on duty during the period encompassing 3 local nights, but not during local sleep hours. The ARC considered if an international reset rest of [30 or 36] hours is reasonable in cases where, for example, the time zone difference between the flightcrew member's home base and the theater where the flightcrew member is operating is 11 hours (11 days to acclimate according to the scientific experts presentations). The ARC discussed an alternate reset of 3 physiological nights' sleep. The ARC also considered a physiological night's sleep (a local night's sleep) to include a 10-hour period encompassing the entire WOCL. The ARC later reviewed a proposal for acclimation after 3 consecutive local nights' rest or 30 hours free from duty. One ARC member stated that 30 hours is insufficient to acclimate and instead 3 consecutive local nights' rest is necessary. One ARC member raised the issue that 3 consecutive local nights' rest would affect certificate holders conducting scheduled operations that wish to keep their flightcrew members on home base time instead of local time. Another ARC member noted that eventual acclimation is inevitable in response to daylight cues.

The ARC reviewed another presentation on acclimation and recovery rest. The ARC members noted that the presentation stated that to determine acclimation, the United States should not be treated as having one time zone, but should have four time zones. In addition, circadian factors also should be considered domestically.

d. Long-range Flying and Recovery Rest

The ARC discussed the rest needed for flightcrew members returning to their home base after becoming acclimated in another theater. ARC members noted that such a flightcrew member is not truly acclimated to the new theater, but is no longer acclimated to his or her home base either. To address the acclimation issue and determine the flightcrew member's next FDP, the ARC presented the following options: (1) use a nonacclimated FDP chart and give the flightcrew member home base reset rest (3 consecutive local nights' sleep or a 36-hour layover (equal to 2 physiological nights' rest)), or (2) use the acclimated FDP chart and the local time in the time zone where the flightcrew member last had an international reset rest period to determine the maximum FDP. One ARC member noted that home base reset rest was intended for flightcrew members who have been away from their home base for at least 96 hours.

The ARC also noted that international reset rest only occurs with a change of more than four time zones; therefore, it would not apply to destinations in North America or South America. However, some ARC members asked to have an international reset occur after a certain number of flight time hours to account for long trips to South America that do not involve shifts of more than four time zones.

The ARC revisited the proposed international rest resets. The ARC members agreed that a flightcrew member must always find at least [30 or 36] continuous hours free of duty in any 168 consecutive hours, and that once a flightcrew member is given this rest, the flightcrew member is considered acclimated to local time. The flightcrew member would determine his or her next FDP according to local time. The ARC members discussed trips where the flightcrew members are at an international destination for a brief time (such as Houston, Texas, to Paris, France, and return to Houston, Texas) and do not need to acclimate but need recovery rest after returning to home base. The ARC determined that under that scenario, because the flightcrew members were not away from home base longer than [60 or 72] hours, the flightcrew member would be given 12 hours minimum rest that encompasses the WOCL. The ARC considered that if a flightcrew member was away from home base longer than [60 or 72] hours, then the flightcrew member would require 2 physiological nights' rest.

The ARC then considered that the amount of rest required depended on how long the flightcrew member was away from home base. The ARC reviewed the current regulation, which requires a flightcrew member that exceeds 12 flight hours to receive twice the rest upon return to home base. The ARC members noted that the current requirement does not take into account how long the flightcrew member had been away from home. The ARC recognized that a flightcrew member is not acclimated to a new theater when flying an international trip with a short layover.

Based on the discussion above, the ARC proposed the following:

- To acclimate, the flightcrew member must always find at least [30 or 36] continuous hours free of duty in any 168 consecutive hours.
- Once the [30 or 36] hours free of duty or 3 consecutive local nights' rest is given, the flightcrew member has been acclimated to local time and will enter the appropriate FDP table based on local report time.

(See the discussion of recovery rest under section Q., Rest Period.)

10. Acclimated Augmented Flightcrew

Based on the above review and considerations, the ARC developed tables C and D for augmented flightcrew operations. (See attached CAA and NACA alternative proposals.) Several ARC members supported the methodology used to calculate the maximum FDP hours but did not agree on the final values in the tables. Table C shows the highest allowable FDP as 19 hours and 20 minutes for an acclimated four-member flightcrew. Table D shows the highest allowable FDP as 18 hours and 30 minutes for a nonacclimated four-member flightcrew. All other values in the tables are less than 18 hours.

Table C—Flight Duty Period: Acclimated Augmented Flightcrew

Time of Start (Local Time)	Maximum Flight Duty Period (hours and minutes) based on Rest Facility and Number of Pilots					
	Class 1 Rest Facility		Class 2 Rest Facility		Class 3 Rest Facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000-0559	13:50	16:05	12:55	14:20	11:45	12:15
0600-0659	15:10	17:40	14:10	15:40	12:55	13:25
0700-1259	16:30	19:20	15:25	17:05	14	14:30
1300-1659	15:10	17:40	14:10	15:40	12:50	13:20
1700-2359	13:50	16:05	12:55	14:20	11:45	12:15

The ARC calculated the maximum scheduled FDPs in table C for augmented flightcrew members who are acclimated based on the following:

- A flightcrew composed of three or four pilots.
- The start time of the FDP.
- The maximum planned FDP.
- The rest opportunity minus 2.5 hours (to account for no possibility for rest from takeoff to top of climb and from top of descent to landing).
- The class of the rest facility.

The FDP values for the class of rest facility were benchmarked from the TNO Report and use the same methodology, with time limits rounded to the closest 5-minute interval.

An ARC member proposed that the maximum number of hours in an FDP for a three-pilot flightcrew be limited to [16 hours] and for a four-pilot flightcrew be limited to [18 hours]. [Maximum values in excess of these limits contained in the table require the certificate holder to use a simplified FRMS process described in section E above.] The maximum FDP can be extended up to 3 hours for unforeseen circumstances under the joint discretion of the pilot in command and the certificate holder. The ARC defined unforeseen operational circumstances as an unplanned event, including unforecasted weather, equipment malfunction, or air traffic delay, that is beyond the control of a certificate holder.

<u>11. Nonacclimated Augmented Flightcrew</u>

The maximum scheduled FDP limitations for augmented flightcrew member operations with a nonacclimated flightcrew are set forth in the table D.

Table D—Flight Duty Period: Nonacclimated Augmented Flightcrew

Time of Start (Home Base)	Maximum Flight Duty Period (hours and minutes) based on Rest Facility and Number of Pilots					
	Class 1 Rest Facility		Class 2 Rest Facility		Class 3 Rest Facility	
	3 Pilot	4 Pilot	3 Pilot	4 Pilot	3 Pilot	4 Pilot
0000-0559	13:15	15:20	12:20	13:35	11:15	11:45
0600-0659	14:30	17	13:35	15	12:15	12:50
0700-1259	15:50	18:30	14:50	16:25	13:30	14
1300-1659	14:30	17	13:35	15	12:20	12:45
1700-2359	13:15	15:20	12:20	13:35	11:15	11:40

The ARC calculated the maximum scheduled FDPs in table D for augmented flightcrew members who are nonacclimated based on the same methodology provided for acclimated flightcrew members in table C above. However, for nonacclimated flightcrew members, there is a 30-minute reduction (derate) in the planned maximum FDP for augmentation calculation. The maximum FDP can be extended up to 3 hours for unforeseen circumstances under the joint discretion of the pilot-in-command and the certificate holder. Some ARC members also proposed that for a nonacclimated flightcrew member, the maximum FDP may not exceed 9 hours until the flightcrew member becomes acclimated. The ARC did not reach a resolution on this proposal.

12. Multiple Flight Segment Augmented Flight Operations

The ARC discussed whether more than two flight segments should be permitted in augmented flight operations and, if so, would an FRMS be required to do so. The ARC considered that the FDP for a two-flight segment trip would be shorter, and the second augmented flight segment reduces the FDP by a certain number of hours. The ARC cautioned that it is not the intent of augmentation to facilitate unnecessary additional flight segments or eliminate flightcrew member swaps. The ARC considered unique operations requiring augmentation for three or more flight segments. One ARC member stated that if a certificate holder is augmenting for more than two flight segments, that would require an FRMS. The ARC noted that the available sleep opportunity for flightcrew members is key when augmenting for multiple flight segments. The ARC considered that a flightcrew member assigned to a multiple-flight segment trip needs a specific amount of available time to rest to be able to fly the multiple segments.

The ARC members considered two proposals on minimum flight segment length for augmented operations, focusing on multiple flight segments. The first proposal presented a minimum flight segment length of 2 hours and 15 minutes. This would provide a flightcrew member with 90 minutes of sleep opportunity, plus 30 minutes for retiring and recovery time. The remaining 15 minutes would allow the flightcrew member to be on the flight deck during takeoff and landing. The proposal was based on a National Aeronautics and Space Administration study on cockpit napping, which was conducted in the early 1980s, and showed that a 40-minute nap with a 20-minute recovery time resulted in increased alertness for the remaining 90 minutes of flight. Some ARC members questioned whether these times were too short to be realistic, especially the length of time given for takeoff and landing. This would result in flightcrew members being subject to greater noise and pressure changes during climb and descent that could make obtaining sleep difficult. Some ARC members also expressed concern that this proposal would only rest one flightcrew member on each flight segment.

The second proposal set a maximum of two flight segments, one of which must be a minimum of 7 hours of flight time and may not be followed by another flight segment. Augmented operations of three flight segments would require an FRMS. The 7-hour flight segment was designed to provide the two flightcrew members at the controls for landing with 2 hours of in-flight rest opportunity, and 1 hour and 30 minutes for the relief flightcrew member. The remaining time provided for 45 minutes on each end of the flight for taxi to top of climb, and top of descent to parking at the gate. The ARC considered these proposals and has included them in the range of alternatives in the proposed rule language.

Some ARC members also proposed that augmented operations be prohibited on domestic flights, because flightcrew member swaps are relatively easy to conduct within the domestic system. This may lead to certificate holders building very long FDPs with numerous flight segments and no real opportunity for adequate in-flight rest. The ARC also considered examples of domestic flights that could be operated using an augmented flightcrew to avoid a long deadhead segment each way for two flightcrews, which is permitted and actively practiced under the current system. Ultimately, the ARC was divided on whether the FAA should permit augmented operations on domestic flights.

L. Flight Duty Period—Single Pilot Operations

The ARC had no recommendation on this subject.

M. Flight Duty Period—Extensions

The ARC's proposal provides that in the event of unforeseen circumstances, the pilot in command and the certificate holder may extend an FDP for a maximum of 2 hours for an nonaugmented flightcrew and a maximum of [2 or 3] hours for an augmented flightcrew. The ARC defined unforeseen circumstances as an unplanned event, including unforecasted weather, equipment malfunction, or air traffic delay, that is beyond the control of a certificate holder.

The ARC noted that certificate holders and flightcrew members should share responsibility to extend the maximum schedule FDP. There was concern that if the decision rested solely with the flightcrew member, the flightcrew member's decisionmaking ability after 13 hours of an FDP might be impaired. The ARC also noted that the desire to return home base might influence the flightcrew member's decision. There also was a concern that certificate holders could pressure flightcrew members to make unwise decisions. The ARC noted that there should be a non-punitive policy for a flightcrew member's decision to not extend the maximum FDP.

When developing extensions to the FDP, the ARC considered—

- Requiring mandatory reporting of extensions to the FAA.
- Limiting the number of extensions permitted within a specified time period. For example, limiting one extension per trip or per week. (The scientific experts supported occasional but not consecutive extensions of duty.)
- Requiring certificate holders to adjust a pairing, if the flightcrew members flying that pairing exceeded the maximum schedule FDP on a predetermined percentage of trips.
- Limiting extensions that fall within the WOCL.
- Increasing the subsequent minimum rest period by the amount of the extension, for any extension beyond the maximum FDP.
- Limiting unforeseen circumstances beyond the control of the certificate holder to the day of the FDP and requiring that the circumstances must directly relate to and affect that flight in the FDP in question.

- Noting that unforeseen circumstances lasting more than 72 hours are no longer unforeseen.

N. Flight Duty Period—Commuting

The ARC discussed commuting as travel of a flightcrew member by air or surface transportation, that is not required by a certificate holder, to report for or return from a duty period.

The scientific experts explained to the ARC that commuting time that is adjacent to a duty period is time the flightcrew member is awake, and commuting may be a concern when there is no opportunity to recover.

Under the ARC's proposal, the time spent commuting is not included in a flightcrew member's FDP or duty period. The ARC emphasized that it is the flightcrew members' responsibility to report for duty rested. (See section C2., Flightcrew Member Responsibilities.)

O. Flight Duty Period—Reserve Duty

<u>1. Definitions</u>

The ARC discussed various definitions of reserve and initially proposed that a reserve flightcrew member does not have a regular flying schedule and is available for flight when contacted by the company. That flightcrew member has no telephone or reporting responsibility to the company. The ARC refined this definition to read "A flightcrew member that a certificate holder requires to be available to receive an assignment for duty."

The ARC established definitions for the following types of reserve duty: long-call, short-call, airport/standby (the word "airport" was added to standby to differentiate between the ICAO term "standby," which is the equivalent of "reserve" in U.S. terminology), and short-call reserve. The ARC noted that there is significant variation between different certificate holders as to the rules and limitations that apply to reserve flightcrew members, but also found that there are some relatively consistent conditions. The ARC also proposed a definition for reserve duty period.

A long-call reserve flightcrew member typically receives an assignment for duty well in advance and will have a sleep opportunity before reporting for duty, and may have enough notice of the assignment to plan his or her rest accordingly. The ARC defined a long-call reserve as "A reserve flightcrew member who receives a required rest period following notification by the certificate holder to report for duty."

Airport/standby reserve is known by several terms among various certificate holders, but ultimately involves a flightcrew member on call at an accommodation or other facility at or near an airport. The flightcrew member is not at home and is not resting. The purpose of such reserve duty is to have an available flightcrew member close to the operation in case of a schedule irregularity. Flightcrew members on these assignments can receive notice to report as little as 1 hour before departure time, requiring them to be in a state of readiness.

The ARC defined airport/standby as "A defined period during which a flightcrew member is required by a certificate holder to be at, or in close proximity to, an airport for a possible duty assignment." Because of the unique nature of these assignments, and the fact that the flightcrew member is not resting, an airport/standby reserve assignment is considered to be an FDP, whether or not a flightcrew member ultimately receives a flying assignment.

A short-call reserve flightcrew member typically would receive an assignment on relatively short notice, meaning he or she would not be provided an adequate time for a legal rest period before reporting for duty. Short-call reserve differs from airport/standby reserve in that the flightcrew member is likely to be at home and available for contact by the certificate holder, rather than at the airport or a hotel actively awaiting an assignment. The ARC defined short-call reserve as "A reserve flightcrew member who does not receive a required rest period following notification by the certificate holder to report for duty." Though the flightcrew member may be at home, the opportunity for sleep before reporting for duty cannot be guaranteed. Therefore, the ARC deemed a limit on the amount of time spent on short-call reserve duty as necessary.

The ARC also developed definitions to describe the duration of reserve duty. The ARC defined a reserve availability period (RAP) as "A period of time a certificate holder requires a reserve flightcrew member to be available for contact." A reserve duty period was defined as "The time from the beginning of the reserve availability period to the end of either the reserve availability period or assigned FDP, whichever is later."

The ARC defined "scheduled" as times assigned by a certificate holder when a flightcrew member is required to report for duty. The ARC also proposed that "assigned" mean "scheduled," as defined in this proposal. The ARC notes that "assigned" and "scheduled" are one in the same; therefore, when a certificate holder assigns a reserve flightcrew member a trip, that certificate holder has given that flightcrew member a schedule. This prevents a certificate holder from assigning a trip to a flightcrew member and stating that the term assigned does not fall under the definition of scheduled.

2. Scientific Considerations

The ARC discussed the topic of reserve duty and its relationship with fatigue. One of the most difficult factors of reserve duty is the lack of predictability. The ARC asked the scientific experts what effect this has on a reserve flightcrew member compared with a lineholding flightcrew member. The scientific experts responded that depending on when a reserve flightcrew member is called and how much notice is given, the flightcrew member may not have the opportunity to nap as compared to a lineholder who would know about the trip and could plan rest accordingly. A reserve flightcrew member who thought a call was unlikely also might not nap to avoid a disrupted sleep schedule. This makes it difficult for the reserve flightcrew member to plan rest around a potential assignment, especially an assignment that would involve working into or through the WOCL. The ARC asked the scientific experts how a reserve flightcrew member could best prepare for a potential assignment. The scientific experts recommended a normal night's sleep through the WOCL and a late afternoon nap in the minor WOCL. This would assume the flightcrew member was on a continuous reserve assignment versus a defined period. The ARC also asked the scientific experts if there was a maximum duty time (for example, 16 hours) that should be set for reserve duty. The scientific experts noted that time on duty is dependent on rest. If 8 hours of sleep in the WOCL is available, then 16 hours is a possibility.

3. ARC Considerations

The ARC cautioned that many of the issues with reserve duty are industrial in nature, rather than safety-based. Through its collective experience, the ARC acknowledged that reserve duty is difficult. While improvements to help manage fatigue were certainly possible, achieving parity with lineholding flightcrew members would most likely not be possible.

Reserve duty is based on unpredictable events, such as covering trips for a flightcrew member who becomes ill or has have difficulty traveling to the airport for an assignment because of weather or other reasons, or severe weather events stranding flightcrew members in one location, creating flightcrew member shortages throughout a certificate holder's system. Therefore, injecting predictability into a reserve flightcrew member's schedule is a challenge. The ARC set a goal to make reserve duty as predictable as possible, and to manage fatigue as much as possible.

a. Long-call Reserve

Long-call reserve flightcrew members are given substantial advance notice of when they are to fly. This notice may range from 9 hours to over 24 hours. One ARC member suggested that, in terms of FDP determination, long-call reserve flightcrew members should be treated the same as flightcrew members holding lines, because they receive adequate opportunity for rest before being required to report for duty. The ARC recognized, however, that depending on the timing of notice and the report time in relation to circadian rhythms, reserve flightcrew members may not be able to obtain a full 8 hours of sleep, despite the opportunity to do so. The lack of predictability of when the flightcrew member will be required to report for duty makes it difficult for a reserve flightcrew member to plan sleep rest cycles. For this reason, the ARC considered that start of duty times should have a greater impact on the maximum FDP for reserve flightcrew members than for lineholding flightcrew members. The ARC also considered whether a minimum time from notification of the trip to report time, dependent on the time of day, should be implemented. The ARC defined short-call and long-call reserve to differentiate limits to the extent necessary to mitigate fatigue for reserve flightcrew members.

The ARC discussed whether long-call reserve encourages flightcrew members to commute rather than live near their home base. The ARC noted that this is a politically sensitive issue, but recognized that safety is potentially impacted if a commuting flightcrew member arrives for duty not fully rested. The ARC discussed whether there could be mandated rest between call in and report time. However, ARC members argued that lineholders also should be on mandated rest when free from duty before starting a trip pairing. Ultimately, the ARC did not propose to mandate such rest for reserve or line holding flightcrew members. The ARC noted that it is very difficult to undertake such actions, because a flightcrew member on a rest period is on personal time, and mandating rest would constitute regulating personal time. However, the ARC reiterated that it is the responsibility of the flightcrew member to report rested for duty. (See discussion of flightcrew member responsibilities above.)

The ARC considered how long a flightcrew member could be on long-call reserve. The ARC noted that some certificate holders required flightcrew members called from long-call reserve to fly 15- or 17-day pairings.

b. Short-call and Airport/Hotel Standby Reserve

Short-call reserve flightcrew members are given less time to report for duty. ARC members noted that report times are typically 2 to 3 hours from notification. Airport/standby reserve flightcrew members are short-call reserve flightcrew members who are assigned reserve duty away from their home, and remain on call at an accommodation or other location at or near an airport. The ARC noted that a number of variables may impact the maximum FDP for a short-call or airport/standby reserve. Factors raised included the following:

- Timing of on-call period within the circadian day**.** ARC members noted that a flightcrew member level of alertness and state of rest may be affected by when an on-call period starts in relation to standard circadian rhythms. Generally, short-call availability periods may be classified as very early morning, daytime, or night. The ARC considered that daytime reserve flightcrew members can be presumed to be well rested and alert at the start of their reserve period because of obtaining a regular night's sleep through the WOCL. Although flightcrew members on night time reserve duty are expected to be adequately rested at the start of their reserve period, circadian factors may make flightcrew members less alert and rested than a daytime reserve. One ARC member suggested that flightcrew members called to report during overnight hours should have a reduced maximum FDP, regardless of other factors.
- Length of on-call period**.** The ARC noted that the length of on-call periods for short-call reserve flightcrew members varies. At some certificate holders, on-call periods are relatively short, lasting only a few hours, while at other

certificate holders, a flightcrew member could be on call for 12 hours or more. The ARC discussed that some certificate holders require reserve flightcrew members to be on call 24 hours a day when on reserve duty; these flightcrew members are considered on rest even though they are available for call by the certificate holder. This presents a difficult situation for flightcrew members because of a lack of predictability; for example, when a flightcrew member has been awake all day and is ready to go to sleep, a certificate holder could call for a trip pairing that would keep the flightcrew member awake all night. Such a reserve scheme provides little to no predictability for a flightcrew member to plan sleep to minimize fatigue and increase alertness.

- Timing of call and report time in relation to on-call period and length of duty day. One ARC member noted that during an on-call period, the time the flightcrew member is called and expected to report may affect the flightcrew member's alertness and rested state. The ARC considered a hypothetical case where a flightcrew member was scheduled with an on-call period spanning from 0800 to 0200. An ARC member questioned whether the flightcrew member could be reasonably expected to fly for a full FDP if the certificate holder called close to the end of the on-call period.
- Recent on-call history**.** The ARC noted that reserve flightcrew members with on-call schedules often change from day to night schedules, or vice-versa, within a short period of time. Such changes, especially if given with short notice, can result in reserve flightcrew members failing to obtain proper rest

before their on-call periods. One ARC member suggested that restrictions or prohibitions be placed on such changes.

- Embedded partial rest**.** An ARC member noted that flightcrew members on short-call reserve might be able to get some restorative sleep during their on-call period, particularly if the period falls completely or partly during a normal circadian night. The ARC considered the value of such rest during the on-call period.

Ultimately, the ARC members expressed concern that reserve flightcrew members would be on flight duty after being awake for extended periods of time. One ARC member suggested that there be a maximum number of hours that a reserve flightcrew member can be expected to be awake. For example, if a reserve flightcrew member is on call beginning at 0800, any FDP to which they are assigned should be scheduled to end no later than a certain time, such as 0200 the following day. One ARC member also suggested that short-call reserve flightcrew members begin their duty period when notified, as opposed to when they report. Others suggested that all time on reserve should count as duty time. Another ARC member argued, however, that whether reserve time counts as duty time should be a function of certain factors, such as the time of day and whether the flightcrew member has an opportunity for embedded partial rest.

The ARC considered that reserve duty be classified as such, and be separate from an FDP or duty period. The ARC also considered that time when a flightcrew member is not on duty or on reserve should be classified as free from duty.

ARC members also raised questions regarding the impact of deadhead flights before reserve duty, or at the beginning of a reserve assignment. The ARC proposed that deadhead flights be considered duty time. If the deadhead flight occurs before a flight segment without an intervening required rest period, it is part of an FDP.

c. Proposed Reserve Systems

The ARC considered two reserve systems developed by working groups consisting of ARC members representing industry and labor groups. One working group proposed a WOCL Aware Reserve System to the ARC. Key points of the system include the following:

- Any reserve flightcrew member called between 2200 and 0600 will receive a minimum of 10 hours of rest before reporting for duty.
- Any reserve flightcrew member called to fly into the WOCL would have to be contacted within the first 6 hours of his or her reserve duty.
- If normal sleep time is not interrupted and a reserve flightcrew member is not being called to fly into the WOCL, he or she would have the same FDP limit as a lineholding flightcrew member because they received similar rest.
- Airport/standby reserve is to be treated like a trip assignment and is considered as an FDP. No part of airport/standby reserve may be considered rest, even if the flightcrew member is at an accommodation.

One ARC member noted that the proposed reserve system protects flightcrew members against changes from night to day reserve duty or vice-versa. The proposed system would require a minimum 18-hour rest period if a reserve duty period starts within 24 hours of the start of the previous period, with the exception that the rest may be reduced to 10 hours twice in any 7 consecutive calendar days. The ARC member stated that the practical result is that a reserve may only be switched from day to night reserve twice in 1 week.

The ARC discussed scenarios and considered questions regarding the timing of rest in relation to the reserve flightcrew member's circadian rhythms. Some ARC members advocated language guaranteeing a physiological night's rest between reserve duty periods.

One ARC member noted that some reserve flightcrew members prefer to be contacted closer to the time of the trip assignment instead of being called early in the morning for an afternoon trip. For instance, many ARC members thought that calling a reserve flightcrew member at 0400 about an assignment with a 1000 report time was not necessary and interrupting a sleep opportunity. However, the ARC noted that some flightcrew members may live a distance of several hours from their home base, and would need the early notification to arrive at work on time. One ARC member suggested that flightcrew members elect to notify their company whether or not they preferred to be called as far in advance as possible, or shortly before the trip begins to delay a call and get more rest. The ARC stated that this is an industrial issue and would be difficult to enforce such a regulation.

The ARC also discussed whether telephone availability should be recognized as duty in some way. The concern was that a flightcrew member could be on telephone availability all day, and then be called to fly a trip near the end of their reserve duty period. One ARC member noted, however, that under the proposed system, day reserve flightcrew members would not be called to fly beyond 0200, and night reserve flightcrew members have predictability that they may be called to fly during the WOCL, and can plan their rest accordingly.

The ARC discussed the timing of rest and duty for a flightcrew member on day reserve called with an afternoon report time. One ARC member expressed concern that such a flightcrew member might not be able to sleep during the day in preparation for the late day departure. One ARC member suggested that a certificate holder give flightcrew members 18 hours of rest after this type of duty to prevent this scenario from occurring on consecutive days. The ARC also discussed limiting duty periods for reserve flightcrew members to prevent them from being awake for 20 hours. (An example was given of a flightcrew member called at 0600 to fly a trip ending at 0200.)

The second proposal presented to the ARC was for a Predictable Reserve System with Circadian Stability (Predictable System). This system was based on three prongs: science, circadian stability, and adequate rest. The proposal incorporated provisions from the Civil Aviation Department (CAD)[2], CAD 371, The Avoidance of Fatigue in Aircrews, and provided some recommendations from a reserve rest ARC that convened in 1999.

The working group defined the following terms:

- Protected time period (PTP) as a time free from all duty and contact.
- Reserve availability period as the time from the end of PTP until the time an assigned FDP must be completed.
- Physiological night's rest as a continuous period of 10 hours including 0100–0600 on home base or acclimated time.

[2] The CAD regulates civil aviation activities in Hong Kong.

The working group proposed that the maximum on-call time be 12 hours. The reserve duty period for a flightcrew member called would end when the flightcrew member reports for an FDP. For airport/hotel standby reserve, the FDP includes the entire on-call period. Otherwise, the maximum FDP will be the more limiting of (1) determined FDP (using the appropriate FDP limits table) or (2) 14 hours from the start of the RAP. An FDP begins at the earlier of actual report time or 4 hours from start of RAP. A certificate holder may assign an FDP without restriction if there is at least 12 hours' notice, including a physiological night's rest, with no duty.

For the minimum prior PTP, the working group proposed—

- At least 10 hours if the WOCL is fully encompassed,
- At least 12 hours if WOCL is infringed,
- At least 12 hours' notice, including a physiological night's rest, before initial scheduling of RAP, and
- A flightcrew member returning from a flight assignment requires rest based on FDP flown.

For the RAP start time, changes in start time between consecutive days and within a block of days is limited. A rest period that contains at least two local nights' rest permits different start times.

Following the working group's presentation, the ARC discussed various scenarios under the proposed scheme, particularly discussions of the maximum FDP based on various RAP start times, call times, and report times. The ARC proposed that standby under this scheme should be called reserve duty to avoid confusion with airport/hotel standby. The ARC noted that flightcrew augmentation could also affect the length of the maximum FDP. The ARC members also discussed the limited shifting of a reserve flightcrew member's RAP forward or backward in time within a block of consecutive reserve availability days to keep the flightcrew member on a stable circadian rhythm.

The ARC debated the proposed provision that would impose a limit on an FDP based on the start of the RAP. One ARC member noted that because the limits on reserve flightcrew members are more stringent than those on lineholders, two reserve flightcrew members would often be needed to cover one lineholder's flying in a day. In response, several ARC members argued that greater restrictions are needed for reserve flightcrew members because they are unable to predict when a certificate holder may call and therefore are unable to rest accordingly. One ARC member asserted that being on reserve duty affects the quality of sleep, because the possibility of being called at any time may lead to sleep disturbance.

One ARC member proposed that the system take into account when during the RAP and during the physiological day a flightcrew member is called. An ARC member argued that if, for example, two flightcrew members start their RAPs at 0300, the flightcrew member called at 1100 should not have the same duty limit as the flightcrew member called at 0500 because the flightcrew member called later would obtain more sleep. Another ARC member noted that there is an apparent conflict between flightcrew members being expected to be on call but asleep during the WOCL. One ARC member suggested that RAP start times be staggered to make some reserve flightcrew members available early and others later.

The ARC discussed multiple scenarios under the Predictable System and WOCL Aware proposals. One ARC member noted that the Predictable System proposal tended to be more limiting, but changing the maximum duty limit of both systems to 16 hours from start of the RAP (from 14 and 18 hours, respectively) would eliminate most of the differences. ARC members commented that, in comparing the two systems, the Predictable System addresses circadian issues slightly better, but it is also more complicated and would likely generate interpretation requests if made part of a proposed regulation.

The ARC combined the Predictable System and the WOCL Aware Reserve System to capture the beneficial elements of both proposals. The ARC considered the scenario of a flightcrew member with a RAP starting during the WOCL, but who is not called until after the WOCL. One ARC member proposed that some credit be given for the sleep obtained before being called. After brief discussion, the ARC moved forward with a maximum FDP limit of 16 hours after the start of the RAP.

The ARC identified the following key points of a reserve system. A reserve system should include—

- A defined RAP, reserve duty period, long-call reserve, and short-call reserve.
- A defined maximum reserve duty day (a combination of telephone availability and FDP) based on the appropriate limit determined from the FDP table, plus 4 hours. For nonaugmented operations, the maximum FDP must not exceed 16 hours.
- Half credit for time on reserve duty during the period from 0000 to 0600, to the extent that flightcrew members are not called. (For example, for a flightcrew

member on reserve from 0300, but not called until 0600, the limit on the length of the reserve's FDP would be determined based on the start of the RAP plus half of his or her reserve time during the period from 0000-0600, or 1.5 hours.) This credit provision recognizes that a flightcrew member may be sleeping on reserve duty but not sleeping normally.

- A scheme for shifting a flightcrew member's RAP.

d. Long-haul Reserve

The ARC also discussed if a separate long-haul reserve concept, which involves augmented flightcrew operations would be necessary. The ARC observed that long-haul reserve presents a particular challenge because reserve flightcrew members must have enough predictability to rest sufficiently for a duty period that could be up to 18 hours in length, but their availability must be great enough to be of use to the certificate holder.

The ARC discussion focused initially on pairings in which a reserve flightcrew member is called to fly an overnight flight. The ARC members discussed various scenarios in which a reserve flightcrew member could or could not fly a given trip based on the combined length of time from the start of the RAP and the length of the FDP.

One ARC member noted that maximum FDPs would increase slightly because of the ability to obtain rest on the aircraft. The ARC discussed that a typical reserve duty period under the proposed system would be 14 hours, with 10 hours of rest. One ARC member stated that under this system, if a reserve flightcrew member is called for a trip in the first 6 hours of his or her reserve duty, the FDP could extend up to 6 hours beyond the end of the reserve time. Otherwise, the FDP would be required to end at the end of the flightcrew member's reserve time.

One hypothetical case used to demonstrate the long-haul reserve system involved a flightcrew member beginning reserve duty at 1800 local time, and whether or not he or she could be assigned a trip to Mumbai, India, leaving at 2300. One ARC member noted that the lookback point for adequate rest is 6 hours before departure. Thus, for a 2300 departure to Mumbai, India, lookback to determine rest would be from 1700. One ARC member noted that the flightcrew member's reserve duty would end at 0800 if he or she was not called. The ARC member stated that if the flightcrew member was called before 0000, the FDP could extend for 6 hours beyond 0800 to 1400. Otherwise, the flightcrew member's FDP must end at 0800.

e. Proposed Reserve Requirements

After considering the above proposals and other discussions, the ARC proposed the following requirements for reserve duty:

- The maximum reserve duty period is the flightcrew member's RAP per the flight duty table, plus 4 hours or 16 hours, whichever is less. See tables E(1) and E(2).
- The 16-hour limit does not apply to an augmented flightcrew—the augmented FDP table limits apply in this case plus 4 hours.
- A short-call reserve duty period may not exceed 14 hours.
- 14 hours of rest is required after notification of an FDP that will begin before a short-call reserve flightcrew member's next scheduled RAP. This would prevent a certificate holder from calling a short-call reserve flightcrew member several hours into the RAP with a minimum rest before such an assignment and thus allow the flightcrew member to better plan for rest and manage fatigue.

- Conversion from long-call to short-call reserve assignment must be preceded by a required rest period in § 117.33.
- A long-call reserve flightcrew member must receive at least 12 hours' notice of an assignment of a trip pairing that will extend into the WOCL.
- Before and after a RAP, a reserve flightcrew member must receive at least the required rest period in § 117.33; reserve duty is not considered rest.
- A reserve flightcrew member's RAP may be shifted under the following conditions:
  - A shift to a later RAP must not exceed 12 hours.
  - A shift to an earlier RAP must not exceed 5 hours, or if the shift will move the availability into the flightcrew member's WOCL, it must not exceed 3 hours.
  - A shift to an earlier RAP must not occur on consecutive calendar days.
  - The total amount of shift in RAPs for a flightcrew member must not exceed 12 hours (regardless of direction) in any 168 consecutive hour period.

Table E(1)— Reserve Duty Period: Nonaugmented Operations, Option 1

Time of Start (Home Base)	Maximum Flight Duty Period Reserve (hours) based on number of flight segments						
	1	2	3	4	5	6	7+
0000-0359	13	13	13	13	13	13	13
0400-0459	14	14	13	13	13	13	13
0500-0559	15	15	15	15	14	13.5	13
0600-0659	16	16	16	16	15	15	14.5
0700-1259	16	16	16	16	16	16	15
1300-1659	16	16	16	16	15.5	15	14.5
1700-2159	15	15	14	14	13.5	13	13
2200-2259	14.5	14.5	13.5	13.5	13	13	13
2300-2359	13.5	13.5	13	13	13	13	13

Table E(2)— Reserve Duty Period: Nonaugmented Operations, Option 2

Time of Start (Home Base)	Maximum Flight Duty Period Reserve (hours) based on number of flight segments						
	1	2	3	4	5	6	7+
0000-0159	13	13	13	13	13	13	13
0200-0459	14	14	14	14	13	13	13
0500-0659	16	16	16	16	15.5	15	14.5
0700-1259	16	16	16	16	16	16	15.5
1300-1659	16	16	16	16	15.5	15	14.5
1700-2159	15	15	15	15	13	13	13
2200-2259	14.5	14.5	14.5	14.5	13	13	13
2300-2359	13.5	13.5	13.5	13.5	13	13	13

The ARC's proposed reserve duty period limits are based on the FDP limits for nonaugmented operations in tables B(1) and B(2). The additional 4 hours allowed for reserve duty period has been added to the FDP limits and, in cases where this addition would exceed 16 hours, the reserve duty period is limited to 16 hours. For the case of a reserve flightcrew member that is given an assignment as part of an augmented flightcrew, the 16-hour limit does not apply and the flightcrew member may work to the flight duty period limits for augmented flightcrews in table B(1) (acclimated augmented flightcrew) and table B(2) (nonacclimated augmented flightcrew) plus 4 hours.

The ARC proposed that a credit be provided to extend the reserve duty period of a reserve flightcrew member who is not called during any part of the period from 0000 to 0600. Although a reserve flightcrew member is on duty during a RAP, that flightcrew member is presumed to be sleeping during the WOCL, which would permit a duty extension. However, the reserve flightcrew member cannot be presumed to be sleeping normally because the certificate holder could call at any time. Therefore, the provision allows for credit of half the time the reserve flightcrew member was not contacted during this time period, up to a maximum of 3 hours. However, the credit does not override the 16-hour limit on the maximum reserve duty period limit for nonaugmented operations.

P. Cumulative Fatigue Limits

1. Current Requirements

The ARC reviewed the current regulatory requirements for mitigating cumulative fatigue. The current regulations limit flightcrew members, depending on the type of operation (domestic, flag, or supplemental), to—

- 30 or 32 flight hours in any 7 consecutive days.
- 100 or 120 flight hours in a calendar month or 30 consecutive days.
- 300 or 350 flight hours in any 90 consecutive days.
- 1,000 in a calendar year or 12- calendar month period.

The ICAO SARPs recommend that member States restrict duty hours within any 7 consecutive days or a week and 28 consecutive days or in a calendar month.

The ARC also reviewed the cumulative limits in CAP 371 and EU OPS subpart Q. CAP 371 includes guaranteed time off provisions and restricts the following FDP hour limits to—

- 55 hours in 7 consecutive calendar days;
- 95 hours in 14 consecutive calendar days and
- 190 hours in 28 consecutive calendar days.

EU OPS subpart Q restricts FDP limits to 60 hours in 7 consecutive calendar days and 190 hours in 28 consecutive calendar days.

One ARC member noted that guaranteed time off provisions, such as those contained in CAP 371, which states that "a single day off shall include 2 local nights and shall be of at least 34 hours duration" would protect flightcrew members from overly demanding schedules. Another ARC member argued that if the ARC carefully crafted duty time limitations, detailed time off provisions would not be necessary. Further, ARC members expressed concern that guaranteed time off provisions would result in flightcrew members having long layovers away from home. The ARC noted that regardless of hours prescribed, the concepts in CAP 371 and EU OPS subpart Q are necessary to mitigate cumulative fatigue so the ARC should consider developing a similar combination of limits.

2. Scientific Considerations

As explained previously in this document, the scientific experts in their presentation to the ARC stated that cumulative fatigue is brought on by repeated mild sleep restriction or extended hours awake. The scientific experts noted that the repeated infringement of duty time on opportunity to sleep results in accumulated sleep debt and that the operative factor in recovery from cumulative fatigue is sleep. The scientific experts added that it is difficult to say precisely what amount of time is necessary, but a flightcrew member flying a nighttime schedule likely would require a greater amount of rest than a flightcrew member flying a daytime schedule, because of circadian issues. The scientific experts stated that during long pairings with significant time zone shifts, a minimum of 24 hours off would be necessary for flightcrew members to find an adequate sleep opportunity, and a minimum of 2 nights of sleep might be necessary to acclimate. Scientific experts cautioned that a rest period of exactly 24 hours might work poorly if, for example, a flightcrew member sleeps for the first 8 hours, and then is awake for 16 hours before reporting for duty.

3. ARC Considerations

a. Flight Hour Limits

The ARC members questioned whether the current cumulative flight time limitations should be changed exclusively to flight duty time limitations within various periods (day, week, month, and year). Some ARC members supported the view that flight duty time more accurately gauges the impact on a flightcrew member's rest level than flight hours. Other ARC members noted that flight duty limits address concerns over transient fatigue and flight time limits address cumulative fatigue. One ARC member commented that time on task and workload is a factor in fatigue and that the ARC must establish monthly, quarterly, and yearly limits to allow the new daily FDP limits to be effective. The ARC also reviewed whether longer term flight hour limits, such as weekly, monthly, or yearly limits, would suffice, or whether there should also be a daily flight hour limit that was within the FDP limit. Several ARC members noted that a rule including dual limits would be complicated and could be difficult to apply.

b. Hours versus Calendar Days

With respect to weekly limits, the ARC considered whether calendar days and weeks should be used, or if a rolling 24- or 168-consecutive-hour period should be used as the standard measure for cumulative limits. The ARC defined calendar day as a 24-hour period from 0000 through 2359. The ARC proposed using rolling consecutive hour periods that look back to find limits or requirements before beginning the next FDP and agreed that a 168-hour window is a more consistent measure than 7 consecutive calendar days.

ARC members again cautioned that implementation of limits that are too restrictive could result in flightcrew members flying many more days out of each month. The ARC considered the concept of 336- or 672-hour (14 or 28 days, respectively) rolling periods, instead of a 168-hour (7-day) period. One ARC member noted that some certificate holders have long-haul pairings as long as 19 days, which would be adversely impacted by either 7- or 14-day limitations. The ARC proposed that a 672-hour/28-day rolling lookback period would be adequate to address cumulative fatigue. One ARC member suggested that with these lookback mechanisms a yearly flight time limit would not be necessary to address cumulative fatigue.

c. Flight Duty Period, Duty Period, and Flight Time

The ARC considered cumulative flight duty period and duty period limits within rolling windows of 168, 336, and 672 hours, and flight time limits within rolling 90-day and 365-day windows. The ARC proposed flight duty period limits of —

- 60 flight duty hours in a rolling 168-hour window (7 days),
- 100 flight duty hours in a rolling 336-hour window (14 days), and
- 190 flight duty hours in a rolling 672-hour window (28 days).

The ARC considered cumulative duty period limitations similar to the cumulative FDP limits with a small increase in time to account for the fact that duty encompasses an FDP. These limits are—

- 65 duty hours in any 168 consecutive hours, and
- 200 duty hours in any 672 consecutive hours.

The ARC considered cumulative flight time limits of—

- 270 hours in a rolling 90-day window, and
- 1,000 hours in a rolling 365-day window.

The ARC discussed whether a 336-hour FDP limitation is necessary, in addition to the 168-hour and 672-hour limitations and the daily FDP limitations. One ARC member argued that the other limitations adequately protect safety, and a 336-hour limitation unduly limits certificate holders, without offering significant protection to flightcrew members. One ARC member asserted that the 336-hour limit prevents flightcrew members from manipulating their schedules to time out, and protects against consecutive weeks with reduced rest. The ARC proposed that the 336-hour limitation be eliminated. The ARC also proposed that a quarterly limit on flight hours is unnecessary. The ARC also discussed the removal of the current weekly limit on flight hours, based on the rationale that daily FDP and duty limits offer sufficient protection against fatigue. However, some ARC members expressed concern that eliminating such a limit could be perceived as damaging to safety. ARC members countered that the weekly flight limit is addressed within the limit on FDP hours in any 168 consecutive hours.

d. 1,000 Flight Hour Yearly Limit

The ARC discussed whether the current yearly flight time hour limits serve a useful purpose. Some ARC members noted that there should be some annual flight hour restriction because a flightcrew member could fully observe the proposed FDP restrictions and fly as many as 2,000 flight hours in a year. The ARC discussed whether flight time should be limited to 900 or 1,200 hours in 365 calendar days. Some ARC members believed that the 1,000 flight hour limit is too restrictive. These members noted that there are resets weekly and monthly for FDP and a 1,000 flight hour limit is unnecessary.
One ARC member noted that the current 1,000 flight hour limit is an arbitrary limit that is out of date. The ARC considered a suggestion to raise the annual limit to 1,200 hours. In

response, another ARC member noted that for every first limit, the second limit is less than a multiple of the first; therefore 1,000 flight hours addresses the cumulative fatigue problem. The ARC member stated that the 1,000 flight hour limit should be lower rather than higher.

e. Cumulative Fatigue Limit Scheme

Some ARC members questioned whether only FDP limitations, rather than FDP limitations and total duty limitations, would be more appropriate. One ARC member questioned whether the multiple duty limit windows discussed above are necessary or if only the lowest window would suffice. The ARC member noted that the progression of the limits through the windows is a declining one, to allow short periods with large amounts of duty, but to prevent them from continuing for long periods. The ARC members discussed their research, which applied the proposed limits to their respective operations. Some ARC members reported that their existing operations would not be workable with these limits.

f. Categorizing Activities

The ARC discussed which activities would be included when calculating cumulative fatigue limits. The ARC considered the following:

- Deadhead flights preceding reporting for flight should be counted toward cumulative duty limits.
- Simulator training should be counted toward the FDP cumulative limits.
- Part 91 flying such as ferry, maintenance flights, and training flights should be counted toward FDP cumulative limits.
- Administrative work for the certificate holder should be included in cumulative duty limits.

One ARC member suggested that only one half of the time for deadheading flights be considered duty if the flightcrew member being positioned is seated in a business class seat or better accommodation.

Another ARC member expressed concern with considering administrative work as part of duty because the cumulative duty limits could preclude management pilots from occasionally flying trips. Some ARC members believed administrative work should not be included as duty; others felt that it should be subject to extended cumulative duty time limitations or that the proposed cumulative 65 hour duty time limits should be increased. The ARC noted that flightcrew members completing both administrative work and flying for certificate holders should be responsible for ensuring that they report for flight duty adequately rested and alert. One ARC member noted that the current block hour limitation does not address issues such as deadheading and administrative work. After some discussion, the ARC proposed that administrative duties fall within the definition of duty time and should not have extended cumulative duty time limits.

g. Proposed Cumulative Fatigue Limits

Based on the above discussion, the ARC proposed the following cumulative fatigue limits:

- Flight Duty Period Limits (hours):
  - 60 flight duty hours in any 168 consecutive hours.
  - 190 flight duty hours in any 672 consecutive hours.
- Duty Period Limits
  - 65 duty hours in any 168 consecutive hours.
  - 200 duty hours in any 672 consecutive hours.

- Flight Time Limits
  - 100 hours in any 28 consecutive days (month).
  - [900 or 1,200] hours in any 365 consecutive days (year).
  - Also see attached CAA and NACA proposals.

h. Deadhead Transportation

The ARC proposed to address the concerns previously raised regarding flightcrew members in deadhead transportation. The ARC considered using a higher set of total duty time limits for flightcrew members spending significant time on deadhead flights, provided the flightcrew members are seated in a business class seat (Class 2) or better accommodations for those flights.

The ARC's proposed limits for flightcrew members in deadhead transportation as follows:

- 75 duty hours in any 168 consecutive hours, and
- 215 duty hours in any 672 consecutive hours.

The extended duty times noted above are allowed for deadhead transportation in Class 2 business seat or better (excluding screening from passengers) outside the cockpit. As an alternative, the ARC proposed the same extend duty times but without the Class 2 rest facility requirement.

The ARC discussed only counting 75 percent of time on deadhead flights toward duty. One ARC member proposed requiring screening of deadheading flightcrew members from passengers, but the idea was rejected because flightcrew members deadheading on commercial flights could not expect to be screened from passengers. One ARC member questioned what to do if a portion of the deadhead transportation is on an aircraft without business class seats available. Another ARC member proposed that the business class seat requirement be eliminated for segments shorter than a certain number of hours within the continental United States.

Several ARC members proposed that a flightcrew member be permitted to exceed the 168-hour duty limit for deadhead transportation before a trip, provided he or she received the needed restorative rest before reporting for an FDP. ARC members expressed concern that these proposals would permit certificate holders to schedule flightcrew members for extremely long positioning flights, therefore contributing to fatigue. See discussion of deadhead transportation under the heading Duty above. Other ARC members responded that weekly and monthly cumulative duty limits would prevent certificate holders from abusive scheduling. The ARC members proposed that a flightcrew member be permitted to exceed the 75 hour duty limit in any 168 consecutive hours for the purpose of a positioning flight back to his or her home base at the end of a trip.

i. Rest Resets

The ARC discussed what would constitute rest sufficient to act as a restorative rest reset for the 168 consecutive hour rolling window. The ARC noted that current regulations require 24 hours free of duty in any 7 consecutive days dependent on the type of operation. The ARC considered whether reset rest should (1) incorporate a minimum of 2 physiological nights' rest or (2) be a fixed number of hours ranging from 30 to 48 hours. The ARC proposed that a [30 or 36] hour rest during any 168 consecutive hours constitutes a restorative rest period. The ARC also reviewed whether restorative rest had to occur at a flightcrew member's home base. Several ARC members believed that this is a quality of life issue and not a safety issue and that there must be a safety link to include such a requirement in a proposed rule. Some ARC members suggested that restorative rest be defined as time free from an FDP rather than time free from duty to allow more flexibility for deadheading flightcrew members.

The ARC also discussed the relationship between administrative work, training, and the restorative rest period. The ARC agreed that a full restorative rest period is not needed after a trip before undertaking administrative work or ground training, but is needed before simulator training. The ARC cautioned that administrative work may not conflict with needed rest before reporting for flight duty.

The ARC discussed whether the lookback for restorative rest should take place at the beginning of each FDP, and whether it should contemplate the scheduled and anticipated actual FDP. The scenario was posed of a flightcrew member who has received 30 hours of rest in the past 168 hours at the start of an FDP, but will not have had that much rest on the last flight segment of the FDP because of weather delays. The ARC noted that the flightcrew member could not fly the last flight. The ARC proposed that each flightcrew member be given [30 or 36] hours free of all duty in any 168 consecutive hours before beginning an FDP.

Q. Rest Period

1. Definition

The ARC defined a rest period to mean a continuous and defined period of time, before and/or following a duty period during which a flightcrew member is free from all duties and is not obligated for direct contact. To define rest period, the ARC reviewed the definition of rest in the ICAO SARPs, CAP 371, and EU OPS subpart Q. The ARC proposed that rest begin when a flightcrew member ends his or her duty period. The ARC considered using the term break in duty to refer to rest. The rationale given was that break in duty would more clearly (1) differentiate between being on duty and off duty and (2) account for a flightcrew member's additional activities after duty such as clearing customs and immigration at international destinations, transportation to a hotel, and hotel check-in that occur before the flightcrew member reaches his or her hotel room to begin actual rest. However, the ARC members noted that the various international standards used the term rest period and that rest period is common terminology currently used in the U.S. air carrier industry.

2. Scientific Considerations

The ARC discussed the information on rest presented by the scientific experts. The scientific experts made the following key points:

- The most effective fatigue mitigation is sleep,
- An average individual needs to have an 8-hour sleep opportunity to be restored,
- 8 hours of sleep requires more than 8 hours of sleep opportunity, and
- Daytime sleep is less restorative than nighttime sleep.

The scientific experts also presented how reduced rest impacts human performance and fatigue risk. The scientific experts noted that there is a continuous decrease in performance as sleep is lost. Examples provided included:

- Complacency,
- Loss of concentration and communicative skills, and
- A decreased ability to perform calculations.

The scientific experts recommended the ARC focus on the total time spent below a benchmark amount of rest to manage total risk. The scientific experts noted that occasional sleep restriction does not have significant effects on performance. However, mild sleep restriction reduces performance over time depending on how much sleep is reduced. The scientific experts recommended that the proposed rules require restorative rest opportunities following reduced rest or extended duty to stop the accumulation of sleep debt.

The ARC members debated whether restorative rest must be at a flightcrew member's home base. Some ARC members questioned if this discussion was a safety or quality of life issue. The scientific experts commented that the difference between hotel and home rest varies by individual. A hotel that is quiet and comfortable, and provides darkness with appropriate temperature during sleep may be equivalent to resting at home.

3. ARC Considerations

The ARC debated what constitutes the minimum rest opportunity a flightcrew member should be afforded and cited the following factors as impacting the quality of rest:

- The comfort of the flightcrew member's accommodations,
- The lack of interruptions,
- The time to transit customs and immigration, where necessary, and
- The distance from the airport to the rest facility.

The ARC originally discussed the length of rest period needed to mitigate fatigue. One ARC member suggested that the length of rest time be proportionate to the length of the duty periods preceding and following it. Another ARC member noted that there is some scientific opinion to the effect that the length of rest needed is not dependent on the length of the preceding duty period. The ARC members discussed that the timing of the duty day preceding a rest period also may impact how much rest is needed. Although flightcrew members are required to report adequately rested, it may not be reasonable to expect a flightcrew member reporting at 1800 local time to be as rested and alert as a flightcrew member reporting at 0800 local time because of the flightcrew member's time since awakening.

For domestic operations (operations conducted within the 48 contiguous United States and its territories and the District of Columbia), the ARC contemplated a minimum rest period between 10 and 12 consecutive hours. ARC members discussed that a 12 hour rest period would provide more time for meals and exercise and allow a better chance for a flightcrew member to obtain an 8-hour sleep opportunity, but noted that by design the proposed 10 hours is a minimum, which is not meant to be scheduled every day of the flightcrew member's schedule. Some ARC members suggested that the proposed minimum rest hours be essentially a behind the door limit (a minimum uninterrupted sleep opportunity) with no transportation, hotel check-in, or other process counted as part of a rest period. The ARC defined transportation local in nature as transportation from a point of last duty to an accommodation for the purpose of a rest period, or from an accommodation to report for a duty period. The transportation does not exceed 30 minutes under normal circumstances. One ARC member suggested that the rest period begin upon arrival at accommodations to eliminate the need for such travel time estimates. Some ARC members noted that additional time should be built into the duty period so as not to reduce sleep opportunity in instances where transportation is known to exceed 30 minutes.

When modeling a schedule with a 12 hour rest period in a certificate holder's scheduling system, the 12-hour minimum rest period caused a significant increase in long layovers of approximately 30 hours, which would keep flightcrew members away from home longer. One ARC member noted that current practice uses time between duty periods of approximately 9 to 10 hours, and speculated that the proposed 12-hour minimum rest periods would not be acceptable to most certificate holders. Many ARC members noted that the basis for the ARC's formation is that the current practice is not acceptable and added that the ARC's proposed rest requirement will result either in a cost to certificate holders, increased trip lengths for flightcrew members, or both.

One ARC member alternatively proposed to set a minimum rest time that could never be deviated below, as well as a higher standard rest time that could be adjusted downward or upward using an FRMS.

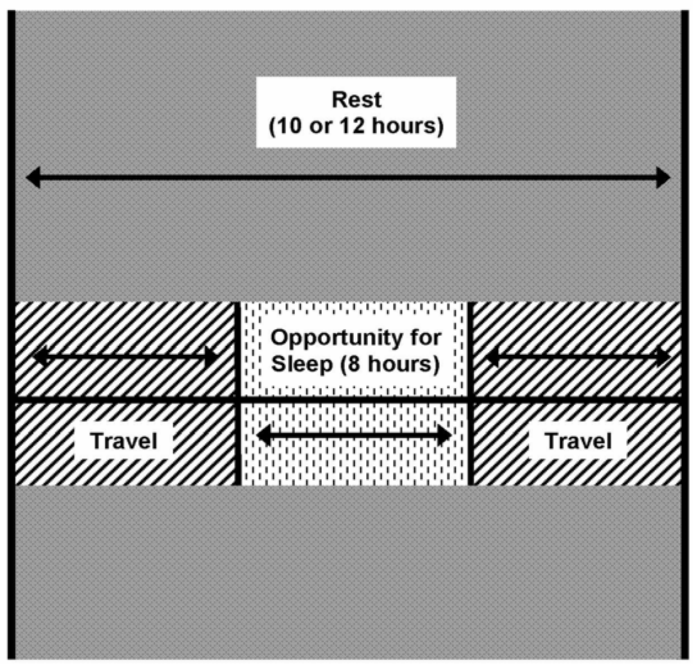
After much discussion, the ARC divided rest into defined components using the following scheme:

- Time free from duty is the time from the end of an FDP, until the flightcrew member reports for duty at the beginning of the next duty period.
- Travel to and from the flightcrew rest facility is included in time free from duty.
- Time free from duty also includes time for meals, hygiene, and exercise, which some ARC members believe has value as a fatigue mitigation technique.
- Within time free from duty is rest time.
- Rest is not equivalent to sleep, but also includes time to wind down and wake up following sleep.
- Within rest time is opportunity for sleep.

- Sleep opportunity should be 8 hours at a minimum, but is impacted by other factors. Sleep opportunity during normal waking hours (for example, beginning at 1200 local time) is not equal to sleep opportunity during normal sleeping hours (for example, beginning at 2000 local time).

The ARC members then developed the proposed rest period requirement by working out in each direction from an 8 hour sleep opportunity, which they believed is essential, with 30 minutes on each end for transportation, and 30 minutes on each end for physiological needs. The ARC proposed that transportation local in nature that exceeds 30 minutes may not be included in required rest and must be accounted for to protect the required rest period. See figure 2.

Figure 2 — Rest Period



The ARC members found that [10 or 12] hours is the minimum period in which a flightcrew member could likely obtain near 8 hours of sleep. The ARC also considered the concept of a [10 or 12]-hour minimum rest period or the length of the preceding duty period, whichever is longer, to avoid long duty periods and short layovers. However, most ARC members preferred that the length of the preceding duty period not be considered a factor in determining rest requirements.

4. International Rest

The ARC noted that flightcrew members require a longer rest period at international layovers (located outside of the 48 contiguous United States and its territories and the District of Columbia) because of issues with time zone changes and possible difficulties obtaining sleep because the flightcrew member is nonacclimated. The ARC proposed a [12 or 14]-hour minimum rest period for international layovers. Some ARC members acknowledged that the minimum period captures the same elements as the [10 or 12]-hour requirement discussed above but includes an additional 2 hours to transit customs and immigration or travel a long distance to hotel accommodations in foreign destinations. However, other ARC members believed that the certificate holder should account for any excessive travel time in the duty period instead of the rest period.

ARC members expressed concern that although a [12 or 14]-hour minimum rest period is an acceptable concept for international destinations, a flightcrew member who flies from Chicago, Illinois, to Toronto, Canada, which is in the same time zone and is a short flight, will now have to have a [12 or 14]-hour rest period when it is not necessary. The ARC considered excepting the [12 or 14]-hour rest period for layovers in international locations such as Canada, Mexico, and some Caribbean islands as these routes are essentially domestic in nature. The ARC members stated that instead the proposed minimum [10 or 12]-hour rest period would apply.

5. Contact During a Rest Period

In defining a rest period, the ARC included that a flightcrew member be free from all contact during a rest period. The proposed definition means that the certificate holder cannot contact a flightcrew member nor can the flightcrew member be required to contact the certificate holder during a rest period. Several ARC members suggested that a flightcrew member be noncontactable during a layover with minimum rest time. The ARC members proposed that passive contact could be made by the certificate holder, such as having the hotel leave any messages for the flightcrew member under his or her hotel room door instead of directly contacting the flightcrew member by telephone. The ARC added the phrase “with the exception of passive contact” to the definition of rest period.

6. Reduced Rest

The ARC discussed permitting the minimum rest time to be reduced to a lower level during unforeseen circumstances. However, ARC members expressed the following concerns regarding reduced rest:

- When the need arises for a minimum rest period, the flightcrew probably had a challenging day with weather or mechanical issues and requires rest not reduced rest.
- The current system relies on an assumption that everything works perfectly, and when this does not occur, sleep time is reduced.
- Any mitigation of reduced rest should consider the extended duty encountered during the previous duty period.

One ARC member stated that reduced rest can be tolerated in isolation but repeated occurrences are fatiguing. One ARC member noted that under the current system, even where flightcrew members are guaranteed compensatory rest during a rest period following one in which rest is reduced, they must often fly a full duty day in the interim. The ARC members proposed that, following any reduced rest, duty should be restricted to mitigate the effects of the reduced rest.

ARC members proposed to allow the ability to reduce a minimum rest period for operational flexibility in unforeseen circumstances, but restrict when and how often it can be done as follows—

- For flights conducted within the 48 contiguous United States and its territories and the District of Columbia, [10 or 12] to [9 or 11] hours and
- For flights conducted outside the 48 contiguous United States and its territories and the District of Columbia, [12 or 14] to [11 or 13].

The ARC proposed that no certificate holder may reduce a rest period on consecutive calendar days. The ARC also considered limiting the number of hours or occurrences in any 168 consecutive hour period. In addition, the decision to reduce minimum rest would be a joint decision between the pilot in command and the certificate holder. The ARC members noted that this is an improvement over current regulations, where certificate holders can actually schedule reduced rest.

<u>7. Recovery Rest</u>

The ARC discussed the rest needed by flightcrew members upon returning to their home base after a trip involving demanding circumstances. One ARC member noted that trips exceeding 168 hours including time zone changes of more than 4 hours may require more rest. The ARC member suggested that in such cases, rest greater than the standard [30 or 36] hours free from duty in the 168 hours preceding the flightcrew member's next FDP is necessary. Some other ARC members agreed, noting that additional rest following a long trip involving multiple time zone changes would be consistent with the longer required rest periods for international trips.

In determining what amount of recovery rest would be appropriate following such a trip, the ARC considered proposals, including a provision similar to the "double-out" provision of § 121.485(b), which would be applied to the minimum international rest requirements, and proposals for a minimum of 2 or 3 nights' physiological rest depending upon the circumstances. With respect to the proposals for 2 or 3 physiological nights' rest, one ARC member stated that in his experience a minimum of 3 days of rest is necessary to recover after long trips crossing multiple time zones.

The ARC proposed that—

- If a flightcrew member crosses more than four time zones during an actual series of FDPs that exceed 168 consecutive hours, the flightcrew member must be given a minimum of 3 physiological nights' rest upon return to home base.
- A flightcrew member operating in a new theater must receive 36 hours of rest in any 168 consecutive hours for recovery rest.
- A certificate holder may not schedule a flightcrew member who is between international rests for more than two rest periods of 18 to 30 hours while that flightcrew member is operating in a new theater; the rest periods cannot be consecutive. This provision addresses the concern that a flightcrew member may not get a full night's sleep through the WOCL during a pairing with

consecutive layovers, especially if the first flight segment ends during the WOCL.

8. Consecutive Circadian Disruptive Layovers

a. Scientific Considerations

The scientific experts noted that an individual's circadian clock is sensitive to rapid time zone changes. They added that long trips present significant issues requiring mitigation strategies. Twenty-four or 48 hours of rest may not be adequately restorative during a trip pairing where a flightcrew member is working 20 days separated by 24-hour rest layovers. In some cases, shorter rest periods, such as 18 hours or less, may be more restorative because of circadian issues.

b. ARC Considerations

The ARC reviewed consecutive layover periods that disrupt a flightcrew member's circadian rhythms. The ARC discussed back-to-back long flights with 24- hour layover rest that does not occur during a flightcrew member's WOCL, which, according to scientific modeling, can be fatiguing. The ARC provided an example of a flight from Washington, DC to Moscow, Russia. The total FDP roundtrip is 22:50 hours. The flightcrew has a 24 hour layover in Moscow and then returns to Washington, DC. The ARC proposed the following to prevent a flightcrew from conducting this trip consecutively: If the flight assignment is for a three pilot flightcrew and the layover is between 20 and 28 consecutive hours and the two FDPs, separated by the layover rest, is greater than [22 or 24] hours then the flightcrew requires 2 physiological nights' rest or 1 physiological night's rest with an 8 hour restriction on the next FDP.

The ARC considered whether this concept instead should be based on the number of time zone changes. However, it was noted that using a time zone metric would not capture flights travelling north-south, northeast-southwest, northwest-southeast, or vice versa. The ARC noted that the concept is predicated on the flightcrew members coming back to theater and noted that a new theater would require 3 physiological nights' rest to be considered acclimated under the ARC's proposed rules. Those ARC members in favor of 24 hours for the combined FDPs noted that 22 hours would eliminate trip pairings that had been conducted for many years to western Europe. ARC members countered that at the end of three round trips to such destinations flightcrew members are fatigued and that a combined FDP of 22 hours is better mitigation for fatigue. The ARC then considered a revised proposal for circadian disruptive layovers, which added that any sequence of FDPs separated by 20 to 28 hour layovers that result in a shift in report time between FDPs of 8 hours or greater would also require the flightcrew to be given either 2 physiological nights' rest or 1 physiological night's rest with an 8-hour restriction on the next FDP.

R. Records and reports

[To be completed.]

IV. Regulatory Notices and Analyses

The ARC proposed requiring a certificate holder to report scheduling data to the FAA every [1month/2months].

[Placeholder for other records and reporting requirements.]

Additional Information

Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. We also invite comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. To ensure the docket does not contain duplicate comments, please send only one copy of written comments, or if you are filing comments electronically, please submit your comments only one time.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed after the comment period has closed if it is possible to do so without incurring expense or delay. We may change this proposal in light of the comments we receive.

Proprietary or Confidential Business Information

Do not file in the docket information that you consider to be proprietary or confidential business information. Send or deliver this information directly to the person identified in the FOR FURTHER INFORMATION CONTACT section of this document. You must mark the information that you consider proprietary or confidential. If you send the information on a disk or CD ROM, mark the outside of the disk or CD ROM and also identify electronically within the disk or CD ROM the specific information that is proprietary or confidential.

Under 14 CFR 11.35(b), when we are aware of proprietary information filed with a comment, we do not place it in the docket. We hold it in a separate file to which the public does not have access, and we place a note in the docket that we have received it. If we receive a request to examine or copy this information, we treat it as any other request under the Freedom of Information Act (5 U.S.C. 552). We process such a request under the DOT procedures found in 49 CFR part 7.

Availability of Rulemaking Documents

You can get an electronic copy of rulemaking documents using the Internet by—

1. Searching the Federal eRulemaking Portal (http://www.regulations.gov);
2. Visiting the FAA's Regulations and Policies web page at http://www.faa.gov/regulations_policies or
3. Accessing the Government Printing Office's web page at http://www.gpoaccess.gov/fr/index.html.

You can also get a copy by sending a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue S.W, Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

You may access all documents the FAA considered in developing this proposed rule, including economic analyses and technical reports, from the internet through the Federal eRulemaking Portal referenced in paragraph (1).

List of Subjects

14 CFR Part XXX

[insert]

V. The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend Chapter I of Title 14, Code of Federal Regulations, as follows:

PART 117—FLIGHT AND DUTY LIMITATIONS AND REST REQUIREMENTS: FLIGHTCREW MEMBERS

§ 117.1 Applicability.

This part prescribes flight and duty limitations and rest requirements for all certificate holders conducting operations under parts 121 and 135 of this chapter. This part also applies to all part 121 and 135 certificate holders when conducting certain flights under part 91, including positioning and training flights.

§ 117.3 Definitions.

In addition to the definitions in § 1.1 of this chapter, the following definitions apply to this part. In the event there is a conflict in definitions, the definitions in this part control.

[*Acclimated* means when a flightcrew member remains in a theater and is given 3 consecutive physiological nights' rest or at least [30 or 36] consecutive hours free from all duty.]

Airport/standby reserve means a defined period during which a flightcrew member is required by a certificate holder to be at, or in close proximity to, an airport for a possible duty assignment.

Assigned means scheduled as defined in this section.

Augmented flightcrew means a flightcrew that has more than the minimum number required to operate the aircraft to allow a flightcrew member to be replaced by another qualified flightcrew member for in-flight rest.

Calendar day means a 24 hour period from 0000 through 2359.

Certificate holder means a person, organization, or enterprise operating an aircraft for compensation or hire.

Deadhead transportation means transportation of a flightcrew member as a passenger, by air or surface transportation, as required by a certificate holder.

Duty means any task that a certificate holder requires a flightcrew member to perform including pre and post flight duties, administrative work, training, deadhead transportation, aircraft positioning on the ground, aircraft loading, and aircraft servicing.

Duty period means a period that begins when a certificate holder requires a flightcrew member to report for duty and ends when that person is free from all duties.

Fatigue means a physiological state of reduced mental and/or physical performance capability resulting from lack of sleep and/or increased physical activity that can reduce a flightcrew member's alertness and ability to safely operate an aircraft or perform safety-related duties.

Fatigue risk management system means a comprehensive range of procedures that are scientifically based and data-driven, allowing a cooperative and flexible means of managing fatigue.

Flightcrew member means a certificated pilot or flight engineer assigned to duty in an aircraft during a flight duty period.

Flight duty period means a period that begins when a flightcrew member is required to report for duty that includes a flight, a series of flights, and/or positioning flights, and ends when the aircraft is parked after the last flight and there is no intention for [further aircraft movement]/[further flight] by the same flightcrew member. A flight duty period includes deadhead transportation before a flight segment without an intervening required rest period, training conducted in an aircraft, [flight simulator or flight training device], and airport/standby reserve.

Flight time means time that commences when an aircraft moves under its own power for the purpose of flight and ends when the aircraft comes to rest after landing. [consistent with 14 CFR § 1.1]

Home base means the location designated by a certificate holder where a flightcrew member normally begins and ends his or her duty periods.

Lineholder means a flightcrew member that has a flight schedule and is not a reserve flightcrew member.

Long-call reserve means a reserve flightcrew member who receives a required rest period following notification by the certificate holder to report for duty.

Physiological night's rest means the rest that encompasses the hours of [0100 and 0700] [2200 and 1000] local time.

Positioning flight means a flight conducted by a certificate holder, that is not scheduled or a charter, for the purpose of ferrying, maintenance, or otherwise moving an aircraft between locations.

Report time means the time that the certificate holder requires a flightcrew member to report for a duty period.

Reserve flightcrew member means a flightcrew member that a certificate holder requires to be available to receive an assignment for duty.

Reserve availability period means a period of time a certificate holder requires a reserve flightcrew member to be available for contact.

Reserve duty period means the time from the beginning of the reserve availability period to the end of either the reserve availability period or assigned flight duty period, whichever is later.

Rest facility means a bunk, seat, room, or other accommodation that provides a flightcrew member with a sleep opportunity. (See CAA September 1, 2009, alternate proposal.)

Class 1 rest facility means a bunk or other surface that allows for a flat sleeping position, is separated from both the flight deck and passenger cabin to provide isolation from noise and disturbance and provides controls for light and temperature.

Class 2 rest facility means a seat in an aircraft cabin that allows for a flat or near flat sleeping position [approximately 80 degrees]; is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation; and is reasonably free from disturbance by passengers and/or flightcrew members.

Class 3 rest facility means a seat in an aircraft cabin or flight deck that reclines at least 40 degrees, provides leg and foot support, and is not located in the coach or economy section of a passenger aircraft.

Rest period means a continuous and defined period of time before and/or following a duty period during which a flightcrew member is free from all duties and is not obligated to be available for direct contact by a certificate holder.

Scheduled means times assigned by a certificate holder when a flightcrew member is required to report for duty.

Schedule reliability means the accuracy of the length of a scheduled flight duty period as compared to the actual flight duty period.

Short-call reserve means a reserve flightcrew member who does not receive a required rest period following notification by the certificate holder to report for duty.

Split Duty means a flight duty period that has a break in duty that is less than a required rest period.

Suitable accommodation means a single occupancy, temperature-controlled facility with sound mitigations that provides a flightcrew member with the undisturbed ability to sleep in a bed and to control light.

Theater means a geographical area where local time at the flightcrew member's flight duty period departure point and arrival point differ by no more than 4 hours.

Transportation local in nature means transportation from the point of last duty to an accommodation for the purpose of a rest period, or from an accommodation to report for a duty period. This transportation does not exceed 30 minutes under normal circumstances.

Unforeseen operational circumstance means an unplanned event, including unforecasted weather, equipment malfunction, or air traffic delay, that is beyond the control of a certificate holder.

Window of circadian low means a period of maximum sleepiness that occurs between 0200 and 0559 during a physiological night on a person's home base or acclimated time.

§ 117.5 Certificate holder responsibilities.

(a) No certificate holder may assign a flightcrew member to a flight duty period if the flightcrew member has reported himself or herself not fit for duty or if the certificate holder believes that the flightcrew member is not fit for duty.

(b) Each certificate holder must implement a nonretribution policy allowing a flightcrew member to remove themselves from flight duty when too fatigued to continue the assigned flight duty period.

(c) Each certificate holder must adjust—

(1) Its system-wide flight duty periods if the total actual flight duty periods exceed the planned scheduled flight duty periods 5 percent of the time, and

(2) Any scheduled flight duty period that is shown to actually exceed the schedule [15 or 30] percent of the time.

(c) Each certificate holder must submit a report detailing the scheduling reliability adjustments required in paragraph (b) of this section to the FAA every [1 month][2 months] in a form and manner prescribed by the FAA.

§ 117.7 Flightcrew member responsibilities.

Each flightcrew member must report for any [scheduled] flight duty period adequately rested and prepared. (Note: Failure to do so is a violation 14 CFR § 91.13.)

§ 117.9 Fatigue policy and education and training program.

(a) Each certificate holder must—

(1) Develop a fatigue policy, and

(2) Implement a fatigue education and training program applicable to all employees of the certificate holder responsible for administering the provisions in this rule,

including dispatch, crew scheduling, and systems operational control, and any employee providing management oversight of those areas.

(b) The fatigue education and training program must include information on—

(1) The detrimental effects of fatigue, and

(2) Strategies for avoiding and countering fatigue.

§ 117.11 Fatigue risk management system.

(a) No certificate holder may exceed any flight time, flight duty period, or duty period limitation or reduce any rest requirement provided for in this part unless the certificate holder has an FAA-approved fatigue risk management system (FRMS).

(b) Except as provided in paragraph (c), the FRMS must include the following elements:

(1) A method to determine a fatigue baseline and establish an acceptable schedule production effectiveness and performance threshold.

(2) A method of conducting scientific evaluation of schedules to—

(i) Determine which schedules do not meet the predetermined minimum schedule production effectiveness and performance threshold, and

(ii) Reanalyze schedules to remove or modify potentially deficient schedules to achieve the desired effectiveness and performance threshold.

(3) A method to manage schedules to minimize or mitigate fatigue to acceptable levels.

(4) A method to analyze schedule modifications because of irregular operations.

(5) A fatigue review panel.

(6) A fatigue education program that includes initial and annual recurrent training for all flightcrew members and affected parties.

(7) An audit program that includes the following:

(i) A monthly reassessment by the fatigue review panel;

(ii) A semiannual internal audit; and

(8) A method to collect, deidentify, and analyze fatigue related data.

(c) A certificate holder may conduct limited operations that exceed the flight time, flight duty period, and duty period limitations or reduce the rest requirements provided for in this part, if the certificate holder has an [FAA-approved] FRMS for those limited operations that contains the following elements:

(1) Scientifically based method to determine maximum duty times, pre-duty, layover, and post duty rest requirements, and in-flight prescriptive rest scheme to ensure adequate alertness is maintained during regular and irregular operations.

(2) Validation of the suitability of the onboard rest facility.

(3) Data gathering methodology to validate the scientific method used.

(4) A feedback process to assess actual operations.

(5) Specific flightcrew training, qualification, and staffing requirements.

(6) A training program for all stakeholders on fatigue and sleep education including mitigation and countermeasures strategies.

§ 117.13 Duty period.

There is no ARC recommendation for this area.

§ 117.15 Flight time limitation: Nonaugmented operations.

No certificate holder may schedule and no flightcrew member may accept an assignment if the total scheduled flight time will exceed the limits specified in table A:

Table A(1)—Maximum Flight Time Limits, Option 1

Time of Start (Home Base)	Maximum Flight Time (hours)
0000-0459	7
0500-0659	8
0700-1259	9
1300-1959	8
2000-2359	7

Table A(2)—Maximum Flight Time Limits, Option 2

Time of Start (Home Base)	Maximum Flight Time (hours)
0000-0159	7
0200-0459	8
0500-0659	10
0700-1259	11
1300-1659	10
1700-2159	9
2200-2259	8.5
2300-2359	7.5

Table A3. See attached September 1, 2009, CAA Proposal

Table A4. See attached NACA Proposal

§ 117.17 Flight duty period: Nonaugmented operations.

(a) Except as for provided for in paragraph (b) of this section and §§ 117.19 through 117.23 of this part, no certificate holder may assign and no flightcrew member may accept an assignment for a nonaugmented flight operation if the scheduled flight duty period will exceed the limits in specified in table [B(1)/ B(2) and the attached September 1, 2009, CAA and NACA proposals.]

Table B(1)—Flight Duty Period: Nonaugmented Operations, Option 1

Time of Start (Home Base or Acclimated)	Maximum Flight Duty Period (hours) for Lineholders Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000-0359	9	9	9	9.	9	9	9
0400-0459	10	10	9	9	9	9	9
0500-0559	11	11	11	11	10	9.5	9
0600-0659	12	12	12	12	11.5	11	10.5
0700-1259	13	13	13	13	12.5	12	11
1300-1659	12	12	12	12	11.5	11	10.5
1700-2159	11	11	10	10	9.5	9	9
2200-2259	10.5	10.5	9.5	9.5	9	9	9
2300-2359	9.5	9.5	9	9	9	9	9

(b) For nonacclimated flightcrew member, the maximum flight duty period in table (B)(1) is reduced by 30 minutes.

Table B(2)—Flight Duty Period: Nonaugmented Operations, Option 2

Time of Start (Home Base or Acclimated)	Maximum Flight Duty Period (hours) for Lineholders Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000-0159	9	9	9	9	9	9	9
0200-0459	10	10	10	10	9	9	9
0500-0659	12	12	12	12	11.5	11	10.5
0700-1259	13	13	13	13	12.5	12	11.5
1300-1659	12	12	12	12	11.5	11	10.5
1700-2159	11	11	11	11	9	9	9
2200-2259	10.5	10.5	10.5	10.5	9	9	9
2300-2359	9.5	9.5	9.5	9.5	9	9	9

(b) For a nonacclimated flightcrew member, the maximum flight duty period in table (B)(2) is reduced by 30 minutes.

[(c) For a nonacclimated flightcrew member who remains in theater, the maximum flight duty period may not exceed 9 hours until the flightcrew member becomes acclimated.]

[Table B3. See attached September 1, 2009, CAA Proposal]

[Table B4. See attached NACA Proposal]

§ 117.19a Flight duty period: Split duty. [Option 1]

For a split duty period, a certificate holder may extend and a flightcrew member may accept a flight duty period up to [50] percent of time that the flightcrew member spent in a suitable accommodation up to a maximum flight duty period of [12] hours provided—

(a) The flightcrew member is given a minimum of [4 hours] actual rest in a suitable accommodation, and

(b) The certificate holder—

(i) Establishes a feedback process collecting actual operational data from flightcrew members and adjusts the schedule as necessary,

(ii) Has a training program that includes information on fatigue and sleep education and mitigation and countermeasures strategies approved by the FAA, and

(iii) The extended duty operation is approved by the FAA.

§ 117.19b Flight duty period: Split duty. [Option 2]

(a) For a split duty period, a certificate holder may extend and a flightcrew member may accept a split duty period up to [75] percent of the time that the flightcrew member spent in a suitable accommodation up to the maximum flight duty period of [13] hours.

(b) No certificate holder may schedule and no flightcrew member may accept more than four consecutive split duty periods without an FAA-approved FRMS.

(c) Following consecutive split duty periods, no certificate holder may schedule and no flightcrew member may accept a [shift] in report time for a duty period that encompasses the WOCL to a duty period that does not encompass the WOCL without the flightcrew member being given 30 hours free of all duty.

§ 117.21 Flight duty period: Augmented flightcrew.

See attached September 1, 2009, CAA proposal.

See attached NACA proposal.

(a) In the event scheduled operations cannot be conducted in accordance with the flight duty period limits in § 117.17, the flight duty period may be extended by augmenting the flightcrew.

(b) *Acclimated.* For flight operations conducted with an acclimated augmented flightcrew, no certificate holder may assign and no flightcrew member may accept an assignment if the scheduled flight duty period will exceed the limits specified in table C:

Table C—Flight Duty Period: Acclimated Augmented Flightcrew

Time of Start (Local Time)	Maximum Flight Duty Period (hours) Based on Rest Facility and Number of Pilots					
	Class 1 Rest Facility		Class 2 Rest Facility		Class 3 Rest Facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000-0559	13:50	16:05	12:55	14:20	11:45	12:15
0600-0659	15:10	17:40	14:10	15:40	12:55	13:25
0700-1259	16:30	19:20	15:25	17:05	14	14:30
1300-1659	15:10	17:40	14:10	15:40	12:50	13:20
1700-2359	13:50	16:05	12:55	14:20	11:45	12:15

(c) *Nonacclimated*. Except as provided in paragraph (d), for flight operations conducted with a nonacclimated augmented flightcrew, no certificate holder may assign and no flightcrew member may accept an assignment if the scheduled flight duty period will exceed the limits specified in table D:

Table D—Flight Duty Period: Nonacclimated Augmented Flightcrew

Time of Start (Home Base)	Maximum Flight Duty Period (hours) Based on Rest Facility and Number of Pilots					
	Class 1 Rest Facility		Class 2 Rest Facility		Class 3 Rest Facility	
	3 Pilot	4 Pilot	3 Pilot	4 Pilot	3 Pilot	4 Pilot
0000-0559	13:15	15:20	12:20	13:35	11:15	11:45
0600-0659	14:30	17	13:35	15	12:15	12:50
0700-1259	15:50	18:30	14:50	16:25	13:30	14
1300-1659	14:30	17	13:35	15	12:20	12:45
1700-2359	13:15	15:20	12:20	13:35	11:15	11:40

(d) (Option 1) *Multiple flight segments*. No certificate holder may assign and no flightcrew member may accept an assignment involving multiple flights segments under this section unless a [1 hour and 30 minute consecutive period] is available for in-flight rest on each flight segment for a flightcrew member.

(d) (Option 2) Multiple flight segments. No certificate holder may assign and no flightcrew member may accept an assignment involving a maximum of two flight segments with one flight segment greater than 7 hours of flight time under this section unless during the flight duty period—

(1) [2 consecutive hours] is available during the flight duty period for in-flight rest for the flightcrew member at the controls during landing,

(2) [1 hour and 30 minute consecutive period] is available for in-flight rest for the additional flightcrew member, and

(3) No flight segment must follow the greater than 7-hour flight segment.

(e) No certificate holder may assign and no flightcrew member may accept an assignment involving three or more flight segments under this section unless the certificate holder has an approved FRMS.

§ 117.23 Flight duty period: Single flightcrew member operations.

The ARC had no recommendation on this subject.

§ 117.25 Flight duty period: Extension.

(a) In the event unforeseen circumstances arise, the pilot in command and certificate holder may extend a flight duty period under §§ 117.17 and 117.23 up to 2 hours.

(b) In the event unforeseen circumstances arise, the pilot in command and certificate holder may extend a flight duty period under §§ 117.21 up to [3 hours][2 hours].

(c) An extension in the flight duty period must not occur on any consecutive calendar day or [x number of times/hours] in any 168 consecutive hour period.

§ 117.27 Deadhead transportation.

(a) Time spent in deadhead transportation is considered part of a flight duty period if it occurs before a flight segment without an intervening required rest period.

(b) Time spent in deadhead transportation is considered part of a duty period if it—

(1) Occurs after the final flight segment within a flight duty period or

(2) Consists entirely of time spent in deadhead transportation.

(c) Time spent entirely in deadhead transportation during a duty period must not exceed the flight duty period limit in table B of § 117.17 for the applicable time of start plus 2 hours.[Option 1]

(c) No duty period that consists entirely of time spent in deadhead transportation can exceed [21] hours and the flightcrew member must travel in a Class 2 rest facility. [Option 2]

(c) A flightcrew member whose duty period consists entirely of time spent in deadhead transportation must be given a rest period equal to the length of the deadhead transportation but not less than the required rest in § 117.33 upon completion of such transportation. [Option 3]

(c) A flightcrew member whose duty period consists entirely of time spent in deadhead transportation must be given a rest period equal to the length of the deadhead transportation multiplied by 1.5 but not less than the required rest in § 117.33 upon completion of such transportation. [Option 4]

See attached September 1, 2009, CAA Proposal. [Option 5]]

§ 117.29 Reserve duty.

(a) No certificate holder may schedule and no reserve flightcrew member may accept an assignment if the scheduled reserve duty period will exceed the limits specified in table E [(1)/(2)]:

Table E(1)—Reserve Duty Period: Nonaugmented Operations

Time of Start of RAP (Home Base or Acclimated)	Maximum Flight Reserve Duty Period (hours) Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000-0359	13	13	13	13	13	13	13
0400-0459	14	14	13	13	13	13	13
0500-0559	15	15	15	15	14	13.5	13
0600-0659	16	16	16	16	15	15	14.5
0700-1259	16	16	16	16	16	16	15
1300-1659	16	16	16	16	15.5	15	14.5
1700-2159	15	15	14	14	13.5	13	13
2200-2259	14.5	14.5	13.5	13.5	13	13	13
2300-2359	13.5	13.5	13	13	13	13	13

Table E(2)—Reserve Duty Period: Nonaugmented Operations

Time of Start RAP (Home Base or Acclimated)	Maximum Reserve Duty Period (hours) Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000-0159	13	13	13	13	13	13	13
0200-0459	14	14	14	14	13	13	13
0500-0659	16	16	16	16	15.5	15	14.5
0700-1259	16	16	16	16	16	16	15.5
1300-1659	16	16	16	16	15.5	15	14.5
1700-2159	15	15	15	15	13	13	13
2200-2259	14.5	14.5	14.5	14.5	13	13	13
2300-2359	13.5	13.5	13.5	13.5	13	13	13

(b) If all or a portion of a reserve flightcrew member's reserve availability period falls between 0000 and 0600, the certificate holder may increase the maximum reserve duty period in table [E(1)/E(2)] by one-half of the length of the time during the reserve availability period in which the certificate holder did not contact the flightcrew member, not to exceed 3 hours; however, the maximum reserve duty period may not exceed 16 hours.

(c) If a reserve flightcrew member is assigned as part of an augmented flightcrew, the maximum reserve duty period must not exceed the flight duty periods in tables C and D in § 117.21 plus 4 hours.

(d) No certificate holder may schedule and no reserve flightcrew member on short call reserve may accept an assignment for a reserve duty period that will exceed 14 hours.

(e) No certificate holder may schedule and no reserve flightcrew member on short call reserve may accept an assignment for a flight duty period that begins before the flightcrew member's next reserve availability period unless the flightcrew member is given at least 14 hours rest.

(f) No certificate holder may schedule and no reserve flightcrew member on long call reserve may accept an assignment for—

(1) A long call reserve duty period or conversion to a short call reserve duty period unless the flightcrew member receives the required rest period specified in § 117.33.

(2) A long call reserve duty period that will begin before and operate into the flightcrew member's window of circadian low unless the flightcrew member receives 12 hours of notice from the certificate holder.

(g) Before and after each reserve availability period, a reserve flightcrew member must be given at least the required rest period specified in § 117.33.

(h) A certificate holder may shift a reserve flightcrew member's reserve availability period under the following conditions:

(1) A shift to a later reserve availability period must not exceed 12 hours.

(2) A shift to an earlier reserve availability period must not exceed 5 hours, unless the shift is into the flightcrew member's window of circadian low, in which case the shift must not exceed 3 hours.

(3) A shift to an earlier reserve period must not occur on any consecutive calendar days.

(4) The total shifts in a reserve availability period in paragraphs (h)(1) through (h)(3) must not exceed 12 hours in any 168 consecutive hours.

§ 117.31 Cumulative fatigue limitations.

See attached September 1, 2009, CAA proposal.

See attached NACA proposal.

(a) No certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total flight duty period in any commercial flying will exceed the following:

(1) 60 flight duty period hours in any 168 consecutive hours and

(2) 190 flight duty period hours in any 672 consecutive hours.

(b) Except as provided for in paragraph (c) of this section, no certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total duty period in any commercial flying will exceed the following:

(1) 65 duty hours in any 168 consecutive hours and

(2) 200 duty hours in any 672 consecutive hours.

(c) Option 1. If a certificate holder transports a flightcrew member in deadhead transportation in a class 2 rest facility, the total duty period in any commercial flying must not exceed the following:

(1) 75 duty hours in any 168 consecutive hours and

(2) 215 duty hours in any 672 consecutive hours.

(c) Option 2. If a certificate holder transports a flightcrew member in deadhead transportation, the total duty period in any commercial flying must not exceed the following:

(1) 75 duty hours in any 168 consecutive hours and

(2) 215 duty hours in any 672 consecutive hours.

(d) No certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total flight time in any commercial flying will exceed the following:

(1) 100 hours in any 28 consecutive calendar day period and

(2) [900 or 1,200] hours in any 365 consecutive calendar day period.

(e) Before beginning any flight duty period, a flightcrew member must be given at least 30 consecutive hours free from all duty in any 168 consecutive hour period.

§ 117.33 Rest period.

(a) For operations conducted within the 48 contiguous United States and its territories and the District of Columbia—

(1) No certificate holder may schedule and no flightcrew member may accept an assignment for a flight duty period unless the flightcrew member is given a rest period of at least [10/12] consecutive hours before beginning the flight duty period.

(2) In the event of unforeseen circumstances, the pilot in command and certificate holder may reduce the [10/12] consecutive hour rest period to [9/10] consecutive hours.

(3) If a flightcrew member's actual series of flight duty periods impinge on the WOCL at least three times during the series, the flightcrew member must be given 2 physiological nights' rest upon return to home base.]

(4) No certificate holder may schedule a flightcrew member for more than three consecutive flight duty periods that infringe upon or encompass the entire WOCL unless the flightcrew member receives a minimum 14-hour rest before the fourth flight duty period infringing upon or encompassing the WOCL. Five consecutive flight duty periods infringing upon or encompassing the WOCL may be conducted only if the certificate holder has an fatigue risk management system approved by the FAA.

(b) For operations conducted outside the 48 contiguous United States and its territories and the District of Columbia—

(1) No certificate holder may schedule and no flightcrew member may accept an assignment for a flight duty period unless the flightcrew member is given a rest period of at least [12/14] consecutive hours before beginning the flight duty period, unless the

certificate holder's operations specifications allow dispatch and operation under domestic operating rules.

(2) In the event of unforeseen circumstances, the pilot in command and certificate holder may reduce the [12 or 14] consecutive hour rest period to [11 or 13] consecutive hours.

(c) No certificate holder may reduce a rest period on any consecutive calendar days or exceed [insert number of hours or occurrences]] in any 168 consecutive hour period.

(d) No certificate holder may schedule a flightcrew member for a reduced rest period.

(e) No certificate holder may assign and no flightcrew member may accept assignment to any duty with the certificate holder during any required rest period.

(f) Transportation local in nature that exceeds 30 minutes may not be included in required rest and must be accounted for to provide the minimum rest specified in this section.

[(g) *Recovery rest.*

(1) If a flightcrew member crosses more than four time zones during an actual series of flight duty periods that exceed 168 consecutive hours, the flightcrew member must be given a minimum 3 physiological nights' rest upon return to home base.

(2) A flightcrew member operating in a new theater must receive 36 hours of consecutive rest in any 168 consecutive hour period for recovery rest.

(3) A certificate holder must not schedule a flightcrew member between international rests for more than two rest periods between 18 and 30 hours in length while that flightcrew member is operating in a new theater; the rest periods must not be consecutive.

(h) Consecutive circadian disruptive layovers. [Option 1] For flightcrews consisting of three flightcrew members—

If …	Then the flightcrew member must receive…
(1) A flightcrew member is scheduled for a rest period of at least [20 or 28] consecutive hours;	2 physiological nights' rest or
(2) The total time of two scheduled flight duty periods with the scheduled intervening rest period is > [22 or 24] hours; and	1 physiological night's rest and the certificate holder may not schedule and the flightcrew member may not accept a flight duty period > 8 hours.
(3) The flightcrew member returns to his or her acclimated theater following the second flight duty period	

(h) Consecutive circadian disruptive layovers. [Option 2]

If …	Then the flightcrew member must receive…
(1) A flightcrew member is scheduled for any sequence of flight duty periods separated by [20 or 28] hour layovers that result in a shift in report time between flight duty periods of 8 hours or greater or	
(2) For flightcrews consisting of three flightcrew members. A flightcrew member is scheduled for a rest period of at least [20 or 28] consecutive hours;	2 physiological nights' rest or
The total time of two scheduled flight duty periods with the scheduled intervening rest period is > [22 or 24] hours; and	1 physiological night's rest and the certificate holder may not schedule and the flightcrew member may not accept a flight duty period > 8 hours.
The flightcrew member returns to his or her acclimated theater following the second flight duty period	

§ 117.35 Records and reports.

Each certificate holder must report scheduling reliability data to the FAA every [1 month] [2 months] in a form and manner prescribed by the FAA.

[Placeholder for other records and reporting requirements.]

Issued in Washington, DC, on .

[insert signature information]

ATTACHMENT I
Cargo Air Carrier Association Proposal

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

RECOMMENDATIONS AND PROPOSAL OF THE CARGO AIRLINE ASSOCIATION SUBMITTED TO THE AVIATION RULEMAKING COMMITTEE FOR FLIGHT/DUTY TIME LIMITATIONS AND REST REQUIREMENTS

Stephen Alterman, President
Yvette A. Rose, Senior Vice President
Cargo Airline Association
1220 19th Street, N.W., Suite 400
Washington, D.C. 20036
Tel. 202-293-1030

Robert E. Cohn
Patrick R. Rizzi
Hogan & Hartson LLP
555 13th Street, N.W.
Washington D.C. 20006
Tel. 202-637-4999

September 1, 2009

\\\DC - 026524/000001 - 2946833 v6

I. INTRODUCTION

The Cargo Airline Association[1] ("CAA") urges the Aviation Rulemaking Committee to recommend, and the FAA to adopt, the following proposal *for all-cargo carriers* as part of any new regulation regarding flight/duty time limitations and rest requirements (the "CAA Proposal" or "Proposal").[2]

The CAA Proposal represents the culmination of intense efforts, numerous meetings, active participation in the ARC, consultations with scientists and fatigue experts such as Dr. R. Curtis Graeber, Ph.D. ("Dr. Graeber"), internal modeling, and operational analyses by CAA members. The CAA has analyzed numerous permutations of possible regulations for all-cargo operations, and this Proposal is the final result of that effort. As is readily apparent, the result is not designed to allow all-cargo airlines a free pass to avoid impacts on their operations – far, far from it. If adopted by the FAA, the CAA Proposal will impose substantial costs and significant scheduling and operational burdens on all-cargo carriers.

The CAA Proposal reflects an appropriate balance between FAA's safety objectives and the needs of the global all-cargo industry, and is supported by available science. Indeed, as noted above, the CAA has retained the services of Dr. Graeber to assist the Association in the development of this Proposal. Dr. Graeber is a highly reputed expert in the field of fatigue science. His biography is attached as Exhibit CAA-1.

It is the CAA's position that "one-size-fits-all" regulations governing flight/duty time limitations and rest requirements that fail to address the attributes of all-cargo operations would:

---

1 The Cargo Airline Association is the nationwide organization representing the interests of the leading U.S. all-cargo carriers before federal administrative agencies, Congress, and various states and localities throughout the United States. All-cargo airline members of the CAA include ABX Air, Atlas Air, Capital Cargo, FedEx Express, First Air, Kalitta Air, and UPS.

2 Individual airline members of the CAA reserve the right to submit separate comments on FAA proposals at the appropriate time in the rulemaking process.

(i) be unsafe;

(ii) not be supported by science validated in all-cargo aviation operations;

(iii) undermine U.S. all-cargo carrier global competitiveness;

(iv) adversely affect military air transport support for the national defense;

(v) adversely affect air transport support for international humanitarian efforts; and,

(vi) substantially increase costs and result in significant service reductions for individuals, businesses, government agencies, and communities that rely on CAA members' services.

Indeed, FAA Administrator Randy Babbitt recently warned about the dangers of a "one-size-fits-all" approach when he discussed this very ARC: "In rulemaking, not only does one size *not* fit all, but *it's unsafe to think that it can*."[3]

Comments on ARC Process. Preliminarily, the CAA remains concerned with the way the ARC processes developed and the discussions that took place as a result of the decisions made at the beginning of the Committee's work. The first job of any body studying the effects of pilot fatigue on aviation safety should be to study and isolate the causes of *aviation* fatigue, including evaluating varying segments of the U.S. air transport industry. After establishing such causes, the body should examine various actions that could be tailored to mitigate the causes of fatigue, again looking at the varying segments of the industry. After those studies are completed — supported by scientific validation to the aviation industry — several alternative regulatory recommendations can be developed to address the issues at hand. Unfortunately, this was not the path taken by the ARC. Instead, from the outset, under an extremely accelerated timeframe, the overwhelming majority of the discussions (e.g., debates) within the ARC were essentially labor-

[3] *We Can't Regulate Professionalism*, Speech of FAA Administrator J. Randolph Babbitt to the ALPA Air Safety Forum, August 5, 2009 (emphasis added).

management negotiations over reductions to current limitations on hours of duty and flight time, which might, or might not, correctly address the primary causes of fatigue in the aviation industry. Pushed to the side, with little or no discussion, were the other significant elements that might create unsafe conditions – elements such as pre-duty activities and conditions, i.e., excessive commuting, working second jobs, and the identification of medical sleep disorders.

In addition, it appears that certain ARC leaders, at least initially, had a pre-set disposition to focus on regulatory proposals that would address the business model of the major domestic legacy passenger carriers, with little recognition given to other important industry segments — such as the all-cargo industry — that have very different operational characteristics that demand different responses and fatigue mitigation strategies.[4] Fortunately, as noted above, FAA Administrator Randy Babbitt acknowledged that "one size doesn't fit all," and, after about a month of ARC activity, the FAA recognized the importance of exploring these differences and expressly invited the all-cargo industry to submit a proposal for the FAA's consideration. CAA's formal presentation was made to the ARC on August 25, 2009, and is hereby submitted for the official record and as part of this submission. (Exhibit CAA-2 attached hereto.)

The CAA Proposal described herein maintains and enhances safety standards for *all-cargo operations*, while, at the same time, recognizes the attributes of the all-cargo operating environment.[5] Accounting for the attributes of global all-cargo carriers in FAA flight duty/rest rules is not a new concept. Supplemental/non-scheduled carriers have long operated under separate regulations for flight/duty time limitations as compared to the domestic passenger rules.

---

[4] The preliminary meeting minutes from the ARC reflect this bias as well, describing assertions made by certain ARC participants as fact rather than opinion, claiming consensus when, in fact, there was none, and detailing labor-side positions with little or no discussion of the positions espoused by industry participants such as the CAA. The CAA has separately submitted to the ARC co-chairmen, for submission into the record, a mark-up of the ARC meeting minutes reflecting a more complete and accurate recitation of the ARC discussions.

[5] The CAA intends to submit specific regulatory language reflecting this Proposal to the FAA in the near future.

In addition, the CAA Proposal strongly supports the development of Fatigue Risk Management Systems ("FRMS") to collect data and validate fatigue science in the context of aviation operations. CAA members plan to adjust their fatigue mitigation programs as the scientific evidence on the effects of fatigue matures through the FRMS process, and to enhance their already robust fatigue mitigation education and training.

II. GUIDING PRINCIPLES UNDERLYING THE CAA PROPOSAL

Several fundamental guiding principles were used by the CAA in the development of this Proposal. The CAA agrees that fatigue is a legitimate flight safety concern warranting reasonable regulation and further scientific study and data collection. The CAA also acknowledges that the *status quo* is not acceptable and that improved safety requires changes to the current regulations governing flight time, duty periods, and required rest. Although the CAA recognizes the need to apply science in this effort, it also understands that the current aeromedical knowledge on fatigue is extremely limited, immature, and has not been scientifically validated in the aviation environment. As a result, the CAA strongly supports the development of an FRMS. And, given the critical deficiency in current aeromedical knowledge on fatigue, the CAA also relied on field science (operational experience) in developing this Proposal, particularly the combined extensive operational experience of its members in operating long-haul, international, backside-of-the-clock operations. And, as previously noted, the CAA was assisted in the development of its Proposal by Dr. Graeber, a renowned expert in the field of fatigue science.

The CAA firmly objects to and opposes any "one-size-fits-all" approach in this critically important ARC and the related rulemaking based on the assumption that the entire industry is operationally homogenous. Such an approach is unacceptable, not only because it would adversely affect our nation's defense, impose substantial costs and unwarranted burdens on the vitally important all-cargo air transportation industry, and undermine U.S. all-cargo carrier competitiveness without any corresponding enhancement of safety, but also because it is – as Administrator Babbitt recently said after initiating this ARC – "unsafe." In light of the safety, competitive, and economic risks associated with such an approach, it is critically important that the FAA "get it right" when revising these regulations, and that necessarily means ensuring that the collective needs and attributes of the all-cargo industry are properly reflected in any final rule the FAA promulgates.

Last year, the Assistant Division Manager of the FAA's Air Transportation Division said that "[w]e must find the right balance of safety, science, cost and operational efficiency regarding amendments to our current rules" in a presentation on crewmember flight, duty and rest requirements.[6] The CAA Proposal meets that objective: It maintains and enhances safety for all-cargo operations, while allowing U.S. all-cargo carriers to remain competitive in light of the distinct environment in which they operate.

A. A "ONE-SIZE-FITS-ALL" REGULATION BASED ON THE OPERATIONS OF DOMESTIC PASSENGER CARRIERS IS NEITHER ACCEPTABLE NOR REGULATORILY JUSTIFIABLE FOR GLOBAL ALL-CARGO CARRIERS.

The all-cargo industry is comprised of both scheduled and on-demand operators providing a worldwide network of air transportation and delivery services. The CAA members with express pickup and package delivery services are a core component of our nation's economy, with customers ranging from an individual or small business in a rural community, to

---

6 Crewmember Flight, Duty and Rest Requirements: FAA Regulations, Initiatives, and Challenges, Presentation by G. Kirkland, FAA, at the FAA Fatigue Management Symposium: Partnerships for Solutions, June 17-19, 2008.

government agencies, to multi-billion dollar corporations shipping packages or heavy freight all over the world. CAA members also provide the Department of Defense, State Department, other government agencies, and non-governmental organizations ("NGOs") such as the United Nations and the World Health Organization, with mission-critical airlift services to virtually all points in the world in support of important military, diplomatic, and humanitarian efforts. In short, the all-cargo air transportation services of CAA members are essential for individuals, businesses, communities, NGOs, the U.S. Government, the national and global economy, and our nation's defense.

The United States all-cargo industry transported 28.9 billion Revenue Ton Miles (RTMs) of cargo in 2007 – 12.7 billion in domestic operations and 16.1 billion internationally. Over 80% of domestic RTMs are flown by the all-cargo segment of the industry and over 65% of international RTMs are generated by the cargo carriers.[7] In 2008, the air cargo industry contributed more than $37 billion to the U.S. economy.[8]

All-cargo carriers/CAA members provide substantial service for the Department of Defense, including the U.S. Air Mobility Command, in support of military operations throughout the world. One of our members, Atlas Air, is one of the largest providers of commercial airlift in the wide-body cargo segment for the Air Mobility Command. Simply put, CAA members provide a massive amount of critically important cargo airlift to various customers in support of commercial, humanitarian, diplomatic, and national defense activities.

To provide these vitally important services in a safe and efficient manner, however, global all-cargo carriers operate in a relatively different environment than U.S. passenger airlines. For example, unlike domestic passenger carriers, all-cargo carriers generally do not

---

[7] FAA Aerospace Forecast, Fiscal Years 2009-2025 (March 2009), at 38-39, 78.

[8] Aviation Safety: Better Data and Targeted FAA Efforts Needed to Identify and Address Safety Issues of Small All-Cargo Carriers, GAO 09-614, at 1 (June 2009).

maintain U.S. domicile bases and regularly operate long-haul flights and point-to-point operations outside of the United States at night and during the backside-of-the-clock, traveling across multiple time zones. All-cargo carriers also regularly operate around-the-world in all directions with extended overseas routings, not quick overnight turns at foreign destinations (e.g., NYC-London-NYC). These backside-of-the-clock and around-the-world operations are the norm for all-cargo carriers, and their experienced flight crews come prepared to fly such operations.

Unlike destinations served by domestic passenger carriers, all-cargo carriers operate service to remote, undeveloped, and even hostile locations requiring timely turnaround capabilities because the pre-positioning of reserve crews at such locations is not possible and the local infrastructure can be minimal (e.g., Bagram Air Base, Afghanistan). All-cargo operations are also typically driven by the customer's schedule, which is often unpredictable, rather than a pre-published schedule from which the customer chooses. In addition, given that the all-cargo air transportation industry regularly operates from ad hoc locations around the world, the traditional crew base model upon which other airline operations are based does not always apply.

Importantly, regardless of whether in the air or on the ground, all-cargo crews have more, longer, and better rest opportunities during a duty period than their domestic passenger counterparts. For example, all-cargo carriers that fly into a hub for package sorting purposes provide their crews with an opportunity for up to four hours' rest in a horizontal sleep facility during the night prior to the next launch while the sort is being done. In this regard, FedEx and UPS have invested millions of dollars to provide their flight crews with lie-flat sleeping room facilities with climate control at their principal U.S. hubs during the package sorting process to facilitate sleep and mitigate fatigue. In addition, all-cargo flight crews have better opportunities for in-flight rest because there are no distractions and noise from passengers and flight attendants to diminish or interrupt the integrity of the rest opportunity. And, these in-flight rest opportunities for long-haul, all-cargo flight crews are enhanced even further because CAA members have invested millions of dollars in high-quality, lie-flat bunks or substantially reclined rest facilities on-board their long-haul aircraft. (e.g., Atlas Air's B-747-400s). In addition, all-cargo pilots typically make fewer annual landings and fly fewer annual hours than their counterparts operating passenger service. The average annual flight hours for a pilot at a major all-cargo carrier ranges between 250-300 hours, well below the average annual flight hours for pilots at passenger carriers.

As explained above, the attributes of global all-cargo carrier operations relative to other air transportation services (e.g., passenger) are indisputable. Failure to adopt the CAA Proposal, which properly accounts for these all-cargo attributes, as part of any new final rule would substantially and detrimentally affect the vitally important cargo air transportation services upon which individuals, businesses, NGOs, government agencies, and the U.S. military have come to rely. For example, any failure to account for the operational characteristics of long-haul, all-cargo global carriers would adversely and materially impact the U.S. military (for whom CAA members provide substantial airlift) by making it difficult or impossible to provide such airlift to the U.S. military for national defense purposes, or, at a minimum, by significantly increasing the costs of providing such vital support services. Similarly, any such failure would also substantially increase costs on commercial all-cargo operations with the result being that individuals, businesses, and communities will face much higher costs for all-cargo service and a significant reduction in such services.

The CAA Proposal properly reflects the all-cargo industry's operational attributes and enhances safety based both on the aeromedical knowledge currently available and on our members' extensive operational experience.

B. CURRENT AEROMEDICAL KNOWLEDGE ABOUT FATIGUE IS EXTREMELY LIMITED AND NOT SCIENTIFICALLY VALIDATED IN THE AVIATION ENVIRONMENT.

The CAA acknowledges that fatigue-induced degradation of a flight crewmember's performance must be mitigated. However, the current regulations on flight/duty time and rest requirements are not anchored in science, nor do they account for the improved crew understanding and ability to deal with sleep-performance issues that has resulted from the training that CAA members have provided to their flight crews. On this point, the Fatigue Countermeasures Subcommittee of the Aerospace Human Factors Committee of the Aerospace Medical Association recently noted: "The prescriptive rule-making approach commonly used by regulatory agencies to regulate crew rest and flight and duty times ***is not derived from the foundational scientific research*** addressing the interaction of sleep and circadian processes and their effects on performance."[9] Similarly, Dr. Graeber recently pointed out: "The Federal Aviation Administration (FAA) regulations governing flight time limitations are no different. They also ***lack a sound scientific basis*** and have remained essentially unchanged for the last fifty years."[10] Simply put, it is beyond reasonable dispute that the science and data on fatigue in aviation operations are still developing, and thus the FAA must be wary of unintended, safety-

---

[9] Fatigue Countermeasures in Aviation, Position Paper, Aerospace Medical Association Fatigue Countermeasures Subcommittee of the Aerospace Human Factors Committee, Aviation, Space, and Environmental Medicine, Vol. 80 No. 1, at 33 (Jan. 2009) (emphasis added).

[10] Testimony of R. Curtis Graeber, Ph.D., before the House Aviation Subcommittee Hearing on Regional Air Carriers and Pilot Workforce Issues, June 11, 2009, at 2 (emphasis added) ("Dr. Graeber Testimony").

reducing consequences from any new regulations based on limited, immature or incomplete science.

In fact, despite the claims about the consequences of fatigue resulting from night-time and backside-of-the-clock operations which all-cargo carriers perform, the large aircraft all-cargo industry has an enviable safety record.[11] In a recent study conducted by the Government Accountability Office ("GAO"), it was concluded that "… they (all-cargo accident rates among the large aircraft all-cargo operators) were comparable to accident rates for large passenger carriers in 2007."[12]

To summarize, the immaturity and need for the ongoing development of scientifically-validated knowledge about fatigue in aviation operations is widely acknowledged. For example, current science and aeromedical knowledge on fatigue does not take into account consistent backside-of-the-clock flying or the attributes of global, on-demand all-cargo operations and the effects on a flight crewmember's performance over an extended period of time (e.g., one month). And, even where agreement exists and science has validated certain general principles about the human body clock and fatigue, the effects of those general principles in real-world operating environments, such as backside-of-the-clock, round-the-world all-cargo operations, have not been scientifically validated.

Indeed, rather than continuing down the regulatory road toward new prescriptive regulations, some experts advocate the development of a far more dynamic FRMS to better understand, prevent, and mitigate fatigue in aviation operations. The CAA strongly supports the development of such a dynamic FRMS based on specific real-world experiences and the

---

[11] CAA members all operate large, transport-category aircraft. Safety issues involving small, Part 135 carriers are not addressed herein.

[12] Aviation Safety: Better Data and Targeted FAA Efforts Needed to Identify and Address Safety Issues of Small All-Cargo Carriers, GAO 09-614, at Preamble (June 2009).

implementation of the three-pronged approach underlying any FRMS (prevention, mitigation, intervention).

III. THE CAA PROPOSAL

The CAA Proposal represents the culmination of intense efforts, numerous meetings, active participation in the ARC, consultations with scientists and fatigue experts, internal modeling, and operational analyses by CAA members. Importantly, it does not constitute an "opening" position with padded numbers or "slack" driven by any assumption that the FAA would eventually revise it to be more operationally restrictive. The CAA has analyzed numerous permutations of possible regulations for all-cargo operations, and this Proposal is the final result of that extensive and detailed effort. And, as noted above, if adopted as part of any final regulation, the CAA Proposal will impose substantial costs and significant scheduling and operational burdens on all-cargo carriers.

By way of overview, the CAA Proposal:

- recognizes the distinct aspects of **domestic vs. international** operations for all-cargo carriers;
- **establishes limits** in areas where there are **no limits currently**;
- accounts for the **time of day ("Window of Circadian Low" or "WOCL");**
- addresses the crossing of **multiple time zones ("acclimatization")**;
- **reduces** the **flight duty periods** for domestic and international operations from those in the current FARs; and
- **increases** the **required rest periods** for domestic and international operations from those in the current FARs.

In sum, the CAA Proposal enhances safety based on current science and aeromedical knowledge as well as the extensive operational experience of CAA members and their flight crews, while accounting for the essential characteristics of the all-cargo operating environment.

A. LIMITATIONS ON FLIGHT TIME ARE NOT NECESSARY TO ENHANCE SAFETY.

Rest is the key to preventing and combating fatigue in aviation operations. Eight hours of sleep is generally recognized as the average amount of sleep an individual needs to avoid sleep deprivation and to prevent cumulative sleep debt. Dr. Graeber recently stated that "(e)ight hours of sleep opportunity is much more important than time on task, duty time, etc. for assuring safe levels of alertness,"[13] and Drs. Belenky and Hursh told the ARC "that eight hours is sufficient to restore the average person, but individuals are subject to variation."[14] "Rest" for a flight crewmember, however, can be protected by flight duty period limitations and rest period requirements, without any need to establish limits on flight time as the current FARs do.

Thus, limitations on maximum flight duty period and minimum requirements for rest go hand-in-hand to fully address fatigue, and there is no need to promulgate any limitations on the amount of flight time within the prescribed flight duty period. We note that the international standards, e.g., CAP 371, do not regulate daily flight time. And, in fact, the FAA considered a "no daily flight time limit" option in its October 2002 Draft Regulatory Impact Analysis stating:

> "Under Option Three, the FAA proposes no daily flight time limit, for any size crew. Under this option the duty period limit and rest period requirements would provide the protection against fatigue. This option provides more scheduling flexibility than option one or option two for certificate holders and flight crews. The FAA does not believe this would result in overly tiring flight schedules, because with multiple takeoffs and landings, it would be difficult to accumulate more than 8 to 10 hours of actual flight time for domestic operations. Conversely,

---

13 R. Curtis Graeber, Ph.D. (August 2009).

14 ARC, RoM, July 21/23, 2009.

> the long-haul operations with only one or two landings per duty period, which are less tiring, could be completed by a flight crew of 2 pilots within the fourteen-hour duty period, while still providing a 10-hour rest before each duty period."[15]

The FAA should follow that approach and not adopt a flight time limitation.[16]

The CAA Proposal described below establishes flight duty periods that account for the WOCL, acclimatization, and the number of sectors. The Proposal's flight duty periods are shorter than those in the current FARs; its rest requirements are longer than those in the current FARs; and it provides for certain cumulative flight time limitations (e.g., annual). This robust combination of the flight duty period limitations and rest requirements in the CAA Proposal provides more-than-adequate safety against fatigue without the need for any limitations on flight time within a duty period. Therefore, as an initial position, the CAA urges the ARC and the FAA to refrain, respectively, from endorsing and issuing regulations with flight time restrictions.

That said, the CAA understands that revisions to the current flight time limitations are being considered by the ARC and the FAA. Accordingly, the CAA Proposal outlined below does include CAA's recommendations for flight time limitations in the event that the FAA determines to adopt flight time limitations as part of any new rule.

B. THE CAA PROPOSAL FOR FLIGHT/DUTY TIME AND REST REQUIREMENTS FOR DOMESTIC ALL-CARGO OPERATIONS.

For purposes of all-cargo operations, it is essential that any flight/duty time limitations and rest requirements distinguish between domestic and international operations. The two sets of operations are distinct, with different operational requirements and different fatigue

---

15 Draft Regulatory Impact Analysis, Initial Regulatory Flexibility Analysis, International Trade Impact Assessment, and Unfunded Mandates Assessment: Flight Crewmember Duty, Flight and Rest Requirements (Part 121) – NPRM (October 2002), at 6-7 (hereinafter, "FAA's October 2002 Draft Regulatory Impact Analysis").

16 In the event the FAA determines to adopt a daily flight time limitation, the CAA is submitting an alternative proposal which contains a recommendation for flight time limits for all-cargo operations.

countermeasures. Indeed, the current FARs governing supplemental operations make a distinction between the two sets of operations. See, e.g., 14 C.F.R. § 121.513 "Flight time limitations: Overseas and international operations: airplanes."

For its definition of "domestic operations," the CAA Proposal invokes the geographic parts of the definition of "domestic operations" from 14 C.F.R. § 119.3, with a relatively minor modification to provide the Administrator with expanded authority to designate certain other operations as "domestic operations."

> For purposes of this Section, "Domestic Operations" are:
>
> (i) Operations between any points within the 48 contiguous States of the United States or the District of Columbia; or
>
> (ii) Operations solely within the 48 contiguous States of the United States or the District of Columbia; or
>
> (iii) Operations entirely within any State, territory, or possession of the United States; or
>
> (iv) When specifically authorized by the Administrator, operations between any point within the 48 contiguous States of the United States or the District of Columbia and any specifically authorized point located outside of the 48 contiguous States of the United States or the District of Columbia, or operations between any two specifically authorized points located outside of the 48 contiguous States of the United States.

This definition provides a bright-line distinction between domestic and international operations based on what all-cargo carriers have long understood to be the distinction, while permitting all-cargo carriers to petition the Administrator as their operations evolve to specifically designate certain other operations as "domestic" operations for purposes of the flight/duty time and rest regulations. This definition of "domestic operations" is not to be confused with the definition of "acclimatization," an entirely different concept which the CAA recognizes and which is defined in terms of number of time zones (as explained below).

In terms of limitations and requirements, the CAA Proposal for domestic all-cargo operations addresses flight duty period ("FDP") and rest. It also accounts for the WOCL, the number of sectors, and operational irregularities based on the substantial operational experience of CAA members and the limited science available.

Flight Duty Period. The FDP for domestic all-cargo operations ranges from 9 hours to 13 hours depending on the time of start at the designated base and the number of sectors. For any FDP encompassing or occurring during the "WOCL" period of 0200-0459, the FDP is limited to 11 hours for 1-to-4 sectors and further limited to 9 hours for 5+ sectors. The FDP for the other periods of 0500-1459 and 1500-1659 are longer because they are effectively outside the WOCL (with one exception[17]). For example, a flight crew starting from its designated base at 0800 has a flight duty period of 13 hours for 1-4 sectors and 11 hours for 5+ sectors. Regardless of the time of start or sectors flown, the CAA Proposal provides that an all-cargo carrier may extend an FDP for domestic all-cargo operations by two hours for "operational irregularities". The CAA Proposal considers "operational irregularities" to include conditions and requirements unforeseen or beyond the control of the certificate holder, including but not limited to weather conditions, aircraft equipment, air traffic control, acts of God, hostilities, etc. It is essential for the rule to permit such adjustments for events that are unforeseen or beyond the control of the all-cargo carrier.

Importantly, the CAA Proposal limiting FDPs for domestic all-cargo operations to 9-13 hours depending on the time of start and number of sectors is far more restrictive than the 16-hour FDP limitation in the current FARs for such operations, and the current FARs do not even account for the WOCL or number of sectors.

---

17 The limitations proposed for the late night/early morning periods do not encompass the 0500-0559 period of the WOCL because a flight crewmember reporting at 0500 will not start flying until at least 0600 because the pre-flight briefing period lasts at least one hour.

Rest Requirement. The CAA Proposal for domestic all-cargo operations sets the minimum rest period at 10 hours. This requirement acknowledges the generally understood science that concludes that 8 hours of sleep is the average amount of sleep an individual needs to avoid sleep deprivation and prevent cumulative sleep debt,[18] by providing an additional 2 hours for hotel transfers, personal hygiene needs, and to get "behind the door." This is also consistent with the FAA's October 2002 Draft Regulatory Impact Analysis, in which the FAA stated that the "FAA [had] found that 10 hours allows a flight crewmember the opportunity for approximately 8 hours of sleep which is generally recognized as the average amount of sleep an individual needs to avoid sleep deprivation and to prevent cumulative sleep debt."[19] The CAA Proposal provides for 25% more minimum rest than the current FARs, which require only 8 hours of rest.

Under the CAA Proposal, the 10-hour rest requirement is reducible to 9 hours at the carrier's discretion, but under the Proposal, this reduction can only be invoked once in any 168-hour look back period. As another safeguard, the CAA Proposal also requires at least one 24-hour rest period in any 168-hour look back (calculated from when the crewmember is scheduled to report for his or her FDP).

Flight Time. As explained above, the CAA submits that flight time restrictions are not needed, particularly given the FDP restrictions and rest requirements the CAA has proposed. Nonetheless, if the FAA decides to maintain some level of flight time restrictions, the CAA proposes that flight time for domestic all-cargo operations be limited to between 7 and 11 hours depending on time of start and number of sectors. For example, a crew starting between 0000

---

18 R. Curtis Graeber, Ph.D. (August 2009); ARC, RoM, July 21/23, 2009 (comments of Drs. Belenky and Hursh).

19 FAA's October 2002 Draft Regulatory Impact Analysis, at 2-3.

and 0459 and flying 5 sectors is limited to 7 total flight hours under the CAA Proposal, but a crew starting at 1200 and operating 2 sectors may fly up to 11 hours.

DOMESTIC ALL-CARGO OPERATIONS

(Metrics Stated in Hours)

	Flight Duty Period			Flight Time		Domestic Rest	
Time of Start (Designated Base)	**1 to 4 Sectors**	**5 + Sectors**	**Extensions for Operational Irregularities**	**1 to 4 Sectors**	**5+ Sectors**	**Minimum**	**In 168 Look Back**
0000-0459	11	9	+ 2	8	7		
0500-1459	13	11	+ 2	11	9		
1500-1659	12	10	+ 2	10	8		
1700-2359	11	9	+ 2	8	7	10*	24

* Reducible to 9 at certificate holder's discretion (can only occur once in any 168 hour look back)

In sum, the CAA Proposal for domestic all-cargo operations set forth above maintains and enhances safety standards for such operations, while recognizing the attributes of the domestic all-cargo operating environment.

C. THE CAA PROPOSAL FOR FLIGHT/DUTY TIME AND REST REQUIREMENTS FOR NON-AUGMENTED, INTERNATIONAL ALL-CARGO OPERATIONS.

As with domestic all-cargo operations, the CAA Proposal for non-augmented international all-cargo operations establishes limitations and requirements for flight duty period ("FDP") and rest. For the reasons discussed above, the CAA does not believe limitations on flight time are necessary. But if the FAA decides to include limitations on flight time, CAA's Proposal contains flight time recommendations.

Flight Duty Period. The FDP for non-augmented international all-cargo operations (2 pilot or 2 pilot and flight engineer) ranges from 11½ hours to 14 hours depending on whether the

FDP occurs during the WOCL, whether the crew is acclimatized, and the number of sectors. In the CAA Proposal, the WOCL for international all-cargo operations is defined as the period between 0200 and 0559 (which is generally understood to be the WOCL period), computed at the crewmember's acclimatized location. Furthermore, a crewmember becomes unacclimatized under the CAA Proposal after duties that exceed four time zones (with the continental United States considered as one time zone).

For example, the FDP for an unacclimatized crew operating five or more sectors within the WOCL is 11½ hours. The FDP for an unacclimatized crew operating 4 or fewer sectors outside of the WOCL is 13 hours. The FDP for an acclimatized crew operating 4 or fewer sectors within the WOCL period is 13½ hours, whereas the FDP for an acclimatized crew operating 1-4 sectors outside the WOCL period is 14 hours. As in the case of domestic operations, the CAA Proposal provides that an all-cargo carrier may extend an FDP for non-augmented international operations by two hours for operational irregularities.

As these examples and the Table below show, the CAA Proposal takes into account the WOCL, acclimatization, and number of sectors in international operations. Specifically, the FDP reduction under this Proposal for an unacclimatized crew is 1 hour, and the FDP reduction for WOCL operations is 30 minutes. The FDP reduction for 5 or more sectors is 1 hour.

Rest Requirement. The CAA Proposal mitigates the FDP for non-augmented international all-cargo operations by increasing the minimum rest period from 8 hours to 12 hours. The 12 hours consists of 8 hours for sleep and 4 additional hours for additional rest, transfers to/from sleeping facilities, and personal hygiene. By establishing a minimum rest of 12 hours, the CAA Proposal provides 50% more minimum rest than the current FARs, which require only 8 hours of rest for similar operations. The 12-hour limitation is reducible to 11 hours at the carrier's discretion, but this reduction can only be invoked once in any 168-hour look back period. As an additional fatigue mitigation countermeasure, the CAA Proposal also requires at least one 30-hour rest period in any 168-hour look back (calculated from when the crewmember is scheduled to report for his or her FDP).

Flight Time. If the FAA decides to maintain some level of flight time restrictions for non-augmented international operations, the CAA proposes that flight time be limited to 8-10 hours for 2-pilot crews depending on the WOCL and acclimatization, and 12 hours for a 2-pilot/1-flight engineer crew.

These Flight Duty Periods Are Critical. The baseline 14-hour FDP for acclimatized, non-augmented crews flying international operations outside the WOCL and the 13½-hour FDP for such crews operating within or through the WOCL is vitally important to the operations of all-cargo carriers. Each of the FDPs for non-augmented international all-cargo operations has been carefully analyzed and reduced to the shortest commercially reasonable and safe duration. Importantly, the FDPs proposed by the CAA for non-augmented international all-cargo operations of between 11½ hours and 14 hours are far more restrictive than the current FAR restriction of 16 hours, which current restriction does not even account for the WOCL, acclimatization or number of sectors.

Any further reduction in the FDP for these operations would impose massive burdens and costs on all-cargo carriers without any corresponding enhancement of safety. In some cases, it may preclude certain all-cargo operators from flying to certain destinations or on certain routings in an efficient and timely manner. For example, an all-cargo carrier operating from Europe to Afghanistan in support of military operations must ensure that its crew and aircraft do not remain on the ground longer than necessary in that remote and hostile environment. Indeed, it would be unsafe for the FAA to impose an FDP lower than that proposed by the CAA on such operations because it would preclude the crew and aircraft from departing such a location in a timely and safe manner.

Nonetheless, given the critical importance of the FDPs established in the CAA Proposal for the international all-cargo operations of CAA members, the CAA incorporated the following significant additional fatigue mitigation countermeasures in its Proposal:

- **increased the minimum rest** period from 8 hours (current FARs) and 10 hours (CAA Proposal – domestic all-cargo) to 12 hours;
- **reduced the FDP** from 16 hours (current FARs) to 11½ - 14 hours;
- **increased the cumulative rest period** (in a 168-hour look-back) from 24 hours (CAA Proposal – domestic) to 30 hours;
- **reduced maximum flight time** from 11 hours (CAA Proposal – domestic) to 8 hours (within the WOCL) and 10 hours (outside the WOCL);
- **established cumulative FDP limitations** of 75 hours and 215 hours in a 168-hour and 672-hour look back, respectively;
- provided a ½ hour **time-of-day/WOCL protection**; and
- imposed an **acclimatization penalty** of 1 hour.

Furthermore, the longest FDP in CAA's Proposal for non-augmented international all-cargo operations is 14 hours, and that FDP combined with the proposed 12-hour minimum rest period amounts to a period of more than 24 hours, which effectively builds in a night's break.

INTERNATIONAL ALL-CARGO OPERATIONS (Non-Augmented Crew)

(Metrics Stated in Hours and Minutes)

	Flight Duty Period			Flight Time		International Rest	
	International 2 Pilot/ 2 Pilot and Flight Engineer 1 to 4 sectors	International 2 Pilot/ 2 Pilot and Flight Engineer 5+ sectors	Extensions for Operational Irregularities	2 Pilot	2 Pilot and Flight Engineer	Minimum	In 168 Look Back
Unacclimatized/ WOCL	12:30	11:30	+ 2	8	12	12*	30
Unacclimatized/ Non-WOCL	13:00	12:00	+ 2	10	12	12*	30
Acclimatized/ WOCL	13:30	12:30	+ 2	8	12	12*	30
Acclimatized/ Non-WOCL	14:00	13:00	+ 2	10	12	12*	30

* Reducible to 11 at certificate holder's discretion (can only occur once in any 168 hour look back)

The CAA Proposal for international all-cargo operations with non-augmented crews set forth above maintains and enhances safety standards for such operations, while recognizing the distinct attributes of the international all-cargo operating environment.

D. THE CAA PROPOSAL FOR FLIGHT/DUTY TIME AND REST REQUIREMENTS FOR AUGMENTED INTERNATIONAL ALL-CARGO OPERATIONS.

The CAA Proposal for augmented international all-cargo operations establishes limitations and requirements for flight duty period ("FDP") and rest, and for flight time in the event the FAA decides to adopt a flight time limitation. This Proposal takes into consideration the type of sleep opportunity available, the number of sectors, and operational irregularities.

Flight Duty Period. The FDPs for augmented international all-cargo operations with 3 pilot or 3 pilot/2 flight engineer crews range from 14½ hours to 16½ hours. The longest FDPs of 16½ hours (1-2 sectors) and 15¾ hours (3-4 sectors) for these crews are possible only when a "horizontal sleep opportunity" is provided. A horizontal sleep opportunity includes lie-flat seating or on-board bunk facilities and is recognized as a fatigue mitigation countermeasure. See

Fatigue Countermeasures in Aviation – Position Paper, Aerospace Medical Association Fatigue Countermeasures Subcommittee of the Aerospace Human Factors Committee, Aviation, Space, and Environmental Medicine, Vol. 80 No. 1, at 52 ("[W]e concur with the present primary reliance on in-flight bunk rest in long-haul operations.").

CAA members have long-haul aircraft with on-board facilities for such horizontal sleep opportunities, and, as discussed earlier, these sleep opportunities are greatly enhanced by the fact that resting crewmembers on an all-cargo flight do not have deal with the noise, distraction, and commotion of passengers and flight attendants. If an augmented 3-pilot crew has access simply to a seat-type rest accommodation, the FDP is reduced to 14¾ hours for 1-2 sector operations and 14½ hours for 3-4 sector operations, thereby recognizing that seat-type rest accommodations do not provide the same quality of sleep opportunity as lie-flat or bunk facilities.

The FDPs for augmented international all-cargo operations with 4 pilot or 4 pilot/2 flight engineer crews range from 19½ hours (1-2 sectors) to 18¾ hours (3-4 sectors). These FDPs only apply to operations where the crew has access to "horizontal sleep opportunities" because CAA members do not envision any 4-pilot augmented crew operating aircraft without such rest accommodations.

In developing these FDPs for augmented international all-cargo operations, the CAA performed detailed calculations accounting for the quality of the in-flight rest opportunity, using conservative sleep factors. In this regard, science has generally determined that natural recuperative sleep has a value of 2x (8 hours of sleep for 16 hours awake), but CAA's calculations conservatively reduced that value further to a .75 sleep factor in the case of horizontal sleep opportunities and a .25 sleep factor in the case of seat-type rest accommodations. See ARC, RoM, July 21/23, 2009 ("Dr. Demitry states that an in-flight bunk provides roughly 75 percent of the restorative sleep value of conventional sleep facilities."). In addition, the CAA calculations factored in the pre-flight time and climb/descent periods when a "horizontal sleep opportunity" would not be possible. The detailed calculations underlying these FDPs are provided in CAA's Presentation to the ARC, attached hereto as Exhibit CAA-2, at 14-17.

As with the proposed FDPs for domestic all-cargo and international non-augmented all-cargo operations, the CAA Proposal provides that an all-cargo carrier may extend an FDP for augmented international operations by two hours for operational irregularities.

Rest Requirement. The CAA Proposal for augmented international all-cargo operations sets the minimum rest period at 12 hours with a requirement that there be at least one 30-hour rest period in any 168-hour look back. The 12-hour rest requirement acknowledges the generally understood science that 8 hours of sleep is the average amount of sleep an individual needs to avoid sleep deprivation and to prevent cumulative sleep debt, and provides a 4-hour cushion for additional rest, hotel transfers, and personal hygiene needs. The CAA Proposal provides 50% more minimum rest than the current FARs, which require only 8 hours of rest for similar operations. The 12-hour limitation is reducible to 11 hours at the carrier's discretion, but this reduction can only be invoked once in any 168-hour look back period.

Flight Time. If the FAA decides to maintain some level of flight time restrictions, the CAA proposes that flight time be limited to 12 hours for 3-pilot augmented crews, which is consistent with current FARs.

INTERNATIONAL ALL-CARGO OPERATIONS (Augmented Crew)

(Metrics Stated in Hours and Minutes)

3 Pilot Augmentation (or 3 Pilot 2 Flight Engineer)							
Flight Duty Period					**Flight Time**	**International Rest**	
International 3 Pilot with horizontal sleep opportunity 1 to 2 sectors	**International 3 Pilot with horizontal sleep opportunity 3 to 4 sectors**	**International 3 Pilot seat 1 to 2 sectors**	**International 3 Pilot seat 3 to 4 sectors**	**Extensions for Operational Irregularities**		**Minimum**	**In 168 Look Back**
16:30	15:45	14:45	14:30	+ 2	12	12*	30

4 Pilot Augmentation (or 4 Pilot 2 Flight Engineer)				
Flight Duty Period			**International Rest**	
International 4 Pilot with horizontal sleep opportunity 1 to 2 sectors	**International 4 Pilot with horizontal sleep opportunity 3 to 4 sectors**	**Extensions for Operational Irregularities**	**Minimum**	**In 168 Look Back**
19:30	18:45	+ 2	12*	30

* Reducible to 11 at certificate holder's discretion (can only occur once in any 168 hour look back)

The CAA Proposal for international all-cargo operations with augmented crews set forth above maintains and enhances safety standards for such operations, while recognizing the distinct attributes of the international all-cargo operating environment.

* * *

The CAA Proposal represents a substantial effort to develop flight/duty limitations and rest requirements using the limited science available and the extensive operational experience of CAA members while accounting for the attributes of global all-cargo operations. The Proposal accounts for distinctions between domestic and international all-cargo operations, the WOCL period, acclimatization, the number of sectors, operational irregularities, and quality of sleep opportunities. In terms of flight duty period limitations and rest requirements, the CAA Proposal is *more restrictive and more fatigue mitigating* than the current FARs.

Comparison of CAA Proposal With Current FARs

Flight Duty Period (Hours)		
	Current	CAA Proposal
Domestic	16	9-13
3 Crew Domestic	16	9-13
International	16	11:30-14
3 Crew International	Unlimited	14:30-16:30

Rest (Hours)		
	Current	CAA Proposal
Domestic	8	10
3 Crew Domestic	8	10
International	8	12
3 Crew International	8	12

In sum, the CAA Proposal for domestic, non-augmented international, and augmented international all-cargo operations maintains and enhances safety standards for such operations, while recognizing the specific attributes of the corresponding all-cargo operating environment.

E. THE FAA MUST ADDRESS PRE-DUTY REQUIRED REST.

The CAA has expended substantial resources and effort in developing this detailed proposal for flight/duty time limitations and rest requirements for all-cargo operations. That said, the proposed limitations and restrictions will not have the desired effect on fatigue mitigation and prevention if the individual flight crewmember does not arrive for his or her flight well rested and fit for duty. As a result, it is clear that flight/duty limitations and rest requirements alone do not address fatigue in aviation operations. Provisions must be adopted to also address pre-duty required rest.

Pre-duty activities vary greatly and can affect flight crewmembers differently. For example, recreation activities, working in another capacity, and excessive commuting to duty fall into this category and must be considered. The fundamental principle and enforcement mechanism for regulating pre-duty required rest is the obligation of each flight crewmember to report fit and rested for duty. That critical obligation is solely the responsibility of the individual flight crewmember, and any regulations covering flight/duty limitations and rest requirements must also address pre-duty required rest of individual flight crewmembers and put teeth into the FAA's enforcement of crewmember responsibility to report to work fit for duty.

F. THE CAA STRONGLY SUPPORTS FRMS.

Rather than continuing solely down the regulatory road toward new prescriptive regulations, some experts also advocate the development of a far more dynamic Fatigue Risk Management System to better understand, prevent, and mitigate fatigue in aviation operations. Dr. Graeber and the Flight Safety Foundation are vocal proponents of FRMS:

> "[FRMS] is a proactive approach to addressing fatigue in a systematic, comprehensive manner that does not rely solely on adherence to a set of prescribed hourly limits of duty and required time off. . . . An FRMS enhances the capability of prescriptive flight-time limitation concepts to provide an equivalent or enhanced level of safety based on the identification and management of fatigue risk relevant to the specific circumstances. Use of an FRMS can allow greater operational flexibility and efficiency while maintaining safety . . . ."[20]

The Aerospace Medical Association's Fatigue Countermeasures Subcommittee of the Aerospace Human Factors Committee likewise supports FRMS.

> "An FRMS offers a way to more safely conduct flights beyond existing regulatory limits and should be considered an acceptable alternative to prescriptive flight and duty time and rest period regulations. . . . Concurrent with the educational effort, a large-scale program should be undertaken to implement a nonprescriptive [FRMS] that determines optimum flight schedules from both a physiological and

20 Dr. Graeber Testimony, at 3, 5.

operational standpoint on a case-by-case basis since prescriptive hours-of-service limitations cannot account for human circadian rhythms or sleep propensity."[21]

The CAA strongly supports the development of such a dynamic FRMS based on specific real-world experiences. The CAA supports efforts to facilitate the collection of data and to validate fatigue science in aviation operations which considers the effects of multiple time zones and acclimatization, backside-of-the-clock operations, augmentation, and on-board sleep opportunities. As the scientific evidence on fatigue matures through the FRMS, CAA members plan to adjust their fatigue mitigation and countermeasure programs accordingly, and to enhance their already robust fatigue mitigation education and training.

[21] *Fatigue Countermeasures in Aviation – Position Paper,* Aviation, Space, and Environmental Medicine, Vol. 80 No. 1, at 34, 52.

IV. CONCLUSION

The members of the CAA diligently participated in the ARC process and dedicated thousands of hours in that endeavor. The CAA made a serious effort to craft a set of proposals that are designed to meet the objectives of the ARC charter. The CAA Proposal recognizes that any proposed rules must take into account the characteristics of the all-cargo industry which operates under a different business model than domestic passenger hub-and-spoke systems. The CAA Proposal fulfills the safety objectives of the FAA while accommodating the attributes of the all-cargo industry. We have based our Proposal, as best we could, on science, recognizing that aeromedical science on fatigue is not mature. The CAA urges the ARC to recommend, and the FAA to adopt, the recommendations contained herein as part of any regulations on flight/duty time limitations and rest requirements.

Respectfully submitted,

Stephen A. Alterman

EXHIBIT CAA-1

CURRICULUM VITAE – GRAEBER, Raymond Curtis
July 2009

PERSONAL

Born Nov. 17, 1945 Buffalo, NY
Married, three grown children

EDUCATION

1963-65 Canisius College, Buffalo, NY
1965-67 Harpur College, SUNY at Binghamton, NY; B.A. in Mathematics & Science (Psychology)
1967-70 University of Virginia, Charlottesville, VA; M.A. (Experimental Psychology)
1970-72 University of Virginia, Charlottesville, VA; Ph.D. (Neuro Psychology)

PROFESSIONAL EXPERIENCE

2009: President, The Graeber Group, Ltd., human performance and aviation safety consultants with a global focus.

1990-2008: Boeing Commercial Airplanes, Seattle, WA (retired Dec. 31, 2008)
Senior Technical Fellow, 2003-2008 (Corporate STF Leadership Team 2005-2008)
Director, Regional Safety Programs, 2006-08.
Chief Engineer, Human Factors, 1997-2008
Chief, Crew Operations, 737-600/700/800 Engineering, 1994-97
Chief, Human Factors Engineering, 1993-94
Manager, Flight Deck Research, Avionics and Flight Systems, 1990-93

1981-90: Aerospace Human Factors Division, NASA Ames Research Center, Moffett Field, CA.
Chief, Flight Human Factors Branch (formerly Aviation Systems Research Branch) 1989-90;
Principal Scientist, Aviation Systems Research Branch, 1988-89;
Research Psychologist/Project Officer, Aeronautical Human Factors Research Office, 1981-87.

1986: Human Factors Specialist, Investigation Staff, The Presidential Commission on the Space Shuttle Challenger Accident, Washington, D.C.

1977-81: Research Psychologist, Department of Military Medical Psychophysiology, Neuropsychiatry Division, Walter Reed Army Institute of Research, Washington, D.C. 1980-81: Deputy Chief.

1972-76: Research Psychologist, Behavioral Science Division, Food Sciences Laboratory, U.S. Army Natick Research and Development Command, Natick, MA.

1970-71: Visiting Scientist, Lerner Marine Laboratory, American Museum of Natural History, Bimini Island, Bahamas.

INDUSTRY ACTIVITIES AND PROFESSIONAL SOCIETIES

Government Support

U.S. Federal Aviation Administration:
U.S. Industry Co-Chair, FAA-JAA ARAC Harmonization Working Group, Flight Crew Error & Performance in the Flight Deck Certification Process, FAR/JAR 25-1302, 1999-2005.
Co-Chair, FAA Certification Process Study, Phase II, Human Factors Team, Sept. 2002-04.
FAA Research, Development, and Engineering Human Factors Subcommittee, 1997-2004.
Co-Chair, Working Group 2 (Human Factors), RTCA Certification Task Force, 1998-99.
Chair, FAA ARAC Working Group for Controlled Rest on the Flight Deck, 1991-93.
Scientific Task Planning Group (cockpit) to develop Aviation Human Factors National Plan, 1990.

European Joint Airworthiness Authorities (JAA) and EASA Human Factors Steering Group, 1995-2008.

International Civil Aviation Organization (ICAO):
  Flight Operations Panel – standards development: Chair, Fatigue Risk Management Subteam, 2005 - 2008. Chair, Flight Time Limitations Subteam, 2004-05.
  Member, Industry Safety Strategy Group, co-author of Global Aviation Safety Roadmap, 2005- 2008.

U.S. National Aeronautics and Space Administration:
  Airspace Systems Program Subcommittee, Aeronautics Research Advisory Committee, 2005.
  Aeronautics Goals Subcommittee, Aero-Space Technology Advisory Committee, 1999-2001.
  Human Factors Subcommittee, Aero-Space Technology Advisory Committee, 1996-2001.
  NATO AGARD Advisory Panel on Aerospace Medicine (NASA representative), 1989-90.
  Investigation Staff, The Presidential Commission on the Space Shuttle Challenger Accident, 1986.

U.S. Congress:
  House Subcommittee on Aviation of the Committee on Public Works and Transportation:
    Testified at June 2009 hearing on Regional Air Carriers and Pilot Workforce Issues.
    Testified at May 1990 hearing on Language Issues in ATM Communication.
  Office of Technology Assessment, Washington, DC. Human Factors in Aviation Safety Working Group, May 1987; Shift Work and Extended Duty Hours Workshop, May 1990.

U.S. National Transportation Safety Board:
  NTSB Human Performance Seminar, Washington, DC, June 1987.

DOD Human Factors Engineering TAG, SUB TAG on Sustained/Continuous Operations, 1985-1990.

Industry Activities and Professional Societies:

Flight Safety Foundation (FSF):
  Chair, Icarus Committee, 2003-08, member since 2001.
  Board of Governors and Executive Committee, 2003-08 (Ex Officio)
  Organizer and Co-Chair, International Ultra Long-Range Crew Alertness Project, June 2001-05.

National Sleep Foundation, Board of Directors, 2008 – present.

Air New Zealand, Independent Alertness Advisory Panel, Chair 2006 – present, member since 1996.

Royal Aeronautical Society, Fellow 1997- present.
  External Affairs Board, 2001- 2008;
  The Boeing Company Technical Focal, 2001-08.
  Founding Member, Seattle Chapter Executive Committee, 2000-09, Vice-Chair, 2003-06.

QANTAS/Civil Aviation Safety Authority/ AIPA: Fatigue Risk Management Steering Committee, 2000 - 2007. Chair, Scientific Review Committee, 2000-06.

Joint United Airlines/ALPA Working Group on Long-Haul Crew Scheduling, Chicago, IL, 1988-2001.

LOSA (Line Operational Safety Audit) International Advisory Board, 2003-07.

International Air Transport Association, Human Factors Working Group, 1995-2005. U.S. Air Transport Association, Human Factors Task Force, 1988-1995.

Editorial Board, *Cognition, Technology and Work Journal,* Springer Publishing, 2002- present.

Associate Editor (N. America), *Human Factors and Aerospace Safety*, Ashgate Press, 1999- present.

Journal Manuscript Reviewer for: *International Journal of Cognition, Technology & Work; Work and Stress; Aerospace Safety &Human Factors; Sleep; Aviation, Space & Environ. Med.; J. Biol. Rhythms.*

Ohio State University, Institute for Ergonomics, Advisory Board, 1998-2002.
Aerospace Medical Association: Fellow 1990, member, 1981-95.
Human Factors and Ergonomics Society: member, 1991-2005.
International Society for Chronobiology: member, 1975-1992. Board of Directors, 1984-1992.
Sleep Research Society, member, 1986-1993, Governmental Affairs Committee, 1987-1992.
Society for Neuroscience: member, 1972-82.
American Psychological Association: member, 1972-75.

HONORS AND AWARDS

Honorary Research Fellow, Massey University, Wellington, New Zealand, 2009-11.

International Council of Aeronautical Sciences (ICAS) Maurice Roy Medal for fostering international scientific cooperation in human factors, 2008.

Flight Safety Foundation – Airbus Human Factors in Aviation Safety Award, 2006.

Senior Technical Fellow, The Boeing Company, 2003.

Cumberbatch Trophy 2000, Guild of Aircraft Pilots and Air Navigators (GAPAN), for the Promotion of Flight Safety and Recognition as a World Authority in Aviation Human Factors, 2001.

Sir Frank Whittle Medal, International Federation of Airworthiness, MEDA Team Award, 2000.

1999 Aerospace Laurel Award, Commercial Air Transport, *Aviation Week and Space Technology.*

Fellow, Royal Aeronautical Society, 1997.

NASA Group Achievement Awards, 1986, 1994.

Fellow, Aerospace Medical Association, 1990.

The John Lane Visiting Lecturer, Aviation Medical Society of Australia and New Zealand, 1990.

Boothby-Edwards Memorial Award for Outstanding Research in Civil Aviation Medicine, Aerospace Medical Association, 1989.

Harold Ellingson Literary Award, Aerospace Medical Association, 1987.

Military Decorations:
- Legion of Merit, U.S. Army, 1989.
- U.S. Army Meritorious Service Medal, 1988.
- Department of Defense Meritorious Service Medal, 1986.
- U.S. Army Commendation medal, 1976, with oak leaf cluster, 1983.

Commander's Award in Science, U.S. Army Natick Research and Development Command, 1974.

National Defense Title IV Predoctoral Fellowship, University of Virginia, 1967-69

B. A. *magna cum laude*, SUNY Binghamton, 1967.

TEACHING:

Visiting Professor, Human Factors, College of Aeronautics, Cranfield University, UK, 2001- 2008.

Faculty, Aviation Safety and Security Management Certificate Program, The George Washington University Aviation Institute, Virginia Campus, 1998-2000.

Lecturer: Sleep Disorders Center, Stanford University School of Medicine, Stanford, CA. Course in Clinical Polysomnography, 1986-90. Physicians' Course in Sleep Disorders Medicine, 1988-89.

Lecturer: Trinity University, San Antonio, TX. Advanced Human Factors Short Course, 1986-90.

Lecturer: USAF School of Aerospace Medicine, Brooks, AFB, TX.
Basic Aerospace Physiology Course, 1986. Operational Problems in Aerospace Physiology, 1987.

Visiting Instructor, Psychology: Framingham State College, Framingham, MA, 1973-76; George Mason University, Graduate Div., Fairfax, VA, 1978; University of Maryland, College Park, MD, 1978-80.

MILITARY SERVICE

U.S. Army: Active duty, Medical Service Corps, July 1, 1969 to June 30, 1989.
Retirement Rank: Lieutenant Colonel

AERONAUTICAL RATINGS

Private pilot: airplane, single engine land (July 9, 1983).

CONSULTING:

Compa Corp., Nuclear Regulatory Commission Control Room Simulator Review Project, 1994.
Federal Highway Authority, Office of Motor Carrier Standards, U.S. Dept. Transportation, Sept. 1989.
SAE A-21 Aircraft Noise Committee (Interior Noise Subcommittee), San Antonio, TX, April 1989.
SAE G-10 Committee on Aerospace Behavioral Engineering Technology: consultant, 1985-1994.
Stanford Research Institute, Inc., Menlo Park, CA. 1986.
Westinghouse-Hanford Co., Fast Flux Test Facility, Hanford, WA. 1986-87.
DOD Uniform Services University of the Health Sciences: December 1986 & November 1987.
San Francisco "Forty-Niners" NFL Football Team, Redwood City, CA, 1986.
NATO AGARD Consultant Mission to FRG National delegation, DFVLR Institute of Aerospace Medicine, Cologne, W. Germany, May, 1985.
National Research Council Committee on Military Nutrition Research Workshop on Cognitive Testing Methodology, Washington, DC, June 1984.
Nuclear Regulatory Commission Shift Work Scheduling Project, Washington, DC, April 1984.
Department of State, Medical Department, 1981.
Office of Naval Research, Oceanic Biology Program, 1974 –79.
U.S. Department of Agriculture (Food for Peace Program), 1973.

MEDIA INTERACTION:

"Working Nights", Soundprint, Minnesota Public Radio/NPR, June 1997.

PBS "Discovery", Cockpit Technology and Automation, 1996.

Swissair Flight Crew Training video, Flight Deck Automation, 1995.

Segment on Cockpit Rest, Medical World News, CNN, International Syndication, Nov. 1990.

"Sleep Alert", PBS national syndication, March 1990.

"The Flying Computer Game", MTV Finland, Helsinki, Finland, fall 1989.

"Pilot Fatigue", eyewitness, LWT (London Weekend Television), London, England, May 1989.

"The Biological Clock", Innovation, WNET-TV (PBS national syndication), New York, NY, Jan. 1989

"The Twenty-Five Hour Day", Horizon, BBC2, London, U.K., Dec. 1986.

Landing of the "Voyager", CNN, human factors of the "Voyager" round-the-world flight, Dec. 23, 1986.

MacNeil-Lehrer News Hour, PBS, live discussion with Congressman W. Nelson on Human Factors Aspects of the Space Shuttle Challenger Accident, Aug. 6, 1986.

PUBLICATIONS

Books

Boy, G., C. Graeber, and J-M. Robert (Eds.): *Proceedings of the HCI-Aero '98 International Conference on Human-Computer Interaction in Aeronautics*. Montreal: Editions de l'Ecole Polytechnique de Montreal, 1998.

Graeber, R.C. (Ed): Sleep and Wakefulness in International Aircrews. *Aviation Space, And Environmental Medicine*, Vol. 57, No. 12, Section II (Suppl.), 1986.

Brown, F. M. and R. C. Graeber (Eds): *Rhythmic Aspects of Behavior*. Hillsdale, N.J.: L. Erlbaum Associates, 1982.

Book Chapters

Balkin, T.J., Horrey, W.J., Graeber, R.C., Czeisler, C.A., and Dinges, D.F.: The Challenges and Opportunities of Technological Approaches to Fatigue Management. In: *Proceedings of Liberty Mutual Hopkinton Conference on Future Directions in Fatigue and Safety Research*, in press.

Gander, P., Graeber, R.C., and Belenky, G.: Fatigue Risk Management. In: M. Kryger, T. Roth, and W. C. Dement (Eds.), *Principles and Practice in Sleep Medicine,* 5th Edition, Elsevier, in press.

Applegate, J.D., and Graeber, R.C.: Integrated safety system design and human factors considerations for jet transport aeroplanes. In D. Harris and H.C. Muir (Eds.), *Contemporary Issues in Human Factors and Aviation Safety.* Aldershot, Ashgate: 2005, pp. 3-23.

Graeber, R.C., and Mumaw, R.J.: Realizing the benefits of cognitive engineering in commercial aviation. 3rd International Conference on Engineering Psychology and Cognitive Ergonomics, Oxford, England, Oct. 1998. In D. Harris (Ed.), *Engineering Psychology and Cognitive Ergonomics, Vol. 3.* Aldershot, Ashgate: 1999, pp. 3-26.

Kovarik, L.E., Graeber, R.C., and Mitchell, P.R.: Human factors considerations in aircraft cabin design. In D. Garland, J. Wise, and V.D. Hopkin (Eds.), *Handbook of Aviation Human Factors*. Malwah, NJ, Lawrence Erlbaum Associates, 1999, pp. 389-403.

Graeber, R. C.: Integrating human factors and safety into airplane design and operations. In B.J. Hayward and A.R. Lowe, (Eds), *Applied Aviation Psychology: Achievement, Change, and Challenge.* Aldershot, UK, Avebury Aviation, 1996, pp. 27-38.

Marx, D. M., and Graeber, R. C.: Human error in aircraft maintenance. In N. McDonald, N. Johnston, and R. Fuller (Eds), *Aviation Psychology in Practice.* Aldershot UK, Ashgate Press, 1994, pp. 87-104.

Connell, L. J., and Graeber, R. C.: Ambulatory monitoring in the aviation environment. In L. Miles and R. Broughton (Eds), *Clinical Evaluation and Physiological Monitoring in the Home and Work Environment.* New York, Raven Press, 1989, pp. 175-185.

Graeber, R.C.: Long-range operations in the glass cockpit: Vigilance, boredom, and sleepless nights. In A. Coblentz (Ed), *Vigilance and Performance in Automatized Systems.* NATO Advanced Science Institutes Series. Dordrecht: Kluwer Academic Publ., 1989, pp. 67-76.

Graeber, R.C.: Jet lag and sleep disruption. In M. H. Kryger, T. Roth, and W. C. Dement (Eds): *Principles and Practice in Sleep medicine.* New York, W. B. Saunders, 1989, pp. 324-331. Also 2nd edition, 1994, pp. 463-470.

Graeber, R.C.: Aircrew fatigue and circadian rhythmicity. In E. L. Wiener and D. C. Nagel (Eds): *Human Factors in Aviation.* New York, Academic Press, 1988, pp. 305-343.

Appendix G: Human Factors Analysis. In Volume II, *Report of the Presidential Commission on the Space Shuttle Challenger Accident.* Washington, D.C., 1986, pp. G1-6.

Graeber, R.C., Foushee, H.C. and Lauber, J.K.: Dimensions of flight crew performance decrements: Methodological implications for field research. In J. Cullen, J. Siegrist, and H. M. Wegmann (Eds): *Break down in Human Adaptation to Stress, vol. 1.* The Hague, M. Nijhoff Publ., 1984, pp. 584-605.

Graeber, R.C.: Alterations in performance following rapid transmeridian flight. In F.M. Brown and R. C. Graeber (Eds), *Rhythmic Aspects of Behavior.* Hillsdale, L. Erlbaum Associates, 1982, pp. 173-212.

Graeber, R.C., H.C. Sing, and B.N. Cuthbert: The impact of rapid transmeridian flight on deploying Soldiers. In L. Johnson, D. Tepas, W. P. Colquhoun, and M. J. Colligan (Eds), *Biological Rhythms, Sleep, and Shift Work. Advances in Sleep Research, vol. 7.* New York, Spectrum, 1981, pp. 513-537.

Graeber, R.C.: Recent studies relative to the airlifting of military units across time zones. In L. Scheving and F. Halberg (Eds), *Chronobiology: Principles and Applications to Shifts in Schedules.* Alphen aan den Rijn, Sijthoff & Noordhoff, 1980, pp. 353-369.

Graeber, R.C.: Behavioral correlates of tectal function in elasmobranchs. In H. Venegas (Ed.), *Comparative Neurology of the Optic Tectum.* New York, Plenum Press, 1984, pp. 69-92.

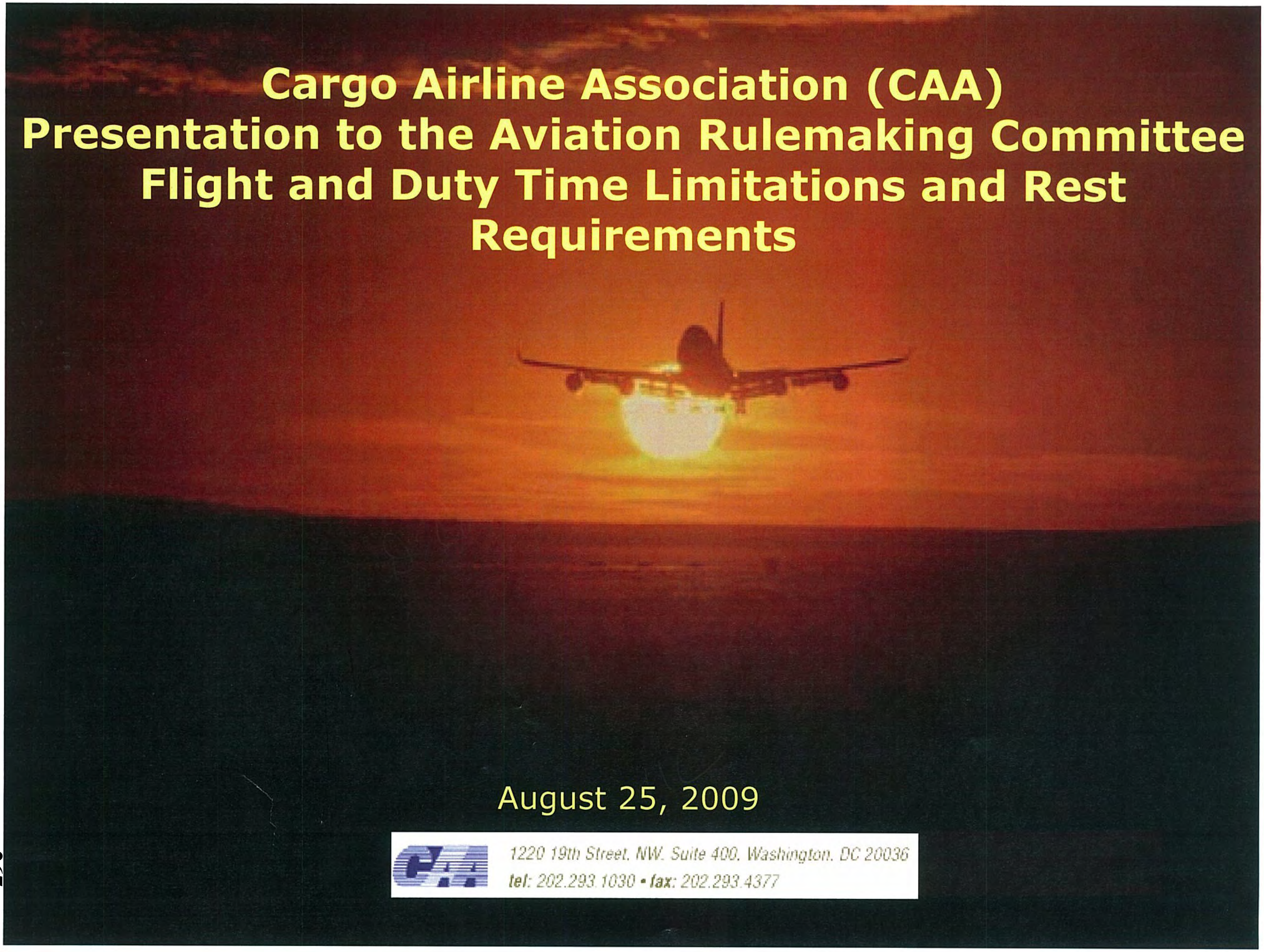
Graeber, R.C.: Telencephalic function in elasmobranchs: A behavioral perspective. In S.O.E. Ebbesson (Ed.), *Comparative Neurology of the Telencephalon.* New York, Plenum Press, 1980, pp. 17-39.

Graeber, R.C.: Behavioral studies correlated with central nervous system integration of vision in sharks. In E.S. Hodgson and R.F. Mathewson (Eds.), *Sensory Biology of Sharks, Skates and Rays.* Arlington, VA, Office of Naval Research, 1978, pp. 195-225.

RESEARCH TECHNICAL REPORTS AND PAPERS

Numerous Research Technical Reports and Papers. List available on request.

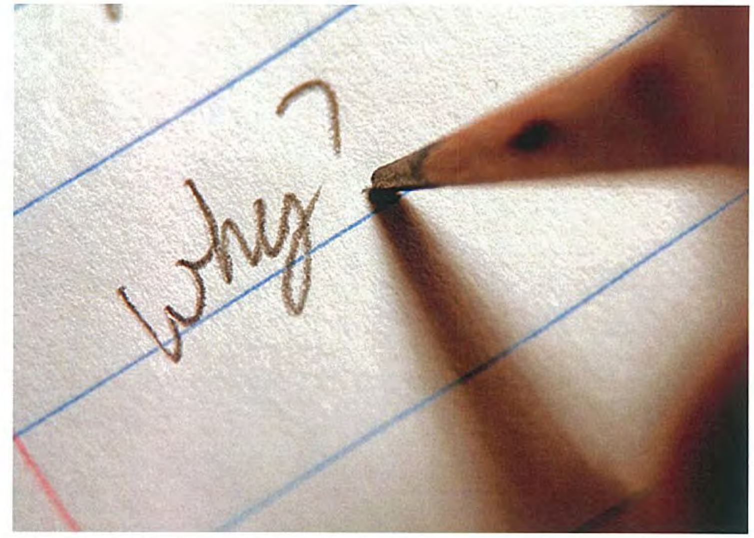
EXHIBIT CAA-2


Cargo Airline Association (CAA)
Presentation to the Aviation Rulemaking Committee
Flight and Duty Time Limitations and Rest
Requirements
August 25, 2009
1220 19th Street, NW, Suite 400, Washington, DC 20036
tel: 202.293.1030 • fax: 202.293.4377

Why are we here?

"We must find the right balance of safety, science, cost and operational efficiency regarding amendments to our current rules."

Gregory Kirkland, FAA,
Presentation on Crewmember Flight, Duty and Rest Requirements, at the FAA Fatigue Management Symposium, June 17-19, 2008.



What is most important?

"Eight hours of sleep opportunity is much more important than time on task, duty time, etc. for assuring safe levels of alertness."

R. Curtis Graeber, Ph.D.
August 2009

Why CAA's all-cargo proposal needs to be adopted?

"In rulemaking, not only does one size not fit all, but it's unsafe to think it can."

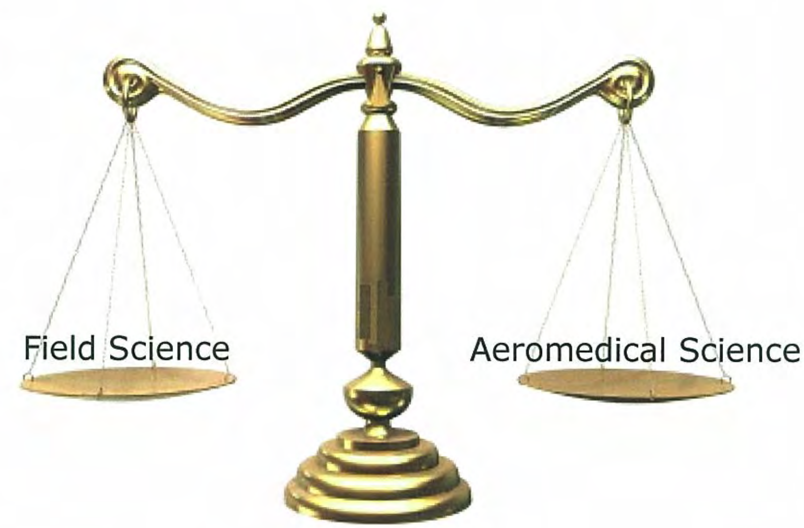
Administrator Randy Babbitt
Speech to the ALPA Air Safety Forum
August 5, 2009.

Safety Risks Of Not Getting It Right

- Unintended consequences can jeopardize safety.
  - No one knows the fatigue tradeoff between:
    - Longer duty periods with fewer nights worked
    - Shorter duty periods with more nights worked
- We need to better understand the cumulative fatigue effect of increased night work/day-life transitions.
- While current scientific models can support Fatigue Risk Management (FRM) with validation, they are too immature to support prescriptive rules.

Guiding Principles

- Responsibility to "get it right".
- Acceptance that fatigue is a legitimate flight safety concern.
- Need to apply science, recognizing the limits of current aeromedical knowledge and lack of scientific validation in the aviation environment.
- Need to apply field science (operational experience), particularly that of international long-haul and domestic cargo carriers.
- Need to maintain and enhance safety while allowing U.S. carriers to remain competitive, recognizing the different business models and distinct operating environments of the aviation industry segments.



Global All-Cargo Operating Environment

- Backside of the clock is the norm, and our crews come prepared...We know how to do it right!
- Around the world in all directions is the norm.
- Traditional crew base model does not always apply.
- Length and number of rest opportunities are greater in cargo operations.
- Less hassle factor and no distractions from passengers and flight attendants.
- Point-to-point operations outside of the United States.
- Remote locations require turnaround capability.
- Fewer annual landings and lower annual flight time per pilot.
- Customer driven schedule, which is often unpredictable.

Competitive & Economic Risks Of Not Getting It Right

- Loss of U.S. carrier competitiveness.
  - Highly competitive global market where foreign competitors are not subject to similar restrictions.
- Adverse effects on national defense.

- Adverse effects on international humanitarian interests.
- Increased operational costs will result in service reductions for individuals, businesses, and communities.

Objectives Of CAA's Recommendations

- Enhance safety based on current scientific knowledge and our members' and our crews' extensive operational experience.

- Recognize the operating environment and business models of all-cargo carriers.

- CAA's proposal harmonizes the flight, duty, and rest rules with our global cargo operations, without discounting current science as the older rules have done.

Principles Underlying CAA's Recommendations

- Protecting sleep is essential – CAA's proposal increases minimum daily and cumulative rest opportunities.

- CAA has established limits in areas where currently there are no limits.
- CAA's proposal takes into account time of day.
- CAA's proposal takes into account crossing multiple time zones.
- Through increased training, CAA members have improved crew understanding and ability to deal with sleep-performance issues.
- It is essential to distinguish between domestic and international Flight Duty Periods (FDP).

CAA's Domestic All-Cargo Proposal

(In Hours)

Time of Start (Designated Base)	Flight Duty Period			Domestic Rest	
	1 to 4 Sectors	5 + Sectors	Extensions for Operational Irregularities	Minimum	In 168 look back
0000-0459	11	9	+ 2 *	10**	24***
0500-1459	13	11	+ 2 *		
1500-1659	12	10	+ 2 *		
1700-2359	11	9	+ 2 *		

* Extensions for Operational Irregularities include conditions and requirements unforeseen or beyond the control of the certificate holder, including but not limited to weather conditions, aircraft equipment, air traffic control, acts of God, hostilities, etc.

** Reducible to 9 at certificate holder's discretion (can only occur once in any 168 hour look back)

*** Applies when report to a FDP

CAA's Domestic All-Cargo Proposal

(In Hours)

	Flight Duty Period			Flight Time		Domestic Rest	
Time of Start (Designated Base)	1 to 4 Sectors	5 + Sectors	Extensions for Operational Irregularities	1 to 4 Sectors	5+ Sectors	Minimum	In 168 look back
0000-0459	11	9	+ 2 *	8	7	10**	24***
0500-1459	13	11	+ 2 *	11	9		
1500-1659	12	10	+ 2 *	10	8		
1700-2359	11	9	+ 2 *	8	7		

* Extensions for Operational Irregularities include conditions and requirements unforeseen or beyond the control of the certificate holder, including but not limited to weather conditions, aircraft equipment, air traffic control, acts of God, hostilities, etc.

** Reducible to 9 at certificate holder's discretion (can only occur once in any 168 hour look back)

*** Applies when report to a FDP

CAA's International Fatigue Mitigation Countermeasures

Domestic → International

CAA's FDP Recommendations

Fatigue Mitigation:

- Increased Rest (Currently 8 Hours)
  10 → 12
- Increased Cumulative Rest
  24 → 30
- Reduced Flight Time
  11 → 8 (Within the WOCL)
- New lower FDP limits
- Cumulative Duty Limit protections
- Time of Day/WOCL protection
- Acclimatization Penalty

CAA's International All-Cargo Proposal

2 Pilot (or 2 Pilot and Flight Engineer)

(In Hours)	Flight Duty Period			Flight Time		International Rest	
	International 2 Pilot/2 Pilot and Flight Engineer 1 to 4 sectors	International 2 Pilot/2 Pilot and Flight Engineer 5+ sectors	Extensions for Operational Irregularities	2 Pilot	2 Pilot and Flight Engineer	Minimum	In 168 look back
Unacclimatized/WOCL***** **	12:30	11:30	+ 2 *	8	12	12***	30****
Unacclimatized/Non-WOCL**	13:00	12:00	+ 2 *	10	12	12***	30****
Acclimatized/WOCL*** **	13:30	12:30	+ 2 *	8	12	12***	30****
Acclimatized/Non-WOCL	14:00	13:00	+ 2 *	10	12	12***	30****

* Extensions for Operational Irregularities include conditions and requirements unforeseen or beyond the control of the certificate holder, including but not limited to weather conditions, aircraft equipment, air traffic control, acts of God, hostilities, etc.

** Crews become unacclimatized after duties that exceed 4 time zones -- 30 hours free from duty to become acclimatized. Continental U.S. is considered one time zone for acclimatization purposes.

*** Reducible to 11 at certificate holder's discretion (can only occur once in any 168 hour look back)

**** Applies when report for a FDP

***** If any portion of the FDP occurs between 0200-0559, time computed at crewmember's acclimatized location.

CAA's International All-Cargo Augmentation Proposal

3 Pilot Augmentation (or 3 Pilot 2 Flight Engineer)
(In Hours)

Flight Duty Period					Flight Time	International Rest	
International 3 Pilot with horizontal sleep opportunity 1 to 2 sectors	International 3 Pilot with horizontal sleep opportunity 3 to 4 sectors	International 3 Pilot seat 1 to 2 sectors	International 3 Pilot seat 3 to 4 sectors	Extensions for Operational Irregularities		Minimum	In 168 look back
16:30	15:45	14:45	14:30	+ 2 *	12	12**	30***

4 Pilot Augmentation (or 4 Pilot 2 Flight Engineer)				
Flight Duty Period			International Rest	
International 4 Pilot with horizontal sleep opportunity 1 to 2 sectors	International 4 Pilot with horizontal sleep opportunity 3 to 4 sectors	Extensions for Operational Irregularities	Minimum	In 168 look back
19:30	18:45	+ 2 *	12**	30***

* Extensions for Operational Irregularities include conditions and requirements unforeseen or beyond the control of the certificate holder, including but not limited to weather conditions, aircraft equipment, air traffic control, acts of God, hostilities, etc.

** Reducible to 11 at certificate holder's discretion (can only occur once in any 168 hour look back)

*** Applies when report to a FDP

Math Behind the Numbers

3 Pilot Augmentation

	1-2 Sectors	3-4 Sectors
Horizontal 3 Pilot	16:30 Hours	15:45 Hours
Seat 3 Pilot	14:45 Hours	14:30 Hours

14:00 Hours (Max 2 Pilot FDP)
- 4 Hours (2½ show & 1½ 2nd sector)

10:00 Flight Hours
÷ 3 (Crew Complement)

3.33
x .75 Horizontal Sleep Factor

2.5 Sleep Credit
+ 14:00 Hours (Max 2 Pilot FDP)

16.5 (16:30) Hours (Max FDP)

Math Behind the Numbers

3 Pilot Augmentation

	1-2 Sectors	3-4 Sectors
Horizontal 3 Pilot	16:30 Hours	15:45 Hours
Seat 3 Pilot	14:45 Hours	14:30 Hours

14:00 Hours (Max 2 Pilot FDP)
- 4 Hours (2½ show & 1½ 2nd sector)

10:00 Flight Hours
÷ 3 (Crew Complement)

3.33
x .25 Seat Factor

.833 Sleep Credit
+ 14:00 Hours (Max 2 Pilot FDP)

14.83 (14:45) Hours (Max FDP)

Math Behind the Numbers

4 Pilot Augmentation

	1-2 Sectors
Horizontal 4 Pilot	19:30 Hours
Seat 4 Pilot	N/A

19:30 Hours (Max 4 Pilot FDP)
- 4 hours (2½ show & 1½ 2nd sector)

15:30 Flight hours (Rest Opportunity)
÷ 2 (2 crews)

7.75
x .75 Horizontal Sleep Factor

5.81 Sleep credit
+ 14:00 (Max 2 Pilot FDP)

19.81 (19:30) Hours (Max FDP)

Math Behind the Numbers

4 Pilot Augmentation

	3-4 Sectors
Horizontal 4 Pilot	18:45 Hours
Seat 4 Pilot	N/A

19:30 Hours (Max 4 Pilot FDP)
- 7 hours (Preflight and Sector Penalty)

12:30 Flight hours (Rest Opportunity)
÷ 2 (2 crews)

6.25
x .75 Horizontal Sleep Factor

4.68 Sleep credit
\+ 14:00 (Max 2 Pilot FDP)

18.68 (18:45) Hours (Max FDP)

Cumulative Time Limits

- Cumulative duty limits (to be determined at the point the crewmember reports for a flight duty period):
  - 24 hour (domestic) - 30 hour (international) free of duty in a 168 hour look back
  - 75 hour duty limit in 168 hour look back
  - 215 hour duty limit in 672 hour look back
  - 100 block hours (in 28 day look back)
  - 1,200 block hours annual (in 365 day look back)
- Deadheading:
  - Front-end: To an operating leg counts in calculation of FDP

Comparisons Between Current FAR and CAA Proposal

Flight Duty Period (Hours)		
	Current	CAA Proposal
Domestic	16	9-13
3 Crew Domestic	16	9-13
International	16	11:30-14
3 Crew International	Unlimited	14:30-16:30

Flight Time (Hours)		
	Current	CAA Proposal
Domestic	8	7-11
3 Crew Domestic	8	7-11
International	8	8-10
3 Crew International	12	12

Rest (Hours)		
	Current	CAA Proposal
Domestic	8	10
3 Crew Domestic	8	10
International	8	12
3 Crew International	8	12

Summary of CAA's Recommendations

- Flight Duty Period (2 Pilots):
  - Domestic: 9-13 hours depending upon time of day and number of sectors.
  - International: 11:30 to 14 hours depending on:
    - Number of sectors
    - Whether or not acclimatized
    - WOCL
- Extension for Operational Irregularities: 2 hours
- Flight Time (2 Pilots):
  - Domestic: 7-11 hours depending upon time of day and number of sectors.
  - International: 8-10 hours

Summary of CAA's Recommendations

- Rest:
  - Domestic: 10 Hours, reducible to 9 (only one reduction in any 168 hour period).
  - International: 12 Hours, reducible to 11 (only one reduction in any 168 hour period).
  - Cumulative: 24 Hours in 168 hour period (Domestic)
    30 Hours in 168 hour period (International)

- Augmentation:
  - 3 Pilot Augmentation
    - Flight Duty Period - 14:30-16:30 hours depending upon level of rest accommodation and number of sectors.
    - Flight Time - 12 hours
  - 4 Pilot Augmentation –
    - Flight Duty Period - 18:45-19:30 hours depending upon number of sectors.

The FAA Must Address Pre-Duty Required Rest

- Flight/duty/rest requirements alone do not address fatigue without also addressing pre-duty required rest.
- Pre-duty activity including recreation, working in another capacity, and commuting to duty must be considered.
- Pilots must report fully rested and fit for duty.
- The obligation to report fit and rested for duty is solely the responsibility of the individual crew member.
- The FAA must promulgate regulatory limitations.

CAA Strongly Supports The Development Of Fatigue Risk Management System (FRMS)

- Collection of data – FAA Scientific Steering Committee.
- Validation of fatigue science to aviation operations which considers:
  - Effects of multiple time-zones and acclimatization
  - Effects of the backside of the clock
  - Augmentation and on-board sleep
- CAA members will adjust fatigue mitigation programs as scientific evidence matures.

Conclusion

- CAA recognizes that improved safety requires rule changes.
- CAA accepts that rule changes will impose significant operational changes and costs on all-cargo operators.
- The attributes of the all-cargo industry must be reflected in flight-duty rules adopted by the FAA.

ATTACHMENT II
National Air Carrier Association Proposal

NATIONAL AIR CARRIER ASSOCIATION
MEMORANDUM TO THE
FAA AVIATION RULEMAKING COMMITTEE ON
FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS

The National Air Carrier Association (NACA) submits this memorandum to the record of proceedings of the Federal Aviation Administration's Flight and Duty Time Limitations and Rest Requirements Aviation Rulemaking Committee (ARC) for consideration of our carrier members' views in developing recommendations for the Administrator for future rulemaking.

NACA, founded in 1962, is comprised of 11 air carriers, certificated under Title 49, Part 121 of the Code of Federal Regulations. Our members represent a diverse group of air carriers, providing regularly scheduled passenger air service, non-scheduled and on-demand passenger charter service, and all cargo operations, both scheduled and unscheduled. NACA carriers fill a unique niche in the air carrier industry, offering both low cost scheduled air services, as well as on demand passenger and cargo services. A significant number of the NACA carriers provide service to the U.S. Department of Defense (DoD) through the Civil Reserve Air Fleet program (CRAF), providing significant lift capacity for troop and cargo movements in support of U.S. DoD missions around the globe.[1]

We appreciate the opportunity to present the views of our carriers to the ARC. As noted above, all of our carriers are Part 121 FAA certificated carriers. However, almost all of the operations performed by the NACA carriers are unscheduled operations. A significant number of NACA carrier members also provide long-haul services. NACA carriers are truly global, serving over 130 countries. Throughout the ARC process, NACA has consistently argued that our operations are different from those of mainline and regional Part 121 air carriers.

We concur wholeheartedly with the statement by the Administrator, in a speech delivered to the Air Line Pilots Association Safety Forum in which, referencing the work of this ARC and the rulemaking process in general, "[i]n rulemaking, not only does one size not fit all, but it's unsafe to think that it can." *See*, "We Can't Regulate Professionalism," remarks of Administrator Randy Babbitt before ALPA Safety Forum, August 5, 2009. It bears repetition, "one size does not fit all."

[1] NACA carriers include: Allegiant Air, Atlas Air Worldwide Holdings, Miami Air International, North American Airlines, Omni Air International, Pace Airlines, Ryan Air International, Southern Air, Sun Country Airlines, USA3000 Airlines and World Airways.

UNIQUE OPERATIONS OF THE NONSCHEDULED CARRIER

Throughout much of the ARC's deliberations, there has been considerable focus on the domestic carriers' hub-and-spoke type systems, which are vastly different from nonscheduled/charter operations of NACA carriers.

Charter operations fill the void for those situations that the regularly scheduled operators cannot provide. Nonscheduled charters respond to the needs of the customer – the concept of non-scheduled service is that the customer works with the air carrier to develop a flight schedule that meets the customer's needs. Charter customers often have unique passengers/cargo, i.e. VIP or high profile type passengers, sports teams, politicians on campaigns, military passengers, time-sensitive military cargo. In addition, non-scheduled operators also provide valuable support in humanitarian relief operations, both nationally and globally. These flights are performed both before and after natural disasters such as evacuations before hurricanes, earthquakes, tsunamis, and floods. Flights into an area both before and after such disasters are usually performed when scheduled operations have been terminated. Operating into an area with significant disruptions at airports has unique and unexpected support challenges.

Charter carriers play a significant role in the transportation of military personnel and cargo. In testimony before the House Aviation Subcommittee, USTRANSCOM Commander General Duncan McNabb testified that the current commitment of CRAF air carriers provides 40.6 million ton-miles/day in bulk cargo capacity and nearly 200 million passenger miles/day. USTRANSCOM typically plans for CRAF carriers to move about 40 percent of the military cargo and 90 percent of the passengers during both peacetime and war. *See*, Statement of General Duncan J. McNabb, USAF, Before the House Transportation and Infrastructure Committee/Aviation Subcommittee, May 13, 2009. The vast majority of these CRAF missions are performed by non-scheduled passenger and cargo airlines.

Even the FAA makes distinctions between scheduled and non-scheduled operations in addressing air traffic management and congestion at U.S. airports. For example, each of the FAA's orders limiting hourly operations into the three commercial service airports of the New York and New Jersey metropolitan area significantly reduces the number of unscheduled operations that are permitted. This is in spite of the significant investment that a number of NACA carriers have made in these airports. *See, for example*, "Operating Limitations for Unscheduled Operations at John F. Kennedy International Airport and Newark Liberty International Airport – Disposition of Comments," Docket Number FAA-2008-0629, 73 Fed. Reg. 64658 (October 30, 2008).

SCHEDULED PASSENGER SERVICE

NACA also represents a number of low cost, scheduled passenger air carriers. These carriers share the broader concerns of the NACA membership outlined above. These carriers agree that a revision of the flight and duty time rules is necessary to reflect the current commercial aviation industry. However, NACA is concerned that the flight and duty limitations which are being put forward for consideration are unworkable and cannot be justified. We note that CAP371 has been the basis for many of the proposals which are being considered by the ARC. However, it would appear to us that the proposals are becoming far more restrictive and are simply becoming unworkable and financially untenable. NACA submits for consideration of the ARC a more simplified flight and duty limitation that we believe reflects the prevailing science, maintains the level of safety and provides the flexibility to meet the needs of the scheduled passenger carriers.

NACA RECOMMENDATIONS

NACA strongly supports the Administrator's statements that the time is right for revising a regulatory scheme that has not kept pace with the advancements in aviation technology and aircraft capabilities. However, we cannot simply impose one regulatory scheme for all Part 121 carriers. Rather, the ARC's recommendations must include recognition that different types of operations within the Part 121 community should have a regulatory structure that is appropriate for the type of operations. Under the current regulations, unscheduled air carrier operations are already treated differently under the current rules. See, 14 C.F.R. §§121.500 – 121.525, Subpart S, Flight Time Limitations: Supplemental Carriers (Subpart S). We see no reason why the final ARC recommendations should not include a similar provision for unscheduled operations. To that end, we believe that Subpart S, in its current form, adequately provides the safeguards for flight crew duty limitations. We would support an additional requirement within Subpart S or its successor provision to enhance the regulatory framework with a requirement that nonscheduled operators develop and implement a Fatigue Risk Management System (FRMS).

It is important to note that the current Subpart S already incorporates fatigue mitigation principles, including rest requirements, throughout the duty day. This regulatory scheme has proven to be successful for non-scheduled operations, while maintaining the equivalent level of safety. Maintaining this regulatory scheme is vitally important to the U.S. national security and the success of the CRAF program, both in times of conflict and peace. In addition to the needs of the U.S. military, this regulatory structure enables the non-scheduled operators to provide the air transportation needs for other Federal agencies, critical to our national security and safety, such as disaster relief flights for the Federal Emergency Management Agency and the detention and removal of illegal aliens by the Department of Homeland Security.

As we have noted throughout this memorandum, a number of the NACA carriers are vital to the success of DoD air transportation needs. Through the CRAF program, NACA carriers are providing essential air lift capability for troops and cargo necessary to meet the strategic commands of the DoD. As contract operators for U.S. Transportation Command/Air Mobility Command, NACA operators are further subject to strict rest and duty requirements pursuant to the government contract. We recognize that TRANSCOM/AMC is a customer and contractual obligations do not have the force and effect of law or regulation. However, we would note that these contractual limitations are similar to the Air Force's own flight and duty time requirements, including the provisions that require a minimum crew rest of 10 hours prior to the first DoD segment or between DoD segments.

Finally, we note our concerns with respect to the rapid pace of this ARC's deliberations and consideration of a very complex issue. We are concerned that this ARC has not, and cannot within the timeframe of its charter, appropriately consider the full ramifications of changes to the flight and duty rules. Given the considerable differences between the operations of the carriers represented in the ARC membership, we believe it would be appropriate for the FAA to commission a separate ARC dedicated to the supplemental carrier industry, with particular emphasis on considering the nature of unscheduled operations and the application of the fatigue science in a real world environment.

SUMMARY OF NACA RECOMMENDATIONS

In summary, NACA proposes that the ARC's final recommendations should include the following:

1. Non-scheduled operations should be treated separate and apart from other part 121 operations.
2. Non-scheduled operations should continue to be regulated under the current regulations at Subpart S, with the additional requirement that non-scheduled operators adopt FRMS.
3. The FAA should consider the establishment of a separate ARC to focus on non-scheduled operators.
4. For scheduled operations, the ARC should adopt the NACA Scheduled Duty Time, Basic (unaugmented) Crew, acclimatized proposal.

NACA Proposal for Regularly Scheduled Carriers

Scheduled Duty Time, Basic (unaugmented) Crew, Acclimatized

	Operating Segments								
Time of start	1	2	3	4	5	6	7+	Extension	CAP371
0000-0059	12	12	12	12	11	11	11	2	11
0100-0159	12	12	12	12	11	11	11	2	11
0200-0259	12	12	12	12	11	11	11	2	11
0300-0359	12	12	12	12	11	11	11	2	11
0400-0459	12	12	12	12	11	11	11	2	11
0500-0559	13	13	13	13	12	11	11	2	11
0600-0659	14	14	14	14	13	12	12	2	13
0700-0759	15	15	15	15	14	13	13	2	13
0800-0859	15	15	15	15	14	14	13	2	14
0900-0959	15	15	15	15	14	14	13	2	14
1000-1059	15	15	15	15	14	14	13	2	14
1100-1159	15	15	15	15	14	14	13	2	14
1200-1259	15	15	15	15	14	14	13	2	14
1300-1359	15	15	15	15	14	14	13	2	13
1400-1459	15	15	15	15	14	14	12	2	13
1500-1559	14	14	14	14	13	13	12	2	13
1600-1659	14	14	14	14	13	13	11	2	13
1700-1759	14	14	14	14	13	13	11	2	13
1800-1859	14	14	14	14	13	12	11	2	12
1900-1959	13	13	13	13	12	11	11	2	12
2000-2059	13	13	13	13	11	11	11	2	12
2100-2159	12	12	12	12	11	11	11	2	12
2200-2259	12	12	12	12	11	11	11	2	11
2300-2359	12	12	12	12	11	11	11	2	11

ATTACHMENT III
Records of the Meetings of the
Pilot Flight and Duty Time Limitations and Rest Requirements
Aviation Rulemaking Committee

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS AVIATION RULEMAKING COMMITTEE

Record of Meeting

July 7, 2009

FAA Headquarters—MacCracken Room

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association, Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
John Gadzinski	CAPA, Southwest Airlines Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Lyle Hogg	ATA, US Airways (attended on behalf of Chip Mayer)
Michael Hynes	ALPA, Continental Airlines (CAL)
Jim Johnson	ALPA (attended on behalf of Don Wykoff, Co-Chair)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
David Rose	National Air Carrier Association, Omni Air International
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
Jim Winkley	RAA, American Eagle Airlines
Selected Additional Attendees	
J. Randolph Babbit	FAA Administrator
Christa Brolley	PAI Consulting (PAI)
Lisa DeFrancesco	PAI
Mike Derrick	PAI
John Duncan	FAA, Air Transportation Division
Peggy Gilligan	FAA, Aviation Safety Division
Pam Hamilton	FAA, Office of Rulemaking (ARM)
Judith Jamison	FAA, ARM (attended on behalf of Shirley Stroman)
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Neil Modzelewski	PAI
Nan Shellabarger	FAA, Office of Aviation Policy & Plans
Kevin West	FAA, Flight Standards Division

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS
AVIATION RULEMAKING COMMITTEE
Record of Meeting

July 7, 2009

FAA Headquarters—MacCracken Room

BACKGROUND

On June 10, 2009, Federal Aviation Administration (FAA) Administrator J. Randolph Babbitt testified before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Aviation Operations, Safety, and Security on Aviation Safety regarding the FAA's role in the oversight of air carriers. He addressed issues regarding pilot training and qualifications, flightcrew fatigue, and consistency of safety standards and compliance between air transportation operators. He also committed to assess the safety of the air transportation system and take appropriate steps to improve it.

The FAA recognizes that the effects of fatigue are universal, and the profiles of operations under parts 121 and 135 of Title 14, Code of Federal Regulations are similar enough that the same fatigue mitigations should be applied across operations for flightcrew members. To carry out the Administrator's goal, the FAA has charted an aviation rulemaking committee (ARC) to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for pilots in operations under parts 121 and 135.

PURPOSE OF THIS MEETING

This meeting was held to introduce the ARC members to one another, to address logistical and administrative matters pertaining to future meetings of the ARC, and to discuss in general the ARC's purpose and mission.

DISCUSSION

Ms. Peggy Gilligan, FAA Associate Administrator for Aviation Safety, and Mr. John Duncan, Manager, Air Transportation Division, thanked the ARC members for their participation and opened the meeting with brief remarks. Ms. Gilligan noted that the ARC has 45 days to complete its task. Mr. Duncan noted the pressing need to address flight duty time limitations and rest requirements, and the challenge before the ARC to quickly develop comprehensive changes to the existing regulatory policy, which consists largely of numerous legal interpretations. He noted that the regulations do not address fatigue and that the FAA has attempted rulemaking several times and has not been completely successful in its efforts. He added that there is new leadership at the FAA and in Congress supporting a change.
Mr. Duncan then introduced the ARC co-chairs, and the remaining ARC members and other attendees introduced themselves and provided a brief background on their expertise in pilot flight time issues.

Record of Meeting

July 7, 2009

FAA Headquarters—MacCracken Room

ADMINISTRATIVE ISSUES

The discussion moved to administrative matters, as follows:

- **ARC members.** There was a request for the release of the names and affiliations of the ARC members. The members did not object to this request, which will be accommodated.

- **Schedule.** The schedule of future meetings was discussed. Given the short timeframe of the ARC's tasking, frequent meetings will be necessary. A proposal to meet Tuesday, Wednesday, and Thursday of each week was discussed, but the consensus reached was to instead meet 2 days per week from 9:00 a.m. to 6:00 p.m. Meetings will be scheduled for Tuesday and Wednesday of each week, with the exception of the week of July 12, 2009, when meetings will take place on Wednesday, July 15, 2009, and Thursday, July 16, 2009. If the suggested schedule of meeting 2 days per week does not provide sufficient time to achieve the ARC's mission, the ARC may reconsider meeting 3 days per week in the future, with Thursday designated as the additional meeting day.

- **Web site.** A Sharepoint Web site has been established for circulation and discussion of documents among the ARC membership.

- **Meeting discussions.** It was noted that discussion at the ARC meeting must be civil and orderly, despite opposing viewpoints. The ARC decided that, for the time being, it will not use an independent facilitator, but will self-govern its proceedings. It was suggested that some system, such as a speaker list, be developed to maintain orderly discussion of topics. It was also noted that during discussion, any ARC member may call a brief recess for any reason.

- **Dress code.** A relaxed/business casual dress code for meetings was proposed and approved by the ARC membership.

- **Alternate representatives.** The ARC discussed attendance at meetings by alternate representatives in lieu of the appointed ARC members. Concerns noted included the need for meeting participants to be familiar with the ARC's previous discussions, and the need to keep the number of meeting attendees to a minimum to avoid disruption of proceedings. The ARC discussed various proposals, including designation of specific alternates by ARC members or participating organizations. Ultimately, the ARC agreed to allow ARC members to designate alternate participants on an ad hoc basis if they are unable to attend a meeting, with the understanding that ARC members will ensure that alternates are briefed on the ARC's previous discussions, and that members will not abuse their authority to designate alternate attendees.

- **Contract support.** The ARC discussed documentation of meetings by the ARC's supporting contractor, PAI. Because the ARC will be meeting on an accelerated schedule, there is a need to develop a record that can be referred to within a relatively short timeframe after each meeting. To that end, PAI will provide two forms of meeting summary for each meeting. PAI will produce a brief meeting summary document that will be made available either the evening after a meeting has concluded or the following morning. The meeting summary will be limited to attendance at the meeting and a statement of each topic discussed, key decisions reached, and any action items assigned. PAI will also produce a more detailed record of meeting for each meeting that will further describe topics discussed and decisions made. By request of the ARC membership, and to encourage free and open discussion at meetings, comments and proposals will not be attributed to specific members or organizations in either document. For the same reason, no audio recordings of the ARC's proceedings will be made.

PARTICIPATION BY NATIONAL TRANSPORTATION SAFETY BOARD (NTSB) AND SCIENTIFIC EXPERTS

A question was raised of whether the NTSB was invited to participate in the ARC. It was noted that the NTSB does not generally participate in consensus-building groups, but it was pointed out that this is not a hard and fast rule, and that the NTSB has participated in ARCs in the past and has contributed to meaningful discussions. It also was noted that flight duty time and rest is an issue that the NTSB has focused on in formulating recommendations. The ARC agreed to extend an invitation to the NTSB to appoint a representative to the ARC.

The ARC also discussed to what extent medical and other experts should be invited to participate in ARC meetings. It was suggested to have a representative of the Civil Aerospace Medical Institute (CAMI) on the ARC. The FAA noted that CAMI has a human factors expert under contract that can be used on an ad hoc basis.

A number of competing concerns were raised about expert participation. It may be desirable for the ARC to be able to rapidly obtain expert opinions on issues as they arise in discussion, and there may be value in having potential expert participants fully familiar with the ARC's discussions. There is, however, also an interest in limiting attendance at meetings to a manageable level to maintain the ARC's effectiveness and flexibility. There is also a concern that having experts in attendance may lead to extended discussion of topics, thus reducing the ARC's already limited time.

Additionally, the scheduling needs of experts and their organizations may not permit them to timely address ARC queries on an ad hoc basis. On the other hand, if invited to join the ARC on an ongoing basis, experts may not be able or willing to devote the significant time necessary to attend meetings in what is largely an on-call role. Finally, even if experts attend meetings, they may not be able to immediately respond to ARC queries, because time may be needed to perform analysis, and they may not have access to necessary data.

A proposed alternative to expert participation in the ARC was to establish a scientific steering committee, to which questions needing expert input could be referred. The committee would then seek out the appropriate expert resources to address the questions, and report back to the ARC. It was noted that an Operations Specifications A332 (Ultra Long Range Operations) scientific steering committee is already established.

The ARC did not reach a final decision on the question of expert participation, and agreed to table the discussion until the next meeting. In the meantime, the FAA will gauge the interest of scientific experts in participating.

The question was raised of why there was no representative of flight attendant interests on the ARC. The FAA stated that the ARC's scope is limited to flightdeck crew duty time limitations and rest requirements, and that similar requirements for cabin crewmembers will be addressed separately after CAMI completes its flight attendant study.

SCOPE OF THE ARC'S PRODUCT

The question was raised if the ARC will be tasked with recommending changes to specific regulatory sections, or if its recommendations will be more broad-based. The FAA responded that its recommendations could be based on the operational environment, but the ARC will have the opportunity to examine all existing regulations. The FAA noted that its recommendations could result in significant changes to the way duty time limitations and crew rest requirements are formulated. For example, it was suggested that the nature of operations involved, such as length and number of legs, could potentially be factors in determining specific requirements, unlike existing requirements, which are general operational rules.

ADDRESS BY THE FAA ADMINISTRATOR

Mr. Babbitt addressed the ARC and made brief remarks. He welcomed and thanked the ARC members for their participation, and stressed the importance of the ARC's task. He noted that he has had a longstanding personal interest in fatigue issues, and was pleased that the issue is being addressed. Mr. Babbitt noted the public interest in flight time limitations and crew rest requirements following a Colgan Air accident earlier this year. He added that he promised Congress that the FAA would review these limitations and requirements.

Mr. Babbitt noted that change is overdue and pointed out significant advances made in understanding fatigue, risk management, and safety management since the existing limitations and requirements were promulgated, including the development of fatigue risk management systems (FRMS). He expressed confidence in the ARC's ability to apply this understanding to the creation of new requirements. He added that the rules the ARC proposes must be flexible enough to adapt to varying conditions, which will be a challenge. Finally, Mr. Babbitt noted the ARC's ambitious timeline for action, and pledged any resources the FAA can offer to support the ARC's mission.

MEDIA POLICY AND LEGAL COUNSEL

It was noted that there may be significant media interest in the ARC's proceedings, in light of the recent public interest in pilot training and fatigue issues. It was requested that, if contacted by the media, ARC members only confirm their participation in the ARC, and provide no information on the ARC's activities.

Ms. Rebecca MacPherson, FAA Assistant Chief Counsel for Regulations, stated that ARC members will not be asked to enter into nondisclosure agreements because of their need to communicate with their constituencies. She requested that, in discussing ARC proceedings outside of ARC meetings, members exercise discretion and stress to colleagues the importance of protecting the

ARC's proceedings from premature public disclosure. Ms. MacPherson stated that it is the opinion of AGC that the ARC's activities are not subject to disclosure under the Federal Advisory Committee Act. She also noted that it is likely that the ARC's activities and documents will be the subject of requests under the Freedom of Information Act and, that while any such requests will be resisted, there is no guarantee that such resistance will be successful.

Ms. MacPherson also stated that the FAA cannot delegate rulemaking authority to the ARC, but will take the ARC's predecisional document as a strong recommendation. She encouraged the ARC to propose clear, unambiguous rule language that addresses all anticipated issues, and stressed the need to fully explain the rationale for all of its proposals in the preamble. Ms. MacPherson stated that, because of the importance of the ARC's mission, she will be in attendance at all meetings of the ARC to offer points of clarification on behalf of AGC.

RULEMAKING PHILOSOPHY AND STRATEGY

The ARC members briefly discussed the level of performance needed from certificate holders under proposed regulations, and the margin of safety offered. That is, it was discussed if the minimum standards under regulations would offer little or no margin of safety, or if they would offer a substantial margin. It was also discussed if the proposed regulations should prescribe actions above and beyond compliance with minimum standards. It was noted that enforcement action cannot be taken for failure to meet a standard higher than the minimum, and that the minimum standard must be robust to ensure a sufficient level of safety. It was also noted that a proposed regulation could provide for a progressive or graduated standard, with increasingly stringent minimum compliance levels implemented over time. Such an approach would, however, be more complex.

There was some discussion of whether the ARC's proposed regulatory structure will need the certificate holder to implement an FRMS. Many ARC members stated interest in mandating implementation of FRMSs.

NEXT MEETING

The ARC began laying the groundwork for discussion at the next meeting. Several proposals were offered for what the ARC's initial focus should be, including the following:

- Achieving consensus on key terms and definitions before taking other action.
- Articulating philosophy on duty time limitations and required rest, including a rough outline of what the proposed regulatory structure should look like.
- Obtaining preliminary briefings from multiple scientific perspectives to identify issues and potential obstacles.

The general consensus was that obtaining preliminary scientific briefings would be desirable, but might not be possible on 1 week's notice. The ARC members agreed to inquire as to the availability of scientific experts for next week's meetings, but, if experts are unavailable, to prepare for each member to discuss his or her philosophy next week and obtain scientific briefings at a later time.

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS
AVIATION RULEMAKING COMMITTEE

Record of Meeting

July 15 and 16, 2009
Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association, Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
Matt Rettig	ALPA (attended on behalf of Greg Whiting on July 15, 2009)
David Rose	National Air Carrier Association, Omni Air International
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
George Villalobos	CAPA, SWAPA (attended on behalf of John Gadzinski)
Greg Whiting	ALPA, United Airlines (attended July 16, 2009, only)
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
Lisa DeFrancesco	PAI Consulting (PAI)
Mike Derrick	PAI
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Neil Modzelewski	PAI (attended July 15, 2009, only)
Kevin West	FAA, Flight Standards Division

BACKGROUND

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for pilots in operations under parts 121 and 135. The first meeting of the ARC was held July 7, 2009.

PURPOSE OF THIS MEETING

This meeting was held to begin discussing substantive topics relating to the ARC's mission.

Record of Meeting

July 15 and 16, 2009

Washington, D.C.

DAY 1–JULY 15, 2009

ADMINISTRATIVE MATTERS

Discussion began with some brief administrative matters, as follows:

- **Sharepoint site.** Mr. Kevin West, FAA Flight Standards division, instructed the ARC members on how to access the ARC SharePoint site and outlined some of the capabilities of the site to the ARC members. All members of the ARC currently, or will in the near future, have access to the site. It was decided that if an ARC member would like an associate to have access to the Sharepoint site, he or she should make a request to the ARC co-chairs, who will forward the request to the FAA.

- **Attendance by non-members.** The co-chairs requested that, in the future, if any ARC member would like potential alternates, other associates, or experts to attend meetings, the ARC member must request permission from the co-chairs. The co-chairs noted that space will be limited at some meetings. Mr. Mike Derrick, PAI, advised that due to room availability issues, the ARC would be meeting in a smaller room on Tuesday, July 21, 2009, and Tuesday, July 28, 2009, as well as August 5 and 6, 2009.

Discussion

ARC Charter

The ARC reviewed its charter to familiarize members with the ARC's mission. It was noted that the ARC's recommendations should provide a single approach to addressing fatigue that replaces existing requirements under parts 121 and 135, and should consider and address—

- Current fatigue science and information on fatigue;

- Current approaches to addressing fatigue in international standards; and

- Incorporation of fatigue risk management systems (FRMS).

It was also noted that the ARC charter specifically states that meetings are not open to the public, and stressed that attendance at the meetings is limited to the ARC members and those individuals approved in advance by the co-chairs.

ARC Process and Product

Ms. Rebecca MacPherson, FAA Assistant Chief Counsel for Regulations (AGC–200), briefly addressed the subject of the ARC's product. The ARC's charter directs it to formulate its recommendations in the form of a draft notice of proposed rulemaking (NPRM). Ms. MacPherson reinforced that the ARC must provide a clearly articulated rationale for the regulatory language it proposes. It is also necessary for the ARC to discuss any alternative proposals it considers, but does not ultimately adopt, including its reasons for not adopting them. Ms. MacPherson also suggested the possibility that the ARC's recommendations could include an entirely new part under Title 14, Code of Federal Regulations, rather than consisting solely of amendments to existing parts.

It was discussed that the ARC need not focus, in its meetings, on the specific regulatory text of its proposal, but may rely on the assistance of its support contractor, PAI. Because of the ARC's limited time, focus should be on development of concepts and on the creation of a logical organizational structure for its recommendations.

There was some discussion of whether the 45 days allotted to the ARC is sufficient for it to reach consensus on issues. Concern with the speed at which the ARC is being tasked to move and the potential for unintended consequences was raised. It was noted that consensus on all issues is not necessary as this is not a negotiated rulemaking. Rather, the ARC's goal should be to reach as much agreement as possible on the prospective regulation. It is unlikely that there will be complete agreement on all issues. It also was noted that the FAA may not accept all of the ARC's recommendations. In that case, it will be explained in the preamble. It was further noted that ARC members are in no way precluded from submitting comments critical of the NPRM to the public docket when it is eventually published.

A question was raised of whether there was sufficient expertise on the ARC to gauge how its recommendations might affect part 135 operators. It was pointed out that there has been a part 135 fatigue ARC in the past that produced comprehensive recommendations. The ARC's part 135 recommendations will be posted to the Sharepoint site.

Finally, the question was raised of what the anticipated timeline for promulgation is after the ARC completes its task. Ms. MacPherson responded that the goal is to have an NPRM in publishable condition to the Department of Transportation for review by November 15, 2009. She also stated that expedited review has been requested from the Office of the Secretary of Transportation and the Office of Management and Budget, with anticipated publication of the NPRM by December 31, 2009.

Review of International Standards

The ARC engaged in a brief review of several international standards addressing flight and duty time limitations and crew rest requirements. Co-chair Mr. Don Wykoff, ALPA, suggested that in examining international standards, the ARC should make a determination of whether any structure part or philosophies can be applied to the ARC's recommendations.

ICAO SARPs

Mr. Wykoff led a brief PowerPoint presentation on Amendment No. 33 to the International Standards and Recommended Practices, Annex 6 to the Convention on International Civil Aviation, Part I, International Commercial Air Transport—Aeroplanes (ICAO SARPs). The key points of the ICAO SARPs are as follows:

- Definitions
  - Transient fatigue
  - Cumulative fatigue
  - Flight duty period (FDP)
    - From reporting for duty to shutdown
    - Does not include commuting–crewmember responsibility to report in adequately rested condition
    - Includes deadheading, if it precedes flight duty
    - Different from duty period
- Designed to address by transient and cumulative fatigue
  - Single FDP limits
  - Limits on additional duty between FDPs
  - Limits spanning multiple FDPs
- Rest–relief from all duties for purposes of recovering from fatigue
- Exceeding limitations
  - At discretion of pilot in command/crew
  - Only in unforeseen circumstances
  - Duty extensions/rest reductions are controlled/limited
- Structure
  - Outlines basic scheme
  - Specific limitation numbers are at States' discretion

The ARC then discussed several aspects of the ICAO SARPs. It was pointed out that the ARC should examine international standards with a critical eye; although, there is a sense of urgency to the ARC's mission, it should not be pressured to adopt an existing standard as an easy solution without ensuring that it is the best approach. It was also noted that the ultimate goal of the ARC is to recommend a standard that ensures flight crewmembers are alert and rested, while maintaining operator competitiveness.

The ARC also discussed the fact that U.S. carriers are increasingly concerned with compliance amid ICAO standards, because they often form the basis for regulation of operations in foreign States where U.S. carriers operate and International Air Transport Association Operational Safety Audit standards often incorporate ICAO standards. It was pointed out that the ARC's recommendations need not rigidly follow the ICAO standards, as long as the standards ultimately adopted by the FAA meet or exceed the ICAO standards.

Finally, the question was raised of whether the ICAO SARPs provide for FRMSs. Apparently, they do not currently address FRMSs, but a working group is currently addressing this issue.

CAP 371

The ARC next reviewed the United Kingdom Civil Aviation Authority's Civil Aviation Publication 371 (CAP 371). It was pointed out that CAP 371 was promulgated over 30 years ago, and that improved understanding of fatigue and rest may have made some of its provisions outdated. It was noted that some key questions to keep in mind when examining existing standards are how overnight ("backside of the clock") flying and pairings/trips spanning multiple time zones are addressed.

Key points of CAP 371 discussed are as follows:

- Definitions
    - Acclimatized
    - Early start duty/late finish duty/night duty
    - Split duty
    - FDP
- Calculation of FDP
    - Derived from tables, based on—
        - Acclimatization
        - Local time at start
        - Number of legs

  - May be extended by—
    - Inflight relief
    - Split duty
    - Captain's discretion
- Cumulative Duty Hours — Maximum hours set for various periods
  - 7 consecutive days
  - 14 consecutive days
  - 28 consecutive days

The ARC discussed the CAP 371 provisions regarding inflight rest. It was noted that CAP 371 provides for two types of crew rest facilities: bunks and seats. It was noted that there currently is a wide variety of inflight crew rest facilities on aircrafts, and that the ARC's recommendations may have to take into account the rest facilities available to a greater extent.

The ARC discussed the CAP 371 provisions regarding extension of duty at the captain's discretion to extend an FDP or reduce a rest period. As under the ICAO SARPs, there are limitations on the extent of such extensions or reductions. The question was raised of whether an operator might potentially violate the spirit of duty time limitations and rest requirements by scheduling a pairing that would likely force the crew to agree to extend their flight duty period. It was also stated that if a pattern of such scheduling became apparent, the FAA would not permit it to continue.

EU OPS Subpart Q

The ARC also reviewed the provisions of Annex III, Subpart Q to the Commission of the European Communities Regulation No. 3922/91, as amended (EU OPS Subpart Q). It was noted that many of the definitions and some of the structure of Subpart Q are similar to those of the ICAO SARPs and CAP 371, although Subpart Q's provisions are generally less restrictive than those of CAP 371. It was pointed out that they do not include limitations on overnight flying that are desirable. It was also noted that Subpart Q contains a specific requirement for crewmembers to make optimum use of rest opportunities and facilities made available to them, and that there is a need to instill in flight crewmembers such a responsibility.

Miscellaneous Issues

During the ARC's discussion of international standards, brief notes were made on several issues not directly related to the international standards, as follows:

- **Single Pilot Operations.** It was pointed out that there are some single pilot air carrier operations in existence, and that the ARC's recommendations should contemplate such operators, and should not be structured so as to preclude such operations.

- **Conventional vs. Augmented Crew Operations.** The ARC briefly discussed the relative merits and safety of operations conducted with augmented crew and inflight rest, as compared to conventionally scheduled operations.

- **Cabin Crew.** The question was raised of how cabin crew duty time limitations and rest requirements would be addressed. The FAA stated that a decision on this issue has not been reached, but this ARC is only addressing requirements for pilots.

- **Controlled Rest.** The ARC discussed the concept of controlled rest, or cockpit napping, in which crewmembers, by arrangement, partake in inflight rest in the cockpit while other crewmembers continue to monitor the status of the flight. Controlled rest is used as a performance enhancing measure, and not to extend duty time. This concept is not currently sanctioned by the FAA, but is sanctioned by some foreign civil aviation authorities.

Philosophy Discussion Points

ARC Co-Chair Jim Mangie presented some parameters for the ARC's recommendations:

- *Science-based*

- *Data Driven*

- *Operationally Oriented (Experience Counts!)*

Regarding administrative procedure for the rule, the FAA stated that the rule has to be cost-justified, which is not necessarily equivalent to showing a benefit greater than cost. Also, regarding operational characteristics, the FAA noted the nature of respective operations should be taken into account.

Scientific Opinion

In the course of its discussion of international standards, the ARC also discussed the state of scientific opinion on fatigue, rest, and duty time limitations. It was noted that there is a wide variance among experts on what operations are considered safe. It was stated that fatigue theory, while scientifically based, is subject to interpretation, and is, in part, art rather than science. Finally, it was recognized that the onset and effects of fatigue will vary significantly among individual pilots, and it is not possible to create a single regulatory structure that will ensure a rested and alert crew in all circumstances. It was suggested that the goal should be to ensure that crewmembers are rested and alert in as high a percentage of operations as possible.

Concept Discussion

The discussion moved to a concept familiarization session. It was proposed that there be three key concept areas discussed: sleep, rest, and circadian rhythms/overnight flying. It was suggested that perhaps FRMS should be a fourth pillar, but the consensus was that FRMS would be an overarching concept that would encompass the three pillars.

It was also suggested that the ARC formulate a comprehensive list of questions to be posed to scientific experts expected to attend meetings the following week. It was pointed out, however, that scientific experts were likely to attend on more than one occasion, so it was not necessary to immediately identify all issues on which the ARC will seek consultation.

Mr. Wykoff acted as a moderator and sought the ARC members' opinions on core concepts of fatigue management. It should be noted that the concepts presented are opinions offered for discussion, and are not to be taken as the consensus or finding of the ARC.

Rest

The ARC began with a discussion of rest. It was debated what constitutes the minimum rest opportunity a crew should be afforded. Several factors were cited as impacting rest. The quality of the rest, including the comfort of crew accommodations, the lack of interruptions, and the distance from the airport to the rest facility, affects the value of rest time.

It was suggested that the length of rest time should be proportionate to the length of the duty periods preceding and following it. It was pointed out, however, that there is some scientific opinion to the effect that length of rest needed is not dependent on the length of the preceding duty period.

It was also pointed out that the timing of the duty day preceding a rest period may also impact how much rest is needed. Although crews are required to report adequately rested, it may not be reasonable to expect a crew reporting at 1800 local to be as rested and alert as a crew reporting at 0800 local.

It was suggested that the ARC break down rest into defined components. A proposed scheme was as follows: Time free from duty is the time from the end of a flight duty period, until the crew reports for duty at the beginning of the next period. Travel to and from the crew rest facility is included in time free from duty. Time free from duty also includes time for meals, hygiene, and exercise, which has value as fatigue mitigation technique. Within time free from duty is rest time. Rest is not equivalent to sleep, but also includes time to "wind down" and wake up following sleep. Within rest time is opportunity for sleep. Sleep opportunity should be 8 hours at a minimum, but is impacted by other factors. Sleep opportunity during normal waking hours (for example, beginning at 1200 local) is not equal to sleep opportunity during normal sleeping hours (for example, beginning at 2000 local).

The question was posed of how to determine how much rest is adequate. With wide variation between individuals, no matter where the minimum is set, some pilots will not get adequate rest. (It was also pointed out that there will always be some pilots who do not exercise responsibility to take full advantage of the rest opportunity that is given to them.) If minimum rest is set too high, duty periods will be shorter and pilots will have to fly more days per month to reach the same number of hours.

Previous analysis has shown this to be relatively cost-neutral to operators. However, many pilots prefer to minimize the days per month spent flying, and express that no matter what rest facilities are provided, they get their best rest when at home between pairings/trips.

It was suggested that the amount of rest should be evaluated for different operating regimes (for example, scheduled vs. on demand or short haul vs. long haul). It was pointed out that this is essentially what an FRMS does. It was also noted that FRMSs will take some time to implement, including time necessary for contract revisions. The FAA will also have to develop a methodology for approval of FRMSs.

Proposals were solicited on how to determine the minimum time required for rest. One proposal was to set a standard rest period and identify exceptions that would permit reductions to it.

A contrary proposal was to set an absolute minimum and identify factors requiring additional rest. For example, assuming 8 hours of sleep is necessary, determine how much time is required to obtain 8 hours of sleep (given variations from circadian rhythms), and then add time for non-sleep rest, estimated travel, meals, hygiene, and exercise to determine the minimum time free from duty. One question raised in response was how to handle overnights, where the preferred crew accommodations are a long distance from the airport.

A variation on this proposal was to set a “behind-the-door” time (that is, a minimum uninterrupted sleep opportunity beginning when the crew checks into the crew accommodations) that would be started on a real time basis when the crew actually arrives at the hotel. This would eliminate the need for travel time estimates.

It was proposed that the minimum time free from duty, incorporating 8 hours of sleep opportunity and all other components, should be 12 hours. This was met with some opposition. The question was raised of whether a reduction in rest would be appropriate following the first day of a trip, where the duty periods preceding and following the rest consisted of a single, short leg.

It was noted that current real world practice used time between duty periods of approximately 9 to 10 hours, and it was speculated that 12-hour minimum rest periods would not be acceptable to operators. This elicited the response that the basis for the ARC’s formation is that the current practice is not acceptable; addressing it will result either in a cost to operators, increased trip lengths for pilots, or both. A proposal was made to set 10 hours as the minimum rest period. There was a relatively even split in support for 10- and 12-hour minimum rest periods, respectively.

A suggestion was made to model the scheduling impact of building in 10- and 12-hour minimum rest periods. It was also suggested that modifications to routings might permit longer rest periods. However, it was pointed out that small increases in the length of time aircraft were left dormant at outstations have significant economic impacts. Increased rest periods in these circumstances would likely require deadheading or 30-hour overnights for crews.

It was pointed out that the current system relies on an assumption that everything will work perfectly, and when this doesn’t occur, sleep time is reduced. It was submitted that such reduced rest can be tolerated in isolation, but repeated occurrences take a toll. It was proposed that, following any reduced rest, duty should be severely restricted to mitigate the effects of the reduced rest. It was pointed out that, under the current system, even where crews are guaranteed compensatory rest during a rest period following one in which rest is reduced, they must often fly a full duty day in the interim.

It was pointed out that an FRMS would address many of the issues raised. The question was posed of whether standards should be different, depending on whether an FRMS is implemented. For example, set a minimum rest time without an FRMS, but permit adjustment below it if an FRMS is implemented. It was cautioned that while FRMSs are valuable tools, they are unlikely to be robust enough to analyze every day of every trip, and thus will not hold all the answers for addressing fatigue.

An alternative proposal was to set a minimum rest time that could never be deviated below, as well as a higher standard rest time that could be adjusted downward or upward using an FRMS. A variation on this proposal would permit the minimum time to be reduced to a lower level under unforeseen circumstances. This resulted in a lengthy discussion on irregular operations.

It was argued that irregular operations provisions are overused by operators to permit extended duty and reduced rest. It was speculated that some operators use irregular operations as a prospective scheduling tool, and a suggestion was made to track the use of irregular operations to determine if an operator was making use of it too frequently. It was also suggested that operators' schedules should take into account prevailing conditions. For example, although thunderstorms on any given day cannot be predicted when scheduling, the probability of thunderstorms in specific locales during specific times of the year should be considered when scheduling.

It was suggested that use of irregular operations provisions would be reduced if crews were not consistently scheduled close to minimum rest, but it was acknowledged that schedulers are under pressure to make optimal use of aircraft and crews.

Consensus was sought as to whether 8 hours was the minimum sleep opportunity that should be provided for, and whether it could be breached under other circumstances, including an emergency situation. The general consensus was that 8 hours was an appropriate minimum, which can be subject to input from scientific experts. As to whether the 8-hour minimum could ever be reduced, it was suggested that reduction below 8 hours be permitted under abnormal circumstances, with the provision that the crew would be relieved during the next duty period upon returning the aircraft to a crew base, and subject to restricted duty time during that duty period.

The question was raised of the timing of reduced rest within a trip. It was pointed out that, for example, abnormal circumstances could call for reduced rest on the fifth day of a trip, when cumulative fatigue has already begun to impact the crew. It was pointed out that the objective of reduced duty is to mitigate transient fatigue in such a way that it does not contribute to cumulative fatigue. It was also suggested that mitigation of reduced rest should also take into account the extended duty encountered during the previous duty period. It was noted that scientific experts expected to attend the ARC's meetings during the week of July 21, 2009, will further discuss minimum rest hours in relation to human performance and any associated risk with the ARC members.

Duty

The discussion then moved to a conversation on duty concepts. The first question raised was how to determine maximum duty times. It was generally agreed that the maximum FDP should be dependent on what time of day a crew is required to report. This raised questions regarding where and when a crew reports. For example: Does a crewmember report at his or her domicile or at the location where the aircraft is? or What impact do significant time zone differences have? The question was also raised of whether or not to address cases where pilots live in a different time zone than their domicile. It was suggested that it falls within a pilot's personal responsibility to report adequately rested, but to recognize that many factors may impact rest and alertness. It was also pointed out that operator cultures should not inhibit pilots from calling fatigue. One ARC member expressed the opinion that industry had done a poor job training and educating pilots on fatigue.

It was suggested that the Basic Crew Duty table from CAP 371 be used as a starting point for determining maximum FDPs, with the understanding that duty times would be impacted by factors such as augmented crew operations, irregular operations, number of legs, and acclimatization or lack thereof. It was further suggested that the ARC combine operational experience and merge it with the applicable science when developing the FDP regulations.

There was a discussion regarding the difficulties encountered in acclimatization on trips where significant time zone shifts are encountered, or that involve shifts in more than one direction in the same trip. The possibility was raised of using a formula rather than a table to arrive at maximum FDPs.

The meeting was recessed for the evening with instructions for ARC members to prepare to begin the following day with proposed maximum FDPs for one-leg duty days and an acclimatized crew.

DAY 2–JULY 16, 2009

ADMINISTRATIVE ITEMS

- **Attendance by Alternates.** Co-Chair Mr. Jim Mangie, ATA, acknowledged some ARC members' desire to bring colleagues to meetings as alternates or observers because they may have unique expertise to share on certain subjects. ARC members may request that the alternate be allowed to address an issue for the group. However, in general, members are reminded to keep attendance of alternates to an essential level, particularly on days that space will be limited. The meetings on Tuesday, July 21, 2009, and Tuesday July 28, 2009, will be in smaller rooms, due to room scheduling issues. Additionally, there will be invited guests at the meeting on July 21, 2009, further limiting space. ARC members are asked to carefully consider bringing any alternates or observers on those days.

- **Meeting Hours.** It was proposed that the second meeting day of each week break earlier than 6:00 p.m. to permit attendees from out of town adequate travel time. To accommodate an earlier meeting end, lunch breaks will be limited to 1 hour on those days.

DISCUSSION

Flight Duty

Discussion on FDPs resumed from the previous day's meeting with an examination of the basic, two pilot, and acclimatized table in CAP 371. Under the table, the maximum FDP is determined by the time of day that the crew reports for duty. It was assumed that the "local time of start" used in the table is the local time at the pilot's domicile. For example, a Los Angeles International Airport (LAX) based pilot would use LAX time even when reporting in other time zones, unless he or she has been acclimatized to another time zone. The definition of FDP was clarified as spanning from crew sign-in, until the aircraft is parked at the end of the duty day.

The ARC also defined a duty period, separate from the FDP, which encompasses duties not included in the flight duty period, such as post-flight checklists, debrief, and logbook write-ups. The question was raised as to why such duties were not included in the flight duty period. The rationale was offered that they did not require the same level of skill as that needed to operate the aircraft. However, it was pointed out that tasks, such as logbook write-ups, can have safety implications for future operations.

It was noted that some carriers also use the concept of a release time, which is typically 15 to 30 minutes after the end of flight duty time, as defined in CAP 371. The question was also raised of when rest time begins. It was suggested that travel time to crew accommodations is not rest time. Questions were also raised of whether deadheading is included in duty time.

The point was made that the table contemplated by the ARC would prescribe a maximum scheduled FDP, and the question was raised of how unforeseen circumstances necessitating a longer FDP should be handled.

It was suggested that crews are currently pressured to extend duty if unforeseen circumstances cause delays, although there was not agreement that this is a widespread problem. It was proposed that there should be an absolute maximum FDP that cannot be exceeded except in case of emergency, and a maximum scheduled FDP that can be exceeded under unforeseen circumstances. The absolute maximum would be determined, based on scientific methodology, to be the maximum period during which a crew could be reasonably expected to operate safely. The scheduled maximum would be a shorter period, separated from the absolute maximum by a buffer.

This proposal met with general acceptance in principle, although there was continuing discussion regarding how the absolute maximum duty period would be determined. There was some skepticism whether a maximum safe duty period could be determined with accuracy by a scientific methodology. A question was raised as to the source of the actual hour limits imposed by CAP 371. Another question included whether the limits were based solely on scientific conclusions, or if they were the product of collective bargaining. It was stated that the single-leg limits were based solely on scientific study, but that the multiple-leg included some judgment based on operational experience.

This led to discussion over what the absolute maximum FDP should be for a single-leg duty period. It was suggested that 13 hours be an absolute maximum, but there was some question of whether a pilot operating in excess of 13 hours can conclusively be said to be impaired.

It was argued that an FRMS is needed to determine the appropriate maximum duty time. It was also argued that scientific opinion was needed before any decision could be made. One ARC member referred to a scientific study that supported a conclusion that accident rates increase five-fold for FDPs exceeding 13 hours. It was suggested that the opinion of multiple experts should be sought, because reliance on a single study or viewpoint could lead to the wrong conclusion. It was also pointed out that science will not necessarily provide clear answers, but can provide assistance in making decisions.

It was proposed that the crew's experience and judgment also be a factor in determining maximum FDP. It was suggested that an FRMS could take into account the operational experience level of the crew, permitting longer FDPs for more experienced crews with better judgment. It was pointed out that FRMSs have not been fully developed, and until a mature FRMS is available, regulations must prescribe specific hour limits.

The question was raised of whether the buffer between the absolute maximum FDP and the maximum scheduled FDP should be prescribed by regulation, or should be left to operators to determine. Prescribing a buffer would reduce an operator's ability to use operational judgment, but would also prevent irresponsible operators from scheduling too close to the absolute maximum.

There was also discussion about how extensions of FDPs should be handled. There was discussion of whether discretion to exceed the maximum scheduled duty time should be left solely to the crew. (A related question was whether the captain would have sole discretion, or would require the agreement of the entire crew to extend duty.) There was concern that crews would abuse this discretion, but there was also concern that operators would pressure crews to make unsafe decisions.

It was noted that, assuming fatigue is an issue, a captain or crew should be able to decline to extend duty without fear of punishment. Questions were raised of how to prevent abuse by crews when fatigue is not present and how to prevent punitive action by operators when legitimate fatigue calls are made. It was agreed that operator fatigue policies should be nonpunitive. *[After review by the ARC membership, whether agreement was reached on this point has been called into question.]* There was some discussion regarding whether a crewmember's ability to call fatigue should be subject to specific regulatory oversight. Generally, the ARC members felt that such regulation would be overly restrictive, although a few members voiced that an FAA-enforced fatigue policy is necessary. It was pointed out that if an operator chose to extend duty over the objection of a fatigued crew, the operator could be subject to enforcement action. The ARC reached consensus that operators and crews would share joint responsibility and discretion over whether to extend duty beyond the maximum scheduled FDP, and that nonpunitive fatigue policies are essential. *[After review by the ARC membership, whether there was agreement that nonpunative policies are essential has been called into question.]*

There was also a question of whether duty time extensions should be regulated. It was suggested that operators should be required to adjust a pairing, if crews flying it exceeded the maximum scheduled FDP on a predetermined percentage of trips.

The discussion returned to a specific definition of FDP. The definition in CAP 371 was discussed, as was the ICAO definition. There was some question as to when, specifically, an FDP ends. A definition that would end the period when the aircraft engines are shut down was proposed, but it was pointed out that at times, for a variety of reasons, the crew does not shut down the aircraft engines at the termination of a flight. The ARC reached consensus that an FDP is defined to be the period from when the crew reports for duty to the block in time at the end of the last segment. *[After review by the ARC membership, whether consensus was reached has been called into question.]* It was noted that careful attention will have to be paid to the ending point when formulating the ARC's recommended regulatory text to address anomalous circumstances.

The ARC also revisited the concept of a "duty period" separate from the FDP. The ARC reached consensus that there should be a maximum duty period and that the scientific experts could help the members determine the appropriate limits. Questions arose of what activities should be considered part of a duty period. For example, it was also pointed out that pilots working for some smaller operators may be required to be at the airport well before departure to clean, load, or deice aircraft. Some operators take the position that, regardless of when a pilot arrives to perform these tasks, duty does not begin until 1 hour before departure.

Additionally, with increased use of electronic flight bags, pilots may begin preparations for a flight before reporting in at the airport. The question arose of when duty begins if a pilot downloads and reviews flight planning paperwork, before leaving the crew accommodations.

It was also proposed that where the operator's scheduling calls for a deadhead flight follows an active FDP it should part of the duty period. The rationale submitted was that deadhead legs, even though not as demanding as flying legs, still take a toll, and crews must have a recovery period appropriate to the length of the preceding duty before they can be adequately rested and alert for duty. This is particularly important when long-range deadheads are taken into account.

The ARC also discussed various concerns related to training administered in close proximity to the beginning or end of an FDP. The question arose of whether training is to be considered to constitute a duty period or an FDP. It was argued that time in training cannot constitute rest, and that pilots must have adequate rest following training before reporting for an FDP. It was also suggested that training preceding actual flight operations be considered part of an FDP, while training following flight operations be considered part of a duty period.

It was also questioned whether pilots must receive a full rest period prior to reporting for training. The example was posed of a crew coming off of a long-range flight from Japan to the United States. The crew would require a 48-hour rest period before undertaking a subsequent FDP, but it was questioned whether that crew could request to attend training after only 24 hours of rest.

Long Range/Overnight Flying

Following the discussion of flight duty time and duty time limitations for a single-leg period with a basic, acclimatized crew, the ARC began to discuss variations, such as long-range operations with augmented crews and overnight operations. Theories were considered for how such operations would be covered. It was pointed out that such operations can be fatiguing, especially if intermixed, and almost always involve out of cycle sleep. It was pointed out that FRMSs will address these variables better than prescriptive rules can, and that the regulations must prescribe rules for the short term while creating an environment for FRMS in the long term.

The ARC discussed the difference between flight hours limitations for domestic and flag operations followed. There was general consensus that treating such operations differently is not necessary or appropriate. *[After review by the ARC membership, whether consensus was reached has been called into question.]*

The ARC then moved to the issue of cumulative duty limitations and rest requirements across multiple FDPs. The question was raised of whether longer term hour limitations (such as weekly and monthly limitations) are necessary if individual FDPs are properly limited.

It was argued that cumulative limits are impacted during the day an FDP falls, with overnight flying, mixed day flying, and night flying having a greater impact on cumulative fatigue. It was pointed out that daytime sleep is less restorative than nighttime sleep. A suggestion was made to always use the same time zone for start time. This issue is further clarified in later ARC discussions.

Cumulative Limitations

A question was raised of whether cumulative time limitations should be changed from flight hour limitations to flight duty time limitations within various periods (day, week, month, and year). There was support for the view that flight duty time more accurately gauges impact on a crew's rest level than flight hours. It was pointed out that other factors, such as the number of legs and the degree of time zone shift, also play a role, although the strength of the underlying scientific support for this proposition was questioned.

With respect to daily and weekly limits, questions were posed of whether calendar days and weeks should be used, or if a rolling 24- or 168-consecutive-hour period should be used. There was a consensus to use rolling consecutive periods where you always look back.

The question arose of what rest period should be required within the rolling 168-hour period. The question was also raised of whether a sufficiently long time off could operate as a "reset," permitting a fresh start on the rolling 168-hour duty limitations. It was suggested that any such "reset" should only be permitted at a pilot's home base. The question arose of whether this was a safety issue for which regulation would be appropriate, or a lifestyle issue outside the FAA's purview.

NEXT MEETING

The ARC closed the meeting by setting forth a number of issues for consideration at the next meeting on July 21, 2009, as follows:

- How will augmented crew accommodations be accommodated under a FDP based scheme? Factors to be considered include:
  - The artificial 8 and 12 flight hours before augmentation used currently.
  - How far can duty time be expanded based on quality of rest facility (seat vs. bunk)?
  - Should flight time continue to be a limiting factor?

- How reserve duty will be accounted for under an FDP scheme.

- Further review and discussion with flight and duty time limitations under CAP 371, EU OPS Subpart Q, and ICAO Annex 6.

Pilot Flight and Duty Time Limitations and Rest Requirements
Aviation Rulemaking Committee
Record of Meeting
July 21 and 22, 2009
Washington, D.C.

Attendees

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Trevor Bulger	International Brotherhood of Teamsters, Airline Division (attended on behalf of Russ Leighton on July 21, 2009)
Jeff Carlson	Cargo Airline Association, Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
John Gadzinski	CAPA, SWAPA
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
Matt Rettig	ALPA (attended on behalf of Greg Whiting on July 15, 2009)
David Rose	National Air Carrier Association, Omni Air International
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
Greg Whiting	ALPA, United Airlines
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
Greg Belenky, M.D.	Washington State University, Sleep and Performance Research Center (attended July 22, 2009, only)
Nancy Claussen	FAA, AFS–200
Lisa DeFrancesco	PAI Consulting (PAI)
Peter Demitry, M.D.	4d Enterprises, LLC (attended July 22, 2009, only)
Mike Derrick	PAI
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division
Stephen Hursh, Ph.D.	Institutes for Behavior Resources, John Hopkins University School of Medicine (attended July 22, 2009, only)
Bob Klothe	Office of the Secretary of Transportation, C–50
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Neil Modzelewski	PAI (attended July 15, 2009, only)
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute (CAMI)
Tom Smith	FAA, Office of Policy and Plans (APO–230)

Pilot Flight and Duty Time Limitations and Rest Requirements
Aviation Rulemaking Committee
Record of Meeting
July 21 and 22, 2009
Washington, D.C.

Background

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for pilots in operations under parts 121 and 135 of Title 14, Code of Federal Regulations. Recently, the ARC held meetings on July 7, 15, and 16, 2009.

Purpose of This Meeting

This meeting was held to continue discussing substantive topics relating to the ARC's mission.

Day 1 — July 21, 2009

Administrative Items

Ms. Nancy Claussen, FAA AFS Air Transportation Division, introduced herself and noted that she is the lead on the FAA's internal rulemaking team for the pilot flight and duty time limitations and rest requirements rulemaking project. In addition, Dr. Tom Nesthus, CAMI, introduced himself and briefly described his involvement in flight and duty time research.

Mr. Mike Derrick, PAI, then briefed the ARC on the records of the ARC's proceedings, which are being maintained by PAI. PAI produces "quick notes" that are posted to the ARC SharePoint site within a day of each meeting date, often during the evening of the same day as the meeting. These "quick notes" contain brief summaries of the topics discussed during the meeting, as well as any action items assigned.

PAI also produces a more detailed record of meeting (ROM) that describes the topics discussed during the meeting in greater detail than the "quick notes." The ROM includes the various positions submitted when discussing or debating an issue, as well as any consensus reached by the ARC. The ROM also contains any action items assigned during the meeting. The co-chairs asked ARC members to point out any errors that they might find in these notes for correction.

Discussion

Review of International Standards

The ARC began the meeting with a discussion regarding two international standards that had been reviewed at the previous meeting: Amendment No. 33 to the International Standards and Recommended Practices, Annex 6 to the Convention on International Civil Aviation, Part I, International Commercial Air Transport—Aeroplanes (ICAO SARPs), and the United Kingdom Civil Aviation Authority's Civil Aviation Publication 371 (CAP 371).

It was noted that the ICAO standards could be adopted by the ARC for its recommendations, if the ARC members deem them suitable. The question was raised of whether the ARC's recommended definitions would have to be synchronized with the definitions in the ICAO SARPs. Ms. Rebecca MacPherson, FAA Assistant Chief Counsel for Regulations (AGC–200), stated that newly created definitions would have to be harmonized with the ICAO standard, but definitions already in 14 CFR could be used without harmonization.

One ARC member stated that, following the ARC's discussion at the previous meeting, he had assembled some scenarios using his carrier's scheduling vendor. Using a minimum 10-hour rest period between duty periods and the flight duty period limits in CAP 371, the number of required long overnights increased dramatically. He also noted that CAP 371's provisions allowed for construction of several pairings that violated his carrier's pilot contract, particularly those involving overnight flying.

Cumulative Limitations and Flight Time Versus Duty Time

The ARC continued its discussion of cumulative limitations from the previous meeting. The concept of limitations, based on a rolling 168-hour period, was reintroduced. It was suggested that the proposed 168-hour window was a better measure of fatigue than the existing rules, which call for 24 hours free from duty every 7 calendar days. It was noted that scientific experts expected to address the ARC the following day would speak to the ARC's proposals on this subject.

The issue was raised that certain aspects of the ARC's discussion, particularly the debate over whether restorative rest must be at a pilot's domicile, potentially touched on quality of life issues, rather than safety issues. It was made clear that there must be a safety nexus with a proposed provision if it is to be adopted by the FAA. It was noted that the scientific experts would be asked about the value of rest at home as compared with rest away from home.

There was a discussion of the difference between flight or block time and duty time. It was pointed out that a pilot flying pairings involving long, single-leg flight duty periods (FDPs) could fully comply with the limitations of CAP 371 and still exceed existing flight hour limitations. It was urged that flight or block hour restrictions are necessary and should be retained, in addition to setting FDP limits. It was suggested, however, that duty time limits were intended to replace flight time limits as more accurate measures of fatigue. This led to discussion of whether fatigue is induced by flight hours, duty time, or both, and whether flight time is more physically taxing than duty time.

There was a discussion on various hypothetical pairings, which included their fatigue impact and their compliance with CAP 371 FDP limits. It was pointed out that scientific studies have focused on flight duty time, but have not addressed non-flight duty time. It was suggested that scenarios where crews fly a single leg to an outstation and then have several hours of downtime before their next flight (sit arounds) contribute significantly to fatigue. It was also pointed out that the difficulty level of the flying experienced also impacts fatigue. For example, a duty time period involving multiple legs where inclement weather requires repeated category II approaches and/or encounters with icing conditions is much more fatiguing than one involving a single, long leg under fair weather conditions. It was suggested that the limits proposed by the ARC should be considered to be bare minimums, and that the particular circumstances under which a pairing is flown (such as flying multiple legs in a turboprop versus flying a single leg in a large commercial jet) could warrant more stringent limitations.

The question arose of whether yearly hour limits on flight time serve a useful purpose. It was pointed out that there should be some annual flight hour restriction, because a pilot could fully observe the FDP restrictions and still fly as many as 1,750 flight hours in a year.

It was pointed out that the National Transportation Safety Board (NTSB) has included a combination of duty time and flight time limitations in its safety recommendations. It was pointed out, however, that where the NTSB has identified fatigue as a accident factor, duty time, not flight time, was the operative issue. It was also noted that the ICAO standards contain flight time limitations. Therefore, removing flight time limitations from 14 CFR would require the filing of a difference from ICAO standards. The FAA also noted that, from a legal standpoint, reducing any safety standard requires a justification. The fact that there is an absence of scientific data supporting the existing standard is not sufficient justification to remove it. Scientific opinion that removing flight hour limits would not impact safety would be required. The ARC would have to show that the combination of duty limits and rest requirements in the new scheme provided an equivalent level of safety.

The ARC further discussed various issues connected with the retention of flight hour limitations in conjunction with the imposition of an FDP limitation. It was pointed out that duty time limitations address concerns over transient fatigue, while flight time limitations address cumulative fatigue issues.

The question was raised of whether longer term limits, such as weekly, monthly, or yearly limits, would suffice, or whether there should be a daily limit that was within the FDP limit. It was pointed out that a rule including dual limits would be complicated and difficult to apply.

It was noted that under the existing flight time limitations, pilots are capable of reaching their monthly flight time limits within 2 weeks. It was speculated that if, for example, the daily flight time limit was eliminated, and instead a rolling 168-hour FDP limitation was implemented, that pilots could still time out quickly. It was noted in response that a proposal for a reset rest period could address this problem, although it would permit pilots to fly up to 5 or 6 consecutive days if the duty hour limitation is not met.

It was cautioned that implementation of limits that are too restrictive could result in pilots flying many more days out of each month. The concept of a 336- or 672-hour (14 or 28 days, respectively) rolling period, instead of a 168-hour (7-day) one, was proposed. It was pointed out that some operators have long-haul pairings as long as 19 days, which would be impacted by 7- or 14-day limitations. The ARC agreed that a 672-hour/28-day rolling lookback period would be adequate to address cumulative fatigue. It was suggested that with these lookback mechanisms in place a yearly flight time limit is not necessary to address cumulative fatigue.

It was also suggested that guaranteed time off provisions, such as those contained in CAP 371 paragraph 20.2, would protect pilots from overly demanding schedules. It was argued, however, that if duty time limitations were carefully crafted, detailed time off provisions would not be necessary. Further, there was concern that guaranteed time off provisions would result in crews having long layovers away from home. The question was raised of whether the time off provisions of paragraph 20.2 are excessive.

It was suggested that, regardless of the number of hours prescribed, the concepts in CAP 371 (absolute flight hour limits, guaranteed days off, FDP limits based on time of report and number of legs, and cumulative duty hour limits), are all necessary. The ARC reached consensus that some combination of these limitations is necessary, although it was urged that modeling be done based on carriers' scheduling restrictions to determine whether a proposed scheme would be workable, particularly for regional and short-haul operators.

Reserve Duty

The ARC discussed the topic of reserve duty and its relationship with fatigue. The ARC was cautioned that many of the issues with reserve duty are industrial in nature, and not safety-based. Various definitions of reserve were discussed. The following definition was proposed "A pilot that does not have a regular flying schedule and is available for flight when contacted by the company. That pilot has no telephone or reporting responsibility to the company." In addition, the different types of reserve duty were established. Reserve duty can be classified as long-call, short-call, or airport/hotel. There is significant variation between different operators as to the rules and limitations that apply to reserve pilots, but there are some relatively consistent conditions. It was proposed that the ARC define a reserve duty period. It was also noted that the reserve duty provisions of CAP 371 are not suitable for operations by U.S. carriers.

Long-call reserve pilots are given relatively substantial advance notice of when they are to fly. This notice may be from 9 to over 24 hours. It was suggested that, in terms of FDP determination, long-call reserve pilots can be treated the same as pilots holding lines, because they receive adequate opportunity for rest before being required to report for duty. It was pointed out, however, that depending on the timing of notice and the report time in relation to circadian rhythms, pilots may not be able to obtain a full 8 hours of sleep, despite the opportunity to do so. It was noted that the lack of predictability of when they will be required to report for duty makes it difficult for pilots to plan ahead in their sleep rest cycles. The question was raised of whether, for this reason, start of duty times should have a greater impact on maximum FDP for reserve pilots than they do for pilots holding lines. It was also questioned whether a minimum time from notification of the trip to report time, that is dependent on the time of day, should be implemented. It was proposed that the ARC define short-call and long-call reserve in its draft document.

The question arose of whether long-call reserve encourages pilots to commute, rather than live near their domicile. It was noted that this is a politically sensitive issue, but it was pointed out that safety is potentially impacted if a commuting pilot arrives not fully rested. The question was raised as to whether there could be mandated rest between call in and report time. However, it was argued that, logically, pilots flying a line should also be on mandated rest when free from duty before starting a pairing.

The question was raised of how long a pilot could be on long-call reserve. It was also noted that at some carriers, pilots called off reserve may be required to fly 15- or 17-day pairings.

Short-call reserve pilots are generally given less time in which they must report for duty. It was stated that report times are typically 2 to 3 hours from call times. Airport/hotel reserve pilots are short-call reserve pilots who are assigned reserve duty away from their domicile, and remain on call at crew accommodations at another location. It was pointed out that a great number of variables may impact the maximum FDP for a short-call or airport/hotel reserve pilot. Factors raised included the following:

- **Timing of on-call period within circadian day.** It was suggested that when an on-call period starts in relation to standard circadian rhythms, alertness and state of rest can be affected. Generally, short-call on-call periods may be classified as very early morning, daytime, or night. It was suggested that daytime reserve pilots can be presumed to be well rested and alert at the start of their reserve period. For the other classifications, although pilots are expected to be adequately rested at the start of their reserve period, circadian factors may make pilots less alert and rested than a daytime reserve pilot. It was suggested that pilots called to report during overnight hours should have a reduced maximum FDP, regardless of other factors.

- **Length of on-call period.** It was noted that there is variance in the length of on-call periods for short-call reserve pilots. At some carriers, on-call periods were relatively short, lasting only a few hours, while at other carriers, pilots could be on call for 12 hours or more. It was discussed that some operators require reserve pilots to be on call 24 hours a day when they are on reserve duty.

- **Timing of call and report time in relation to on-call period and length of duty day.** It was pointed out that during an on-call period, the time the pilot is called and the time the pilot is expected to report may affect the pilot's alertness and rested state. A hypothetical case was stated where a pilot was scheduled with an on-call period running from 8:00 a.m. to 2:00 p.m. The question was raised of whether the pilot could be reasonably expected to fly for a full FDP if he or she was called close to the end of the on-call period.

- **Recent on-call history.** It was noted that pilots with on-call schedules often change from day to night, or vice-versa, within a short period of time. Such changes, especially if given with short notice, can result in pilots failing to obtain adequate rest before their on-call periods. It was suggested that restrictions or prohibitions be placed on such changes.

- **Embedded partial rest.** It was pointed out that pilots on short-call reserve might be able to get some restorative sleep during their on-call period, particularly if the period falls completely or partly during normal circadian night. The question was raised as to the value of such rest during the on-call period. It was agreed that this question would be posed to scientific experts scheduled to address the ARC.

Ultimately, the concern raised by consideration of all of the above factors was that pilots would be on flight duty after being awake for extended periods of time. It was suggested that there be a maximum number of hours that a reserve pilot can be expected to be awake. For example, if a pilot is on call beginning at 8:00 a.m., any FDP to which he or she is assigned should be scheduled to end no later than a certain time, such as 2:00 a.m. the following day. It was also suggested that short-call reserve pilots begin their duty period when called, as opposed to when they report. Others suggested that all time on reserve should count as duty time. It was argued, however, that whether reserve time counts as duty time should be a function of certain factors, such as the time of day and whether the pilot has an opportunity for embedded partial rest.

It was suggested that reserve duty be classified as such, and be separate from flight duty or the duty day. It was also suggested that time when a pilot is not on duty or on reserve should be classified as free from duty. It was noted that the ICAO standards call this time "a break in duty."

Certain questions were also raised regarding the impact of deadhead flights before reserve duty, or at the beginning of a reserve assignment. There was general agreement that deadhead flights are to be considered duty time. The issue of how operational delays affect reserve duty was also discussed. Finally, there was discussion of how augmented reserve crews might be used to mitigate fatigue and rest issues related to reserve duty. It was noted that the type of rest facilities need to be addressed in the rule or in advisory material.

DAY 2 — JULY 22, 2009

ADMINISTRATIVE ITEMS

Co-chair Jim Mangie, ATA, reminded the ARC of the importance of reviewing the notes from the previous meetings and to bring any discrepancies to the attention of the co-chairs to keep an accurate record of the group's work on an accelerated timeline.

DISCUSSION

Presentations by Scientific Experts

Drs. Greg Belenky, Washington State University, Steven Hursh, John Hopkins University School of Medicine, and Pete Demitry, 4d Enterprises, LLC, were introduced to the ARC. Drs. Belenky, Hursh, and Demitry are experts in the field of sleep, fatigue, and human performance. Drs. Belenky and Hursh made presentations to the ARC on studies relevant to the ARC's tasking. Dr. Demitry did not present to the ARC, but provided commentary related to the application of the science in the operational environment and responded to questions from the ARC.

Drs. Belenky's and Hursh's presentations can be found on the ARC SharePoint site in a folder titled "Scientific Expert Presentations," in the Background Documents library. The topics covered by each presentation are listed below, but no attempt has been made to summarize the presentations here. Selected comments of interest made by each scientist are noted below each presentation. It should be noted that the ARC was cautioned against extracting a single finding from a study and applying it as a broad, guiding rule.

Presentation — Dr. Belenky

- Operational environment and sleep
- Sleep/wake cycle
- Sleep deprivation/restriction
    - Importance of sleep
    - Effects of sleep deprivation
    - Fatigue
    - Sleep restriction and performance
- Shift work
- Regulation and prescriptive hours of service rules
- Fatigue risk management systems

Comments

- As you age, your ability to obtain sleep deteriorates.
- Eight hours of sleep a night sustains performance indefinitely.
- Scientists do not know how long it takes to recover from prolonged sleep restriction.
- People differ in how they respond to sleep loss and resulting performance.
- People are not good judges of how fatigued they are.
- Five percent of the population is resistant to sleep loss.
- Performance degrades at 36 hours with overt lapses in performance.
- Napping increases total sleep time.
- Caffeine should be used to stay awake only when needed so a tolerance to its effects is not developed.
- The fact that performance and sleep propensity follow the 24-hour circadian rhythm in body temperature is something you cannot change.

Following Dr. Belenky's presentation, Dr. Demitry briefly addressed the ARC. He noted that a tremendous amount of work has been done in the field of sleep and fatigue study since the 1980s, and only now are the most important findings of that work being applied operationally.

Presentation — Dr. Hursh

- Fatigue
    - Symptoms/consequences
    - Major factors
    - Benefits of reduced fatigue
- Biomathematical modeling of fatigue and performance
    - SAFTE simulation model
    - Model results
- Fatigue factors in aviation
    - Work schedules and circadian patterns
    - Sleep opportunities
    - Mitigating sleep debt
        - Augmented sleep (naps)
        - Controlled rest on flight deck
        - Layover requirements
        - Recovery sleep
    - Cognitive fatigue and workload
    - Preventing fatigue — Fatigue risk management systems (FRMS)

Comments

- There is no physiological marker for fatigue.
- The sleep reservoir is sensitive to quality of sleep. Sleep should not be fragmented with interruptions. Temperature, noise, and turbulence modulate how beneficial the sleep is and how performance is restored.
- There are lapses in attention with reduced sleep.
- People are not good at judging their own level of sleepiness.
- Total sleep is the key.
- In-flight naps with augmented crews are dramatically helpful.
- Prescriptive regulations help you eliminate cases of high fatigue but do not enhance performance of those fully rested.
- Be careful what you wish for in drafting regulations. Look for downstream effects that would offset your benefits.

After the presentations, Dr. Nesthus provided an overview of current studies underway. He noted that CAMI is performing a study on ultra-long-range (ULR) flight operations that will not, unfortunately, be ready before the ARC completes its tasking. CAMI is also engaged in a field study of flight attendant fatigue. Dr. Nesthus noted that flight attendant work schedules are comparable to those flown by pilots.

Drs. Demitry and Hursh cautioned the ARC on the limits of applying scientific conclusions to a specific scenario. Dr. Demitry stated that modeling is valuable, but it is difficult to ascertain the validity of a model when it is not corroborated by empirical data. Dr. Hursh also addressed the limitations of models. He noted that the structure of a model may not accurately depict the real world. Additionally, he noted that models make use of assumptions regarding how much sleep people get under various circumstances. To the extent that these assumptions are incorrect, the models are not accurate. Dr. Hursh noted, however, that ongoing studies using wrist-worn actigraphs may provide better information on how much sleep people actually get. Finally, he noted that model-based studies draw conclusions about the average person, and there is no way if knowing if a specific individual will behave in accordance with the model's predictions. Ultimately, a model is a good tool for assessing comparative risk, but will not predict an accident with any accuracy.

Dr. Demitry echoed Dr. Hursh's thoughts on the limitations of models. He stated that a model cannot be used to derive a bright-line safety standard. He suggested that an ideal approach would be to consider fatigue as one factor in a matrix of risk factors, incorporating all circumstances encountered on a particular day.

Questions and Answers

Following formal presentations, the ARC and the scientific experts engaged in an extensive question-and-answer session. First, Drs. Belenky, Hursh, and Demitry addressed a list of questions that the ARC members had prepared in advance. They then accepted additional questions from individual ARC members.

Prepared Questions

What is the science behind the limitations contained in the ICAO SARPs (Annex 6)/CAP 371/ EU Subpart Q?
Dr. Demitry noted that Dr. Curtis Graeber is the authority most familiar with the basis for the ICAO SARPs. He stated that they were based largely on subjective work using the Samn-Pirelli subjective scale, which can result in skewed, biased, or otherwise inaccurate data. He also noted that the ICAO SARPs do not include performance metrics or physiological metrics.

Dr. Hursh noted that the ICAO SARPs paved the way for the use of circadian rhythms in rulemaking.

Is there data that shows that a shift from a flight time limitations scheme to a duty time limitations scheme is safer?
Dr. Hursh stated that researchers can only extrapolate from the physiology lessons they learn in the laboratory. He stated that duty time, and not flight time, is what limits pilots' opportunity to sleep. Dr. Demitry stated that science describes what you need to sleep, and recommended starting with the necessary sleep time and build from that to where you want to be. Dr. Belenky noted that duty time limitations are a stronger predictor of sleep and rest opportunities than flight time limitations.

How does fatigue vary among the different types of operations? Number of legs?
Dr. Demitry stated that there have been studies involving multiple-leg pairings. More legs are fatiguing, although a one-leg difference may not make a discernible difference in fatigue. It is important to note that fatigue is dependent on factors such as the time of day, how demanding the flying conditions encountered are, and when you are flying in your circadian rhythm. Dr. Hursh noted that takeoffs and landings were taken into account with other factors in studies he had performed.

Discuss number of legs (Are seven legs worse than two, with a 4-hour sit between?).
Dr. Belenky stated that there has been no formal study comparing the scenarios posed, so there is anecdotal data only. He stated that the adrenaline rush of takeoff and landing can wear you down, but that some find downtime between flights exhausting.

Dr. Demitry referenced a New Zealand study that determined that fatigue levels vary for pilots flying a seven-leg trip, depending on what other factors are present.

Drs. Hursh and Belenky pointed out that the 4-hour wait certainly extends the pilot's duty period, causing him or her to be awake for that much longer.

Discuss "backside of the clock flying" and flying across multiple time zones.
Dr. Hursh acknowledged that some operations inherently and unavoidably involve "backside of the clock flying," but stated that such flying is not necessarily unsafe. It does, however, require mitigations, such as napping facilities and training for pilots on mitigations for sleep restriction. He noted that pilots who do not regularly engage in "backside of the clock flying" are likely to have a more difficult time in comparison to pilots who regularly fly during the late night/early morning hours.

Discuss acclimatized versus flying based on operational environment. (Continuous overnight flying versus intermixed schedule.)
Dr. Belenky stated that a person 12 hours out of phase will gradually acclimatize to the new time zone. He stated that full acclimatization to a 6-hour time shift requires 6 days, depending on the person in question and the amount of light exposure. He stated that continuously working night shifts does not acclimatize a person to working at night. A night shift worker will remain synched to normal daytime activities with nocturnal sleep, and will revert to that schedule on days off. He stated that an intermixed schedule is probably better than continuous overnight flying, because light cues assist acclimatization.

Dr. Demitry stated that no one acclimatizes fully, but only get closer to the new time zone. Dr. Hursh posed the hypothetical case of a pilot who flies from the east coast of the United States and to Asia, and then continues to fly within the new time zone. He stated that the pilot may synchronize to Asia time, experiencing acute sleep debt and then recovering. He noted that once this has occurred, it is necessary to readapt to home time once you return.

Discuss more than three nights of all-night flying.
Dr. Belenky stated that repeated overnight flying will degrade performance. He stated that 3 days with 5 hours of sleep per night will systematically degrade performance over time. Dr. Hursh concurred, noting that there is no magic number that will tell you what is safe and what is not. Repeated overnight operations are a degrading factor that could be problematic.

Discuss extending duty by augmenting crews.
Dr. Belenky noted that augmented crews present a good opportunity for in-flight sleep, but it must be taken advantage of. Augmented crews do no good if the entire crew is awake. Dr. Demitry noted that the value of augmented crew operations depends on the sleep facility available. A quiet, flat bunk is the most desirable. He observed that ICAO addresses rest facilities very eloquently in a common sense way, with weighted levels based on facility. Dr. Belenky stated that sleep in flight has some restorative value, and noted that the flatter you are able to lie, the more benefit, because sitting up increases blood flow to the brain and causes emission of norephrenephrine, which is arousing.

Can the scientific data for very long range (VLR) apply to 10 hours of flying?
Dr. Demitry said that some VLR and ULR data could apply to shorter flights. He cautioned that such operations could not be started when tired, and that the middle of the window of circadian low (WOCL) was bad. Preflight and in-flight mitigations would be the same for both VLR and shorter legs, but it would depend whether the sleep opportunities are the same. Dr. Hursh stated that in-flight rest should be proportional to the length of the trip, and is typically 5 to 6 hours for ULR.

What is the scientific data on traveling on long deadhead flights (14 hours) before conducting international flights? Acclimatized to home base.
Dr. Hursh stated that deadheading before flying an international trip could be done if there is a nighttime sleep opportunity on home base time. Dr. Demitry stated that mitigation strategies would be necessary. Dr. Nesthus referenced a CAMI study of maintenance personnel traveling long distances, and noted that anecdotally, it is a difficult situation. Dr. Hursh stated that acclimatization is not the most significant factor, and sleep opportunity before flying is the most important.

Discuss rest (8 hours of uninterrupted sleep opportunity (does 4 hours + 4 hours not = 8 hours?)
Dr. Belenky noted that split sleep is an area of intensive work. All other factors being equal, if the total amount of actual sleep is the same, split sleep is as valuable as continuous sleep. All sleep is, to some extent, restorative, but the value of sleep is impacted by when in the circadian rhythm it falls. Dr. Belenky stated that split sleep with 4 hours during a circadian night is better than 8 hours of continuous sleep not during a circadian night. Dr. Hursh stressed that actual sleep is important, and noted that a 4-hour sleep opportunity may only net 2 hours of actual sleep. Dr. Demitry stated that it is less clear if a split sleep involving a 2-hour segment and a 6-hour segment is equivalent to 8 hours of continuous sleep.

Discuss sleep, rest, and circadian rhythms.
It was noted that this question has been covered in detail during the presentations.

Discuss sleep accommodations: bunk versus seat.
It was noted that this question had largely been covered already during the presentations. Dr. Demitry stated that an in-flight bunk provides roughly 75 percent of the restorative sleep value of conventional sleep facilities. He noted that lying flat on an aircraft is not as good as lying flat on a bed on the ground. Dr. Hursh stated that his models value sleep on a bunk at approximately 66 to 80 percent of normal sleep, and values sleep in a coach seat at approximately 50 percent of the value of normal sleep.

Discuss minimum rest hours and the affect on human performance. What are the risks?
Dr. Belenky stated that there is a decrease in performance as sleep is lost, but there is no bright line where performance suddenly declines. Dr. Hursh stated that the decline is continuous. He stated that the focus should be on the total time spent below some benchmark amount of rest to manage total risk. Dr. Demitry stated that reduced rest will result in complacency, loss of concentration and communicative skills, and a decreased ability to do calculations.

Dr. Hursh stated that crew resource management (CRM) is a good first approximation to a mitigation. Fellow crewmembers should be cognizant of things such as slurred speech, droopy eyes, or requests to repeat things, combined with looking at the length of time left in the duty period. He stated that planning ahead is important; any decrease below 7 or 8 hours of rest will reduce performance. He urged that rules be written to permit restorative rest opportunities to stop the accumulation of sleep debt.

Is there scientific data that supports going below minimum requirements?
The doctors agreed that there are too many factors such as time of day and weather, which have to be considered to provide an answer. Dr. Hursh noted that it is possible to fly to the west coast of the United States and then back east, and still sleep 8 hours at night if done at the right time of day. Dr. Demitry pointed out that no anomalies can occur in that scenario.

What is the scientific data on reduced rest and duty the following day?
It was noted that mild sleep restriction reduces performance over time, depending on how much sleep is reduced. Dr. Belenky urged the members to review the sleep dose/response study results in his presentation.

Discuss the difference between being tired and being fatigued.
Dr. Demitry stated that a tired person can still perform, while a fatigued person will experience demonstrably decreased performance. Dr. Hursh stated that a combination of effects, such as time of day (landing in the WOCL) and workload, contribute to fatigue.

Discuss transient fatigue versus cumulative fatigue.
Dr. Demitry stated that there are three types of fatigue: transient, cumulative, and circadian. Transient fatigue is acute fatigue. Dr. Hursh urged the ARC to be clear on definitions, because they are pivotal to how scientists interpret data.

Discuss the cumulative effects of duty time.
Dr. Hursh stated that repeated infringement of duty time on opportunity to sleep is accumulated sleep debt.

What are fatigue mitigation techniques? (Exercise? Cockpit napping?)
It was stated that the biggest mitigations were sleep and avoiding flying during the circadian low. Cockpit napping was advocated. Dr. Nesthus stated that the Aerospace Medical Association is developing a resolution to support cockpit napping, and that short bouts of sleep are helpful out of proportion to the sleep exchange.

Dr. Demitry stated that exercise[1] as a mitigation has mixed reviews. He stated that bright lights are not especially effective in affecting melatonin. Sleep is a consistently helpful mitigation, and caffeine is effective at increasing performance in the short term.

Are there studies on performing activities that are not rest before reporting for flight duty? Commuting?
Dr. Belenky stated that commuting is a controversial subject. He stated that the total wake time is at issue. A commute abutting your duty day is time awake. Commuting separated from duty by sleep is not an issue. Dr. Demitry stated that commuting must be examined on a case-by-case basis.

Dr. Nesthus stated that if there is no opportunity to recover, commuting is not good. Dr. Demitry pointed out that the effects of commuting are highly variable. You can commute a long distance via automobile in heavy traffic or via airplane. He noted that a mature FRMS would take into account

[1] The question on exercise as a fatigue mitigation strategy referred to exercising on a layover at a hotel. Dr. Demitry's response was regarding exercise as a fatigue mitigation technique aboard the aircraft.

factors affecting the pilot's alertness. He stated that ultimately, the amount of sleep is the answer. It was also noted that in the Colgan accident, modeling predicted that the first officer would be more alert than the captain with her commute from the west coast of the United States, and the captain had been awake since early in the day.

What is the science on resynchronization issues? Twenty-day pairings with 24-hour layovers with one, two, or three legs.
Dr. Belenky stated that resynchronization requires 1 day for each time zone you shift. The circadian clock is sensitive to rapid changes in time zone. Dr. Demitry stated that there are many variables, but long trips are a potential disaster requiring mitigation strategies. He stated that 24 or 48 hours of rest is not adequate rest during such pairings. He pointed out that sometimes 18 hours or less of rest opportunity is actually more restorative because of circadian issues.

Discuss studies that show an increase in accident rate past a given point (13 hours cited).
Dr. Belenky stated that an extension of the duty day leads to more accidents. However, you can have accidents in the first 1 to 2 hours of duty. The models show that as the duty day is extended beyond 16 hours, you will see degradation in performance.

Discuss cumulative fatigue-rest in a hotel versus. rest at home.
Dr. Demitry stated that hotel rest is not as restful as home rest. Dr. Belenky pointed out that some people tolerate a hotel environment better than others, and hotel rest could be the same as rest at home. Dr. Demitry acknowledged that if the hotel is quiet and comfortable, and provides darkness with an appropriate temperature during sleep, it should be okay.

Discuss performance level degrading with occasional sleep debt (that is, normal sleep, then one night of less than normal sleep because of operational necessity).
Dr. Belenky stated that recovery sleep should be used to address sleep debt, but occasional restriction of sleep is okay. He stated that in the first 24 hours of sleep loss, the primary component of degradation is circadian, not time awake. Dr. Demitry stated that the scenario falls into the cumulative bin of sleep debt.

Discuss: FRMS is at a very early stage and not a silver bullet. We cannot rely on it too heavily at this point for solutions.
Dr. Belenky noted that two airlines have implemented FRMS: EasyJet and Air New Zealand. He noted that EasyJet's FRMS is complicated. He stated that Air New Zealand uses the Samn-Pirelli fatigue scale and works to reduce high scores. He added that Air New Zealand has a collaborative relationship with its regulator on the FRMS.

Dr. Demitry stated that mitigations need to be explored scientifically, and it is important to have a feedback loop so that improvements can be recognized. He noted that methodology is important, and industry appears be headed toward FRMS.

Dr. Belenky stated that a mature FRMS could be circadian aware, and account for individual differences, perhaps even including actigraph data. An FRMS should manage supply of sleep as a matter of safety, performance, and reduced risk.

Ad Hoc Questions

Slingshot trips.
A question was posed regarding boomerang or slingshot trips, where position of travel around the globe is changed. Dr. Hursh stated that having sleep opportunities during physiological night is the most important mitigation, and arranging block times to permit that is key. He also suggested that an applicable regulation should allow for flexibility and iterative adjustment.

Team performance metrics.
It was noted that studies have focused on individual performance metrics, and it was asked if team performance has been studied. Dr. Hursh stated that the National Aeronautics and Space Administration is doing research involving simulated missions at night, and has observed that communication deteriorates in the middle of the night. Dr. Demitry stated that such an observation could be implemented into training. Communication deterioration would be dependent on training and crew discipline. Dr. Hursh stated that fatigue awareness training should be a key part of CRM. He also suggested that route guides for positioning of sleep could be developed for augmented crews.

Split sleep.
A question was asked of how best to position split sleep. Dr. Demitry stated that the larger portion of split sleep would ideally fall during the WOCL. Dr. Belenky reiterated that split sleep with a component at night is better than consolidated sleep during the day. Dr. Hursh recommended protecting some sleep to take place at night, and not to discourage taking naps. It was pointed out that there is an overhead involved in getting to sleep, and that split sleep multiplies that overhead. Thus split sleep with 4 hours at night and 4 hours during the day would, over time, result in a cumulative sleep debt.

Number of flight segments.
It was asked if there is any data on the impact of number of flight segments. The scientific experts stated little has been done to study the effects of adrenaline. Dr. Hursh noted that the number of segments has some impact on pilots calling in fatigued, but quantitative data is not available to equate sectors to sleep debt. As a result, judgment and common sense must be used.

The question was raised of whether the vibration of a turboprop compounds fatigue in comparison to a turbofan. Dr. Hursh stated that there was likely little quantitative science addressing the question, and common sense would have to be relied on. He stated that a mature FRMS would help identify sources of fatigue through feedback loops.

Establishing duty limits.
The question was asked on how to write rules where the science is not clear. It was noted that the ARC had looked at CAP 371, and the duty limits in column 1 of paragraph 20.2 appear reasonable. The remaining limits are presented by number of sectors in a linear fashion, gradually reducing the duty limits with a corresponding increase in the number of sectors. It was further asked if there is a problem with a linear approach. Dr. Belenky noted that a statistically linear assumption may not be a bad approach. He then asked what is the slope of the degradation.

Dr. Hursh noted that flying four sectors is not much more than flying two sectors, but additional limits would be needed for flying six and seven sectors. He recommended using ranges for the number of sectors instead of a single column for each sector: 1 to 3 or 6 to 9. Dr. Hursh noted that you have to consider how the limits in the table in combination with the other rules force you to perform operations that are more fatiguing in order for the operator to make money. He cautioned the members to review the limits as a whole and test the downstream consequences.

Continuous duty overnights.
A question was posed regarding standup overnight trips and what recovery is necessary following them. Dr. Hursh responded that factors such as ground transportation and rest facility quality play into the equation. Dr. Demitry stated that the rule has to address this practice to require sleep at the hotel. It was noted that a schedule that allowed the pilot to get some sleep during the WOCL at an adequate rest facility, and then obtain the remainder during the day, would be generally okay. However, it was pointed out that irregular operations can sometimes eliminate the opportunity for sleep during the WOCL. Dr. Hursh stated that standup overnights are economically driven, industrial issues that create fatigue.

Maximum duty time.
The question was posed of what the maximum time on duty should be, in light of the sharp increase in accidents as duty time increases. A 16-hour duty day was specifically referenced. Dr. Belenky pointed out that time on duty is dependent on rest. If 8 hours of sleep in the WOCL is available, then 16 hours is a possibility.

Sleep requirements.
A question was raised of whether the amount of sleep required is impacted by the time on task before or after. Drs. Belenky and Hursh stated that 8 hours is sufficient to restore the average person, but individuals are subject to variation. Dr. Hursh suggested that better data collection in the future could offer a clearer answer. Dr. Belenky noted that 8 hours of sleep requires more than 8 hours in bed.

Maximum flight duty period.
A question was posed regarding setting a maximum FDP. The concept of setting an absolute maximum and working backward to establish a buffer was discussed. It was noted that people are not very good at evaluating their own fatigue level or predicting how it will progress. It was noted that science could not provide a clear answer on how to structure the requirement. Drs. Belenky and Hursh stated that occasional extensions of duty would likely be okay, but consecutive extensions would not be. They suggested that if a duty period was extended once, subsequent extended duty periods should not be allowed and recovery rest should be required. Dr. Hursh suggested that a maximum duty limit be set and allowed to be exceeded with a frequency check.

Recovery test.
A question was raised of whether 24 hours of rest is adequate to recover from cumulative fatigue. Dr. Hursh stated that it depended how the 24 hours is used, but the operative factor in recovery is sleep. They noted that it is difficult to apply controlled studies to real-world operations, so it is not possible to say with certainty what amount of time off is necessary. It was noted, however, that the amount of rest required for a pilot flying a daytime schedule would likely be insufficient for a pilot flying overnight

pairings, because of circadian issues. The question was raised of what additional factors must be considered for pilots on long pairings with major time zone shifts. Dr. Hursh stated that 24 hours off would be necessary to find the right sleep opportunity, and that two nights of sleep might be necessary to recover from desynchronization. It was cautioned that 24 hours might be a poor choice if, for example, a pilot slept for the first 8 hours and then was awake for 16 hours before reporting for duty.

Crew scheduling crossing multiple time zones.
A question was posed involving a hypothetical trip departing San Francisco International Airport (SFO) at 10:30 p.m. and arriving at Washington Dulles International Airport (IAD) at 6:30 a.m., with a 12-hour layover and a return trip to SFO. The question was whether a west coast or east coast crew is best positioned to fly the sequence. It was stated that it did not make much of a difference, but the west coast crew was entering their WOCL at the time of landing, whereas the east coast crew would have already passed through the WOCL before landing and actually be on an upswing, giving them a slight advantage.

Excess rest.
The question was raised of whether there is such a thing as too much rest. Dr. Belenky stated that studies have shown 8 hours to be optimal for most people. He stated it is not possible to get too much sleep. If your sleep reservoir is full, you will not continue to sleep.

Reserve/stand by duty.
The question was raised of whether the unpredictability of reserve flying impacted ability to rest before a trip, as compared with the predictability of a lineholder's schedule. There was not clear agreement between the scientific experts, but it was agreed that, depending on when a reserve pilot is called and how much notice he or she is given, he or she may not have the opportunity to nap that a lineholder would have. It was also noted that a reserve pilot might not nap if he or she thought a call was unlikely. The question was raised of how a reserve pilot on short notice with a rolling window should best prepare for the possibility of a call. Dr. Belenky suggested a normal night's sleep and a late afternoon nap during the afternoon minor WOCL.

International flying.
A hypothetical question was posed in which a pilot flies from somewhere in the Midwest to Narita International Airport. The question was raised of whether duty time should be shorter because the pilot is nonacclimatized. The consensus of the scientific experts was that it would depend whether the pilot is given a sleep opportunity during the WOCL for his domicile time, and what the timing of that sleep opportunity is. It was noted that, if, for example, the WOCL for the pilot's domicile fell during the beginning of a 24-hour layover, the pilot would be entering his or her WOCL when reporting for duty the next day. Dr. Hursh suggested that in this case, a 36-hour rest period might be more appropriate. Dr. Belenky stated that it is not difficult to shift the WOCL forward by staying up late and sleeping in, as long as sleep beings in the WOCL. It was pointed out however that, depending on the pilot's pairing schedule, it may be desirable to stay on domicile time. Dr. Demitry stated that the best practice will be dictated by what the pilot's next duty day consists of. It was suggested that augmented crews and in-flight sleep could mitigate many of the potential problems raised in this case.

Consecutive night duty periods.
A question was raised of why, on a pairing with five consecutive night duty periods, the first night is the most difficult. Dr. Hursh noted that modeling predicts otherwise, the acknowledged that the models could be wrong. Drs. Belenky and Hursh stated that it could be because of the difficulty in changing sleep patterns. They also suggested that the first night may only be perceived to be the worst because the pilot adjusts to the impairment caused by the sleep restriction.

Commuting.
A question was posed regarding the impact of commuting on fatigue. It was noted that the issue is not commuting, but whether the pilot has had adequate sleep (7 to 8 hours of sleep every 24 hours) and if the duty period requires him or her to work through the WOCL.

Acclimatizing in Asia.
A question was raised of whether a pilot would acclimatize to a major time zone shift from the United States to Asia if he or she flew within Asia for several days. Dr. Belenky responded that over time, the pilot would gradually acclimatize because of light exposure. It was asked if this would be impacted if the pilot's schedule called for a mix of day and night flying. Dr. Hursh responded that it would be difficult to predict the pilot's exact circadian rhythm under such circumstances.

Next Meeting

Mr. Mangie stated that at the next meeting, the ARC will discuss the timeline of the work necessary to meet its deadline of September 1, 2009, and stated that drafting work must begin. ARC members are encouraged to familiarize themselves with the definitions and limits in CAP 371, ICAO Annex 6, and European Union Regulations, Subpart Q documents and how they pertain to potential new regulations for the United States The ARC should also be ready to begin populating the foundation of duty limitations for a single-leg, two-person, and acclimatized crew.

Mr. Mangie reminded the ARC that the space for the meeting on Tuesday, July 28, 2009, will be constrained, and asked the ARC members to consider very carefully before bringing additional personnel, to avoid exceeding the capacity of the room.

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS
AVIATION RULEMAKING COMMITTEE
Record of Meeting
July 28 and 29, 2009
Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association (CAA), Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
John Gadzinski	CAPA, SWAPA
Michael Gerdes	CAA, ABX, Air Inc. (attended on behalf of Jeff Carlson on July 29, 2009)
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
David Rose	National Air Carrier Association, Omni Air International
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
Greg Whiting	ALPA, United Airlines
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
Peter Belenky, M.D.	Office of the Secretary of Transportation, C–50 (attended in the afternoon, on behalf of Bob Klothe on July 28, 2009)
Lisa DeFrancesco	PAI Consulting (PAI)
Mike Derrick	PAI
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division
Bob Klothe	Office of the Secretary of Transportation, C–50
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute (CAMI)
Matt Rettig	ALPA
Tom Smith	FAA, Office of Policy and Plans (APO–230)
Larry Youngblut	FAA, AFS–200

Record of Meeting

July 28 and 29, 2009
Washington, D.C.

BACKGROUND

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for pilots in operations under parts 121 and 135 of Title 14, Code of Federal Regulations. Recently, the ARC held meetings on July 7, 15, 16, 21, and 22, 2009.

The ARC discussed some issues on both days of this week's meeting. For this reason, this record of meeting is not divided into 2 days, but instead addresses the issues and topics discussed at the meeting.

PURPOSE OF THIS MEETING

This meeting was held to continue discussing substantive topics relating to the ARC's mission.

ADMINISTRATIVE ITEMS

Co-chair Mr. Don Wykoff, ALPA, presented a timeline for the ARC's achievement of its mission to provide recommendations to the FAA by September 1, 2009. The timeline calls for the ARC to address maximum duty periods and minimum rest, and begin to address reserve duty during the current week's meetings. It was noted that the ARC has limited time and will have to reach as much consensus as possible without protracted discussion of each issue to be addressed.

A question was raised of what implementation timeframe the FAA expects once a regulation is promulgated. It was stated that the implementation timeframe will likely be 2 years.

To accelerate its progress, it was proposed that beginning the week of August 9, 2009, the ARC meet from 9:00 a.m. to 1:00 p.m. on Thursday, August 13, 2009, in addition to meeting Tuesday, August, 11, 2009, and Wednesday, August 12, 2009.

DISCUSSION

In previous meetings, the ARC developed baseline concepts and received briefings from scientific experts in the field of sleep, fatigue, and human performance. In this meeting, the ARC began deciding on actual standards to become part of its recommendations to the FAA.

Flight Duty Period (FDP) Limits

The ARC first addressed proposed crewmember FDP limits. The discussion focused on a chart in a format similar to the tables contained in United Kingdom Civil Aviation Authority's Civil Aviation Publication 371 (CAP 371). It was noted that the limitations contained in CAP 371, and those of annex III, subpart Q to the Commission of the European Communities Regulation No. 3922/91, as amended (EU OPS subpart Q), were the product of both scientific conclusions and negotiation, and that both consideration of the scientific expert briefings and negotiation would be necessary to arrive at the ARC's recommended figures.

The ARC began by discussing the maximum scheduled FDP under given conditions for a two-man, acclimatized, unaugmented crew. The ARC co-chair presented the group with a FDP concept based on time of day and sectors. The table presented was populated with numbers offered for discussion purposes. Discussion resulted in a proposed table to determine maximum scheduled FDPs based on report time and number of sectors (also known as flight segments or legs). The table is preliminary in nature and is subject to additional changes in the future by the ARC. The current version of the table has been posted on the ARC's SharePoint site. During the course of the discussions leading to the creation of the table, a number of issues were raised and discussed.

General Issues

Flight duty. In setting maximum scheduled FDPs, the ARC took into account the information it had received from scientific experts on the relationships between fatigue, rest, time awake, time on task, and circadian rhythms. It was noted that, in general, scientific conclusions are derived from models that may or may not be accurate, and that operational experience should also be considered when setting limits. In response, it was pointed out that a history of conducting operations a certain way does not equate to validation of that approach because of the potential for conditioning.

It was noted that many of the maximum scheduled FDPs initially proposed were more conservative than those contained in CAP 371. It was argued that CAP 371 is a 10-year-old document, and the basis for its limits is in question. In response, it was noted that the limits currently in CAP 371 were revised 5 years ago, and scientific research in the intervening time warrants more conservative limits. It was also noted that the proposed table prescribes maximum scheduled FDP, and suggested that the maximum scheduled FDPs could be exceeded up to an absolute maximum FDP yet to be determined. Opposition was expressed to any proposed maximum scheduled FDP that is lower than those contained in CAP 371 or EU OPS subpart Q. Some operators did not support 9 hours of maximum scheduled FDP. It was noted that 16-hour duty periods are normal operations for some cargo operators. It was further noted that the reduction from 16 hours to 9 hours of duty is too drastic, and moreover would not work for more than one flight segment. It was suggested that an 11-hour maximum schedule FDP would work better than the 9 hours proposed for night operations.

It also was argued that the maximum scheduled FDPs proposed would be highly detrimental to regional carriers, because they represent significant reductions from the duty periods currently scheduled by those carriers. In response, it was noted that the proposed changes to flight duty time limitations and rest requirements would very likely require operators to modify their operations.

It was observed that regulations cannot entirely eliminate fatigue, but can improve safety over current levels. It was acknowledged that the ARC's recommendations must still allow carriers to remain competitive. It was speculated that overly restrictive limitations might allow unfair competition from foreign carriers in the U.S. cargo market. In response, it was argued that the proposed limitations would bring the United States in line with 90 percent of the rest of the world. It was suggested that the regulations should not be geared toward the relatively small number of nations without robust oversight of flight operations.

It was also noted that there is little data on overnight and ultra-long range operations to validate the proposed FDP limitations. A data collection program by three major carriers was cited as good progress in acquiring data. Large cargo operators conducting a significant part of their operations on the backside of the clock were urged to collect and share operating data with the FAA. This would help to validate if pilots operating in these systems are indeed acclimated to this type of flying in some fashion, or whether they are essentially coping with irregular sleep patterns.

It was noted that to be effective, changes to regulations must be coupled with a robust education initiative. Pilots must be aware of the relationships between fatigue, rest, and duty time, and must know how to plan their rest to best prepare for upcoming duty periods.

Fatigue risk management system (FRMS). The issue was raised of permitting deviation from the prescribed limits in the proposed table by operators with a comprehensive or mature FRMS. It was discussed whether the proposed regulation should simply provide for an FRMS, or if it should actually prescribe an FRMS methodology, or at least a methodology for determining the extent of deviation to be permitted based on a specific operator's FRMS and other mitigations. It was noted that the end goal of the regulator is to have a comprehensive regulation that will cover all operations and avoid a patchwork of regulations, waivers, and advisory circulars. The FAA envisioned a centralized FAA organization responsible for processing FRMS requests. It was suggested that the issues surrounding FRMS might be better handled by a workgroup than by the entire ARC.

Possible timelines were discussed for development of FRMS from the perspective of both operators and the FAA. Extended twin-engine overwater operations, the advanced qualification program, and area navigation/required navigation performance were all given as examples of operators investing in equipment and training to operate to a higher standard with definitive benefits, much as FRMS is envisioned to bring relief on overly prescriptive duty time limits. It was also noted that along with the regulation, education is needed to train pilots on FRMS core assumptions so that pilots can be properly rested to carry out their duties safely.

It was proposed that, for some combinations of report times and segments, the maximum scheduled FDP could potentially be higher if certain mitigations are present. When a limitation in the table produced by the ARC is marked with an asterisk, operators may be permitted to increase the maximum scheduled FDP by the implementation of specified mitigations.

The ARC discussed a mitigation based on the opportunity for sleep during the duty period. This would apply to split duty/continuous duty overnight (CDO) pairings, in which a crew has a downtime of several hours between flights within the same FDP. Factors affecting the level of mitigation were identified to include the quality of the sleep facility (flat bed versus recliner, noise level, and temperature), and the duration of sleep available. The question was raised of whether this mitigation would be necessary to increase maximum scheduled FDP for a single-leg overnight pairing, because the crew would be expected to arrive adequately rested. The point was also made that sleep opportunities, to be valuable, must coincide with times in a pilot's circadian cycle when he or she is able to actually sleep. This could be problematic for non-overnight split duty scenarios, where the sleep opportunity would fall during the day. It was noted that providing a sleep opportunity in a sleep room is equivalent to the concept of crew augmentation in the air.

The ARC also discussed a group of mitigations that can be described as a simplified FRMS. It is anticipated that development and approval of a comprehensive, mature FRMS will be lengthy, but a simplified FRMS could be implemented relatively quickly to permit operators to increase maximum scheduled FDPs.

It was speculated that the requirements would be similar to those in existing operations specifications (OpSpecs) A332. It was unclear whether the simplified FRMS requirements would be included in the regulations to be promulgated, or would be part of an operator's OpSpecs. This question was tabled for later consideration.

It was suggested that other items to be included in a simplified FRMS would be an education and data collection component, a feedback process, and a review process. The concern was expressed that education is not an adequate substitute for quality sleep, and that simplified FRMS approvals would be too easily granted. It was noted that fatigue and rest education is an existing requirement for all carriers, so the education component of a simplified FRMS would have to include enhancements or increases, such as a required number of training hours for fatigue mitigation/countermeasures.

Specific Issues

***Definition of domicile*.** A question was raised of how a crew's base would be defined. It was suggested that the International Civil Aviation Organization (ICAO) definition is overly broad. It was also suggested that some operations are not based on a traditional domicile concept.

***Overnight operations*.** It was argued that the effect of overnight operations, particularly repeated overnight operations, should be carefully considered. It was stated that circadian rhythm effects can impair ability to monitor flight status or to deal with simultaneous irregularities. There was a suggestion to prohibit overnight pairings on consecutive nights, but it was pointed out that report times for some cargo operators result almost exclusively in overnight flights. It was further suggested that efforts be geared toward mitigation of cumulative fatigue by providing rest "behind the door," rather than outright prohibition of consecutive overnight operations. It was noted that pilots who consistently fly overnight trips tend to learn mitigation practices, which allow them to cope better than pilots who only occasionally fly such trips.

***CDOs*.** The interplay between maximum scheduled FDP and CDO pairings was raised. It was suggested that the combination of a restrictive maximum scheduled FDP and a delay on the inbound segment(s) of a CDO could result in crews having minimal or no rest before the outbound segment(s). It was suggested that split rest concepts could be used to permit longer maximum scheduled FDPs for CDOs than for other operations.

***Time of day*.** There was some discussion over what maximum scheduled FDPs should be prescribed for trips starting in the afternoon. One ARC member stated that his carrier would be required to use double crews for trips to Europe under the proposed limitations.

The question was raised of why maximum scheduled FDPs beginning during the window of circadian low (WOCL) are higher than those beginning in the hours preceding the WOCL. The reasoning was offered that flights commencing shortly before the WOCL are more likely to have landings during the WOCL, while those taking off during the WOCL would likely land after the WOCL. It was suggested that this approach would protect the flightcrew in the middle of the night and give the crew the ability to fly longer during the day.

The question of acclimatization in this context was also raised. It was noted that scientific experts had advised that individuals acclimatize at a rate of approximately one time zone per day, but it was suggested that three local nights be deemed sufficient for full acclimatization.

Maximum scheduled time. It was questioned why the longest maximum scheduled FDP proposed in the table is 13 hours. It was noted that the National Transportation Safety Board has recommended a 13-hour maximum duty day for pilots. It was also suggested that there is scientific support for a 13 hour limitation, but the validity of this support was challenged as being inconclusive and inapplicable. It was pointed out that other studies indicate a high accident rate for the first leg of the first day of a pairing.

FDP Extensions

The ARC also discussed to what extent and under what conditions an FDP could be extended beyond the maximum scheduled FDP due to unforeseen circumstances. A variety of factors were discussed.

It was noted that a maximum scheduled FDP represents a point within a margin of safety, and any extension of the FDP must still fall within that margin.

It was proposed that the amount an FDP can be extended should depend on what time the maximum scheduled FDP ends. For example, it was suggested that FDPs not be extended at all if the extension would be during or run into the WOCL, but that a nominal extension of hours be permitted at other various times of day. In response, it was argued that although repeated operations during the WOCL pose an unacceptable fatigue risk, isolated extensions into the WOCL pose an elevated although acceptable level of risk.

The question was raised of how long of an extension should be permissible; for example, whether extensions of 3 hours should be permitted and if any mitigations should be required. It was noted that a 3-hour extension on a 13-hour maximum scheduled FDP would amount to a 16-hour FDP, which is the same as the current duty limit. Instead, an absolute maximum 14-hour FDP was proposed. In response, it was noted that there is a difference, in terms of fatigue, between repeated 16-hour FDPs and a single 16-hour FDP caused by unusual circumstances.

It was suggested that there be a limit on use of extensions within a given time period. For example, whether consecutive extensions should be prohibited or if extensions should be limited to once per trip or once per week. It was also suggested that an opportunity for restorative rest be required between extensions. The ARC also discussed the relationship between extensions and a 168-hour lookback provision. Finally, it was suggested that extensions be limited to 2 hours instead of 3 hours. The FAA also noted that schedule integrity must be an important component of the proposed regulation.

Commander's discretionary authority. The question was raised of whether the pilot in command (PIC) would have sole discretion to accept or reject an extension. It was noted that giving the PIC sole discretion could prevent operators from pressuring crews to extend, but it was also noted that the decisionmaking abilities of a PIC on duty for 13 hours may be impaired, and that the desire to get home may influence fatigued crews to continue to fly. It was suggested that making an extension a joint decision between the PIC and the operator would address these issues, and that joint responsibility currently exists in the requirement for dispatch releases to be amended to extend duty.

The issue was raised of whether there should be mandatory reporting of extensions to the FAA, and whether measures should be taken to ensure that schedules reasonably reflect actual operations. In more general terms, there was discussion on the best way to prevent operators without an adequate safety culture from abusing extensions to the detriment of safety.

It was noted that when considering extensions, it is also necessary to consider that extending an FDP often means that the subsequent rest period is reduced.

Consensus position. At the close of its discussion, the ARC's consensus position, as represented in its preliminary draft FDP table, is that FDPs may be extended up to 2 hours beyond any given maximum scheduled FDP by joint decision of the PIC and operator. *[After review by the ARC membership, whether consensus was reached has been called into question.]*

FDP Reductions

The ARC discussed reductions in maximum scheduled FDPs based on the number of sectors (also known as flight segments or legs) in the FDP. Again, the ARC considered several factors in reaching its preliminary recommendations, including the following:

- Whether the reduction based on the number of sectors should vary based on the initial reporting time.
- Whether, in the case of CDOs, the makeup of the pairing (for example, whether there are one or two outbound legs) should be taken into account. Alternatively, it was discussed whether CDOs should be treated differently, with their own maximum scheduled FDP table, or whether some sort of credit toward maximum scheduled FDP should be given for actual sleep opportunity during CDOs. Several factors included the following:
  - Specific silos,
  - Amount of sleep, and
  - Quality of the sleep facility.
- Whether the FDP reductions should be linear-based on number of flight segments, and whether ranges of 1 to 3, 4 to 5, and 6 plus flight segments could be treated equally within that range.
- Whether there should be an absolute minimum maximum scheduled FDP, regardless of the number of flight segments (that is, regardless of the number of legs and/or time of day, the maximum scheduled FDP will never be less than X hours).

- Whether reductions could be eliminated, lessened, or start after a higher number of sectors if mitigating factors are demonstrated. Factors mentioned include the following:
  - Details of previous and subsequent duty
  - Amount and timing of sleep opportunities
  - Time for nonrest physiological needs
  - Quality of crew rest facilities
    - Soundproofing/noise level
    - Temperature control
    - Ability to obtain horizontal sleep
  - Scheduling reliability
  - Simplified FRMS process factors
    - Pilot education
    - Safety reporting structure
    - Data collection and feedback (observe, orient, decide, and act)
    - Nonpunitive fatigue policy

It was noted that some of these factors, such as pilot education and scheduling reliability, should be mandatory items, and not optional mitigations.

The result of the ARC's discussion is reflected in its preliminary draft FDP table. The limitations currently in the table reflect no reduction in maximum scheduled FDP for the first four segments when the report time is between 0600 and 1659 hours, and no reduction for the first two segments at other times of day. The current proposed limitations also call for a minimum maximum scheduled FDP of 9 hours, regardless of the report time or number of segments scheduled.

Minimum Break in Duty (Minimum Rest)

The ARC began to formulate minimum rest requirements. First, it was noted that the concept of rest would be referred to a minimum break in duty under the ARC's proposed scheme. The ARC defined break in duty period as a continuous and defined period of time subsequent to and or prior to duty during which flight or cabin crew members are free of all duties. This definition is based on the ICAO definition of rest period.

It was noted that proposals for minimum rest of 10 hours and 12 hours had been made at a previous meeting. There was some discussion of which proposal was more likely to guarantee that crewmembers would receive 8 hours of actual rest. It was noted that this depends on how rest is defined. The question was also raised of whether minimum rest at a pilot's domicile should be the same as minimum rest away from the domicile.

The ARC discussed at length whether transportation local in nature (travel to and from crew accommodations) should be considered to be duty or rest, or if it should have its own classification. An assumption of 30 minutes of travel in each direction was suggested, but the question was raised of what to do if travel exceeds 30 minutes. It was noted that the PIC would have the discretion to extend the minimum break in duty period to obtain 8 hours of sleep opportunity.

A number of other items were discussed in connection with the time required to acquire 8 hours of sleep at a hotel. It was noted that hotel check-in and check-out take additional time. It was suggested that, in addition to transportation, a minimum break in duty period should provide for 1 hour on each end of the 8 hours sleep, which would necessitate at least an 11-hour period.

Several operators discussed the results of modeling based on the proposed minimum break in duty periods. It was noted that at least one regional operator maintaining a minimum break in duty period of 10 hours or more would result in more overnight layovers and more days per month flying, based on current staffing levels. Another operator's representative stated that double overnights and deadheading would increase dramatically. In addition, it was stated that overhead costs for hotels, per diem, duty rigs, and deadheading would increase.

A proposal was made for a minimum 10-hour break in duty period that could be reduced to 9 hours once during every pairing or per 168 hours. It was pointed out that several scientific opinions were to the effect that isolated, minor sleep deficit would not significantly impact fatigue.

The ARC also discussed mitigations for reduced rest. It was proposed that, following an extended FDP and subsequent reduced minimum break in duty period, extension of the next day's FDP be prohibited.

Crew Augmentation

The ARC discussed long-range operations with an augmented crew. It was recommended that before the next meeting, the ARC members read the TNO study conducted by Mr. Mick Spencer for the Dutch government. The study will be placed on the SharePoint site.

As an initial matter, the question was raised of whether the current 8-hour flight time limitation will continue to be necessary with the proposed FDP restrictions. It was suggested that limiting FDPs goes a long way in reducing fatigue risk, and it was pointed out that CAP 371 contains no daily flight time restrictions.

It was cautioned that changing a variable such as this one could have unpredicted consequences. It was discussed that 12-hour flight operations with three-person crews (two pilots and one flight engineer) used to be common, and it was questioned whether fatigue mitigations would permit longer flight times for unaugmented crews. In response, it was noted that in a three-person crew, or an augmented two-pilot crew, the additional crewmember in the cockpit permits other crewmembers freedom to move around. It was also noted that fatigue may be influenced by exposure to factors such as noise, vibration, and radiation and that eliminating the 8-hour flight time limit would increase exposure to those factors.

It was discussed whether the 8-hour flight time limitation was based on science, or was purely arbitrary. It was questioned whether the need for augmentation should be strictly based on flight time limitations. It was suggested that a flight of, for example, 8 hours and 45 minutes during the day could be safely operated by an unaugmented crew, but that an overnight flight of 7 hours and 30 minutes should perhaps be augmented. It was also noted that longer flights may cross multiple time zones, which may, in itself, be a reason for augmentation. It was also questioned whether flight time or block time limitations could be variable, like FDP, and based on factors such as report time and circadian rhythms.

It was discussed that for those operators who would have difficulty augmenting their flightcrew to fly increased flight time or FDP hours, the solution would be an FRMS.

It was proposed that for some report times in the high risk area, maximum flight time be increased to 10 hours.

Next Meeting

Mr. Wykoff stated that at the next meeting, the ARC will finish its discussion of flight and duty time limitations, discuss the difference between a break in duty at home and a break in duty away from home, and address reserve duty concepts.

Record of Meeting

August 4 and 5, 2009

Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association (CAA), Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue Airways
David Rose	National Air Carrier Association, Omni Air International
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
Greg Whiting	ALPA, United Airlines
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
J Barnes	UPS (attended August 5, 2009, only)
Jim Dann	U.S. Department of Transportation (DOT) Office of the Secretary of Transportation (OST) (attended in the afternoon, August 5, 2009, only)
Pete Davis	ALPA, Atlantic Southeast Airlines
Lisa DeFrancesco	PAI Consulting (PAI)
Mike Derrick	PAI
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division
Scott Foose	RAA (attended in the afternoon, on behalf of Wayne Heller August 5, 2009)
Leo Hollis	FAA, AFS–200
Theo Kessaris	FAA, AFS–260
Bob Klothe	Office of the Secretary of Transportation, C–50
Tracy Lee	CAL, Systems Operation Center
Rich Lewis	FedEx (attended August 4, 2009, only)
Scott Lindsay	Atlas Air
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute

Pilot Flight and Duty Time Limitations and Rest Requirements
Aviation Rulemaking Committee

Record of Meeting

August 4 and 5, 2009

Washington, D.C.

Name	Affiliation(s)
Michael Price	DOT OST, Air Carrier Fitness Division (attended in the morning, August 4 and 5, 2009, only)
Ty Prettyman	National Air Carrier Association (attended August 4, 2009, only)
Roger Quinn	ATA, UPS
Paul Railsback	ATA
Matt Rettig	ALPA
Bart Roberts	ATA, American Airlines (attended August 4, 2009, only)
Yvette Rose	CAA
Tom Smith	FAA, Office of Policy and Plans (APO–230)
George Wilson	World Airways
Larry Youngblut	FAA, AFS–200

Background

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for pilots in operations under parts 121 and 135 of Title 14, Code of Federal Regulations. Recently, the ARC held meetings on July 7, 15, 16, 21, 22, 28, and 29, 2009.

Purpose of This Meeting

This meeting was held to continue discussing substantive topics relating to the ARC's mission.

Day 1–August 4, 2009

Administrative Items

A concern was raised regarding the number of alternates and observers in the ARC meetings, and the fact that there is no way for ARC members to know who, specifically, is observing proceedings. It was decided that a rollcall procedure will be instituted, and PAI will begin including a full attendance roster with records of meeting. Previously, only ARC members and selected other attendees were listed on the records of meeting; this record of meeting lists all attendees to the August 4 and 5, 2009, meetings.

Caucus Meetings

The ARC divided into separate caucuses at 9:00 a.m. to discuss the ARC's direction and the affect of its proposed recommendations on ARC member companies. The full ARC reconvened at 11:00 a.m. to resume the meeting.

The full ARC ended its meeting at approximately 3:30 p.m. and divided into caucuses again for the remainder of the day.

DISCUSSION

Flight Duty Period (FDP) Limits

Following the morning caucus meetings, the operator representatives brought up the FDP limit table developed at the meeting Wednesday, July 29, 2009. It was stated that the limitations on that table did not include a daily block time limitation, because scientific research into fatigue and performance has focused on flight duty periods rather than block time. It was also stated that the FAA has advised that the ARC's proposal should continue to incorporate a block time limitation. Revisions to the FDP limit table, which included incorporating block time limits and an increase in the FDP limits for certain times of day and sectors, were proposed. Under the proposed revisions, for each combination of reporting time and number of legs, a block time limit and a maximum FDP is proposed. The question was raised of where the proposed limits came from. In response, it was stated that the proposal was produced by the ATA membership, with participation by the RAA.

The ARC engaged in extensive discussion regarding the newly proposed FDP limits. A number of arguments were raised in support of and in opposition to amending the previous proposal, including the following:

- In opposition to amending the previously proposed limits:
  - It was observed that the proposed limitations were consistently greater than those in the table developed last week.
  - It was argued that the newly proposed limits fail to give adequate protection to operations during the window of circadian low (WOCL). There was concern that a pilot would be required to fly during the WOCL, then given 10 hours rest only to be assigned to fly in the WOCL the next night. It was stated that a separate discussion regarding reporting times in the "green band" (0000 to 0559) is necessary because beginning an FDP in the WOCL is physiologically difficult.
  - It was argued that the 9-hour FDP limit originally proposed for operations involving the WOCL is more conservative than the 11-hour FDP limit now proposed. It was noted that some foreign countries currently employ 11-hour limits, and those limits have been questioned as being too high. It was suggested that the newly proposed limits are influenced more by economic concerns than available scientific data, especially with regard to "back side of the clock" flying.
  - It was noted that for reporting times in the "green band," there is no decrease in maximum FDP based on the number of legs until the fifth leg. It was argued that decreases are necessary for any more than two legs.

  - It was pointed out that the earlier table provided, where denoted by an asterisk, for an increased maximum FDP if certain mitigations were implemented. It was stated that the newly proposed table contains no such asterisked limitations, but simply increases all FDP limits without any requirement for fatigue mitigation.

  - It was noted that the newly proposed limits represent an increase over the existing limits for flight time in a single day, with a 9-hour flight time limit for some report times. It was noted that, in addition to any safety concerns, increasing flight time limits could have a negative public perception. In response, it was argued that sleep opportunity and time awake are more important than flying time in predicting and mitigating fatigue, and retention of low flight time limits would result in an inability to compete globally.

  - There was some criticism of the impact of the proposed limits on extended-range twin-engine operations (ETOPS) operations. It was noted that the incapacitation of one crewmember on a transatlantic flight with an unaugmented crew would leave only one pilot on the flight deck. In response it was noted that this scenario had been considered during initial ETOPS certification.

- In support of the newly proposed limits:

  - It was noted that the most recently proposed FDP limits are now constrained by a block time limit, which is a more conservative approach.

  - It was stated that the newly proposed limits are reasonable based on the existing science and operational experience. It was noted that the new limits take into account pilots' circadian rhythms, based on their domicile time, which represents an improvement over existing requirements. It was also noted that some operator pairings currently involve 16-hour duty days, and even with the increases over the original proposal, the newly proposed limits will be an improvement.

  - It was pointed out that no scientific model supporting criticism of an 11-hour limit has been validated. It was argued that the proposed revisions represent a conservative approach, pending validation of models.

  - It was noted that some research data presented to the ARC by scientific experts supports a higher maximum FDP than was originally proposed. For example, with a 0700 report time, Dr. Gregory Belenky's research indicated that subjects still operated at 84 to 87 percent of peak effectiveness after 14 hours.

  - It was stated that the proposed revisions assume that elements of a fatigue risk management system (FRMS) would be required under the new regulations to alter the limits and mitigate fatigue. However, it was argued in response that requiring FRMS elements will have a greater impact at larger, established operators than at smaller, less mature ones.

Questions were raised regarding the relationship between the newly proposed FDP limits, required rest, and cumulative fatigue. It was suggested that adjusting the maximum FDP might require adjusting the required rest period following it. It was also proposed that limits should be placed on the number of consecutive days pilots could be scheduled to the maximum FDP limit. It was noted that the United Kingdom Civil Aviation Authority's Civil Aviation Publication 371 (CAP 371) contains such limits, and it was suggested that the ARC's FDP limit proposal should not be significantly different.

ARC members in support of and in opposition to the newly proposed FDP limits cited scientific data presented to the ARC by scientific experts. "Cherry picking" of points from such data was cautioned.

After a lengthy discussion, it was pointed out that little progress was being made. It was noted that the existence of current practices alone does not justify continuing them, and it was argued that both operators and pilots would have to do business differently once new regulations are enacted. It was stated that some compromise would be necessary to reach a consensus.

The ARC reexamined the table offered for review in the morning session, which had been revised to include both increased FDP and block hour limits. FDP extensions of 2 hours remained across the board as previously proposed. A number of observations were made both in support of and opposition to the newly proposed limits:

- It was noted that the FDP limits in the table under review do not vary significantly from the earlier proposal for report times from 0600 through 2259. Some ARC members voiced concerns regarding the FDP limits in the newly proposed table for report times from 2300 through 0559, and the amount of the FDP reductions based on the number of legs.

- It was argued that 11-hour FDP limits for late night and early morning report times are at odds with scientific advice and should be lower.

- Some ARC members expressed concern that the FDP limits in the newly proposed table for some reporting times were too low, arguing, for example, that a 13-hour FDP limit is appropriate for an 0500 through 0659 report time. In response, it was pointed out that two key points from the scientific experts were that sleep during the WOCL offers the best rejuvenating value, and that sleep can be moved forward, but not backward. It was argued that setting higher FDP limits for early morning report times disregards these points.

- It was noted that the limits in the table are significantly lower than the 16-hour duty periods currently used by some operators.

- Some ARC members noted the table was based in part on Dr. Belenky's data. In response, it was observed that Dr. Belenky's research, while offering valuable insight, was not validated for aviation operations. Some of Dr. Belenky's assumptions regarding time between waking and reporting were also questioned. It was also pointed out that Dr. Belenky's model would permit a one-time operation to the maximum FDP, assuming a fully rested crew. It was suggested that the model does not apply after the first day of a trip or if a crew has already operated an extended duty day.

- Some ARC members disagreed with the elimination of asterisked limits, which indicate a potential for extension based on implementation of mitigations. The question was raised of whether requiring a full FRMS for report times from 1700 through 0600 would be an appropriate mitigation for the corresponding increased FDPs.

- It was argued that the outer limits of the newly proposed table were not restrictive enough. A scenario was posed using the newly proposed table wherein a pilot who reports at 0500 with a FDP until 1800 (11-hour FDP), be expected to sleep from 1900 to 0300, and report for duty again at 0400. It was argued that such scheduling would be onerous, but within the limits of the proposed table.

- It was observed that all flight duty time numbers in the past have been arrived at with the restriction of a maximum of 8 hours flight time. It was suggested that the effect of a less restrictive flight hour restriction could not be predicted. In response, it was noted that a comprehensive alertness management program implemented and evaluated at a commercial airline identified no degradation in performance during the time periods when more than 8 hours of flight time would be permitted under the newly proposed table.

- It was questioned why block time limits are necessary, because an appropriate FDP limit would impose natural limits on block time. It was suggested that use of both block time and FDP limits would require an unnecessarily complicated hybrid approach.

- It was questioned whether the FAA would accept an increase over the existing 8-hour-per-day flight hour limitation. The FAA noted that the ARC would have to provide rationale for exceeding 8 hours of block time. It was also confirmed that the FAA would support FRMS processes to alter any of the limits.

Ultimately, it was suggested that, given the ARC's short timeframe, it should make a decision on an FDP limit table, regardless of the level of consensus. It was also suggested that the ARC move on to other issues so as to provide the FAA with as complete a recommendation as possible under the circumstances.

Review of CAP 371

It was suggested that the ARC review CAP 371 as a baseline for further discussions. During the review, various criticisms of CAP 371 were registered, including the following:

- It was argued that CAP 371 is not based on science. It was suggested that CAP 371 does not appropriately account for acclimatization and augmentation needed for the operations conducted by U.S. air carriers.

- It was pointed out that CAP 371 does not extensively treat "backside of the clock" (overnight) operations, most likely because such operations are uncommon in Europe.

- It was noted that CAP 371 contains no block hour or limitations.

It was suggested that the ARC next examine the provisions of CAP 371 other than the FDP limitations. A number of observations included the following:

- The ARC discussed the provisions of sections 14 and 15 as they relate to long-range operations. It was suggested that the ARC examine a report on extended FDPs based on crew rest facilities prepared by TNO Human Factors for the Ministry of Transport of the Netherlands (TNO Report). It was noted that the TNO Report based FDP extensions on the type of rest facility available on the aircraft.

- The ARC briefly reviewed the split duty provisions of section 16, and it was suggested that they might be applied to continuous duty overnight operations.

- It was observed that the rest period provisions of section 17 are geared more to the types of pairings encountered in Europe.

- It was noted that under sections 18 and 19, the aircraft commander has discretion to extend duty or reduce rest. It was noted that in Europe the air carriers do not have systems operation centers like carriers in the United States, and their flight crewmembers are more independent in making operational decisions.

- It was stated that the provisions of section 20 regarding days off may not be workable for U.S.-certificated operators.

- It was observed that section 21 applies absolute flight hour limits over periods of 28 days and 12 months to prevent cumulative fatigue.

Augmentation

The ARC postponed discussion of FDP limits and turned to augmentation requirements. The provisions of the existing U.S. regulations, CAP 371, and the TNO Report were reviewed.

It was noted that both the TNO Report and CAP 371, to varying degrees, assign value to inflight rest opportunities that depend on the quality of the rest facility available on the aircraft. The TNO Report ranks the quality of the facility from 1 to 4, with 1 being the best quality (flat bunk separated from passenger cabin), and 4 being the worst quality (coach seat). Not augmentation is allowed with a category 4 rest facility. Under the TNO Report, FDPs may be extended by use of augmentation, with the amount of the extension dependent on the length of the planned FDP and the quality of the rest facility available.

The question was posed of whether the ARC would like to adopt the TNO Report scheme as the basis of its recommendation. The ARC was generally in favor of adopting the TNO Report rationale, although the following suggested modifications and other observations were made *[After review by the ARC membership, whether there was general agreement on this point has been called into question.]*:

- It was suggested that factors such as noise, temperature, lighting, and proximity to activities by other persons (for example, passengers, flight attendants, or loadmasters) be accounted for.

- It was suggested that the ARC's scheme include five categories, rather than four, with the highest quality category being a crew rest bunk compliant with FAA Advisory Circular (AC) 121–31, Flight Crew Sleep Quarters and Rest Facilities. The five categories include Category 1, a separate, horizontal, overhead, or underneath bunk; Category 2, lie flat (a true lie flat horizontal seat); Category 3, reclining (seat includes a foot rest); Category 4, traditional business seat; and Category 5, a coach seat.

- It was suggested that a percentage of the time during which a pilot occupies a rest facility be credited as sleep, permitting an extension of FDP. The percentages proposed ranged from 65 percent of time occupied for the highest level sleep facility to 0 percent for the lowest level (coach seat in passenger cabin). The percentages are as follows: Category 1, 65 percent; Category 2, 20 to 50 percent depending on the time of day; Category 3, 33 percent; Category 4, 25 percent; and Category 5, 0 percent. These percentages were largely based on those in the TNO Report.

- It was noted that carriers and crews should have flexibility in how they choose to arrange rest opportunities to address both foreseen and unforeseen circumstances.

- It was suggested that time of day of the departure be factored into the augmentation scheme. It was observed that this would be part of an FRMS.

- It was questioned whether when conducting augmented crew operations, a modifier should be applied to the standard FDP limit table, or if a separate table combining values from CAP 371 and the TNO Report should be created for augmented operations. It was agreed that there should be a separate table. Mr. Don Wykoff, ALPA, agreed to produce a draft table for the following day's meeting.

- It was suggested that the ARC's recommendations regarding augmentation not be tied to absolute limits (that is, requiring one additional crewmember for flights scheduled over 8 hours, and two crewmembers for flights over 12 hours), but should be geared toward augmenting those operations that would experience the greatest benefit from augmentation.

DAY 2–AUGUST 5, 2009

Co-Chairs Mr. Jim Mangie, ATA, Delta Air Lines, and Mr. Wykoff opened the second day of the meeting, announcing that the plan for the day was to continue the discussion of augmented crew operations from the previous day, and to discuss reserve duty.

ADMINISTRATIVE ITEMS

Mr. Wykoff reminded the ARC members that the ARC would be meeting on Thursday, August 13, 2009, from 9:00 am to 1:00 pm at the FAA's conference room in L'Enfant Plaza, Room 554, in addition to its previously scheduled dates of August 11 and 12, 2009.

DISCUSSION

Augmentation (continued)

Mr. Mangie opened the discussion of augmentation, noting that the discussion would be conceptual in nature initially, and cautioning the ARC members not to fixate on the numbers for the time being.

The ARC reviewed a table that combined limits from the first (one leg) column of the existing FDP table with principles from the TNO Report. It was noted that an absolute cap of 16 or 18 hours (for a three or four pilot crew, respectively) had been imposed on the FDP, even if the TNO Report scheme would result in a higher FDP. It was noted that higher FDPs could be achieved only by use of an FRMS.

A question was raised of how the numbers in the TNO Report were derived. It was stated that the TNO Report had benchmarked existing research.

The ARC also reviewed the CAP 371 methodology for determining the maximum FDP for an augmented crew. It was noted that CAP 371 determines maximum FDP based on the number of planned block hours and the number of sectors (flight segments).

It was requested that a comparison table combining the TNO Report and CAP 371 approaches be produced so ARC members could generate sample pairings using the numbers in the table. It was noted that a comparison table was created, and that table was uploaded to the SharePoint site, under the file name "flighttime limits v4.xls."

Following a break, several ARC members presented pairing scenarios to demonstrate how they would work under the TNO Report and CAP 371 approaches, respectively. It was noted that some extremely long flights, such as Washington Dulles International Airport to Beijing Capital International Airport, bump against the absolute 16- and 18-hour limits in the TNO Report approach. It was also noted that return trips on such long-leg pairings are problematic, because of domicile time and acclimatization issues. A suggestion was made that a prescriptive approach could be crafted to apply to most operations, but operators engaged in ultra-long range (ULR) operations could use an FRMS to develop an alternate means of fatigue mitigation tailored to their specific operations. It was also noted that some types of operations, such as cargo operations, which operate under different demands and circumstances, might approach augmentation and fatigue differently than other operations.

Questions were also raised about the value of rest on deadhead flights, and its impact on acclimatization. An example was posed of a pilot deadheading from the United States to Europe to fly pairings. The question was raised of whether rest during the deadhead flight could reduce the acclimatization necessary. It was speculated that it would depend on where the flight falls in relation to the pilot's WOCL. There was some debate over whether such a question should be addressed by a prescriptive regulation or an FRMS.

Some ARC members expressed the belief that although acclimatization presents a complex problem, it does not necessarily require a complex solution. It was suggested that an additional table could address the uniqueness of cargo operations. Other ARC members felt that a table cannot address the multiple variables in play, and stated that a process is necessary to fill the gap until a mature FRMS can be developed. It was suggested that the process in operations specifications paragraph A332 be codified and made part of the ARC's recommendation.

It was noted that the overall FDP table was working well but that there are some cargo operations that have been conducted over a long period of time whose business model does not fit into the proposed table. It was recognized that these operations might achieve the same level of safety under a different approach. Affected ARC members were directed to develop procedures that would implement safeguards and countermeasures that address the science and allow safe operations. It was noted that there will be prescriptive requirements for the majority of operators and that use of the FRMS will be reserved for ULR operations. It was noted that hose operators that cannot operate within the proposed table must develop a proposed procedure that will be fully vetted by all the ARC members.

Reserve Duty

General

Following a break, the ARC resumed its meeting with a discussion on reserve duty. Before continuing the discussion, Mr. Mangie introduced Mr. George Wilson, World Airways, Mr. Scott Lindsay, Atlas Air, Mr. Scott Foose, RAA, and Mr. Leo Hollis, FAA, AFS–200, to the ARC. Except for Scott Foose, these individuals had not been regular attendees at previous ARC meetings or had not been previously identified to the full ARC as designated alternates.

The ARC divided reserve into three categories: long-call reserve, airport/standby reserve (also known as airport alert), and short-call reserve.

Next, a WOCL Aware Reserve System was proposed to the ARC. Some key points of the system were presented:

- Any reserve pilot called between 2200 and 0600 will receive a minimum of 10 hours of rest before reporting.
- Any reserve pilot called upon to fly into the WOCL would have to be contacted within the first 6 hours of his or her reserve duty.
- If normal sleep time is not interrupted and a pilot is not being called upon to fly into the WOCL, he or she would have the same FDP as a pilot holding a line.
- Airport reserve duty is to be treated like a trip assignment and is part of the FDP.

The ARC discussed proposed definitions for reserve time and standby duty. The definitions are contained in the WOCL Aware Reserve System document, which has been posted to the ARC SharePoint site under the filename "WOCL Aware Reserve System4.doc."

It was noted that the proposed reserve system protects pilots against changes from night to day reserve duty or vice-versa by requiring a minimum 18-hour rest period if a reserve duty period starts within 24 hours of the start of the previous period, with the exception that the rest may be reduced to 10 hours twice in any 7 consecutive calendar days. It was stated that the practical result is that a pilot may only be switched from day to night reserve twice in 1 week.

Certain questions and scenarios were posed regarding the timing of rest in relation to the pilot's circadian rhythms. Some ARC members advocated language guaranteeing a physiological night's rest between reserve duty periods.

It was noted that some pilots prefer to be contacted closer to the time of the trip assignment instead of being called early in the morning for an afternoon trip. It was agreed that this is an industrial issue and would be difficult to enforce from a regulatory position.

There were also concerns that phone availability be recognized in some fashion. The concern was that a pilot could be on phone availability all day, and then be called upon to fly a trip near the end of his or her reserve duty period. It was noted, however, that under the proposed system, day reserve pilots would not be called upon to fly beyond 0200, and night reserve pilots have predictability that they may be called to fly during the WOCL, and can plan rest accordingly.

There was a discussion regarding the timing of rest and duty for a pilot on day reserve who is called with an afternoon report time. The concern articulated was that such a pilot might not be able to sleep during the day in preparation for the late day departure. It was suggested that such pilots be given 18 hours of rest after such duty to prevent such scenarios occurring on consecutive days. There was also discussion of limiting duty periods for reserve pilots to prevent pilots being awake for 20 hours. (An example was given of a pilot called at 0600 to fly a trip ending at 0200.)

There was also a question regarding the necessity of the 10 hours of rest for a pilot called between 2200 and 0600. The opinion was expressed that this should be adjusted downward.

There was general support among the ARC membership for the proposed reserve system. It was suggested that the system be put in tabular form for simplicity of understanding. The ARC co-chairs then requested that the members address any remaining concerns with the proposed reserve system next Tuesday, August 11, 2009.

Long-haul Reserve

Following a break, the ARC focused on a long-haul reserve concept, which involves augmented crew operations. It was observed that long-haul reserve presents a particular challenge, because pilots must have enough predictability to rest sufficiently, but their availability must be great enough to be of use.

The discussion focused initially on trips in which a reserve pilot is called on to fly an overnight flight. The ARC members discussed various scenarios in which a reserve pilot could or could not fly a given trip based on the start of his reserve duty and the length of the trip. It was noted that maximum FDPs would increase slightly because of the ability to obtain rest on the aircraft. It was discussed that a typical reserve duty period under the proposed system would be 14 hours, with 10 hours of rest. It was stated that under the proposed system, if a reserve pilot is called up for a trip in the first 6 hours of his or her reserve duty, the FDP could extend up to 6 hours beyond the end of the reserve time. Otherwise, the FDP would be required to end at the end of the pilot's reserve time.

One hypothetical case used to demonstrate the system involved a pilot going on reserve duty at 1800 local time, and whether or not he or she could be assigned a trip to Mumbai, India, leaving at 2300. It was noted that the lookback point for adequate rest is 6 hours before departure. Thus, for a 2300 departure to Mumbai, Inida, lookback to determine rest would be from 1700. It was also noted that the pilot's reserve duty would end at 0800 if he or she was not called. It was stated that if the pilot was called before 0000, the FDP could extend for 6 hours beyond 0800 to 1400. Otherwise, the pilot's FDP must end at 0800.

The ARC went on to discuss other long-haul reserve scenarios, including coverage of air turnbacks. There was some concern that pilots called near the end of the first 6 hours of their reserve duty could potentially be awake for 20 hours. It was suggested that such a scenario to be modeled. It was further suggested that the system should be modified to prevent such an occurrence. Mr. Mangie asked that the ARC members develop suggestions for modifications to the proposed reserve system over the weekend and present them at the meetings next week.

Cumulative Duty

The ARC next discussed cumulative duty limits. The concept of maximum duty hours within rolling windows of hours was discussed. It was noted that CAP 371 and Annex III, Subpart Q to the Commission of the European Communities Regulation No. 3922/91 use cumulative duty time limits for 7, 14, and 28 days. The ARC members previously agreed to use 168 consecutive hours and 672 consecutive hours for cumulative duty limits.

The ARC discussed what constitutes duty time, including the International Civil Aviation Organization definition and the ARC's current draft language. There was some discussion of whether on-airport aircraft positioning and similar activities should be included in a duty period or a flight duty period. It was noted that under the definition proposed by an earlier ARC addressing fatigue in part 135 operations, positioning would be included in a flight duty period. It was pointed out, however, that it seems unnecessary to, for example, augment a crew simply to cover the potential need to position an aircraft.

It was suggested that positioning could be accomplished under a 2-hour extension for unforeseen circumstances. It was pointed out, however, that if positioning was consistently called for after flights, than it could not be considered unforeseen. A suggestion was made that any activities after a flight is concluded, such as positioning or engine runups, should be considered part of a duty period, but not part of a flight duty period.

Next Meeting

Mr. Mangie stated that discussion of cumulative duty time limits would continue at the next meeting, and asked the ARC members to apply the CAP 371 limits to their own operations and report back with the results. It was suggested that the members also examine the impact of section 20 of CAP 371, which addressed required days off.

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS
AVIATION RULEMAKING COMMITTEE
Record of Meeting
August 11, 12, and 13, 2009
Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association (CAA), Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Pete Davis	ALPA, Atlantic Southeast Airlines (attended on behalf of Greg Whiting on August 13, 2009, only)
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
George Villalobos	CAPA, Southwest Airline Pilots Association (permanent replacement for John Gadzinski)
Greg Whiting	ALPA, United Airlines
George Wilson	World Airways (attended on behalf of David Rose, National Air Carrier Association, Omni Air International)
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
J Barnes	UPS (attended August 5, 2009, only)
Joe Burns	United Airlines
Jim Dann	U.S. Department of Transportation (DOT) Office of the Secretary of Transportation (OST) (attended in the afternoon, August 12, 2009, only)
Pete Davis	ALPA, Atlantic Southeast Airlines (August 11 and 12, 2009)
Lisa DeFrancesco	PAI Consulting (PAI)
Mike Derrick	PAI
Paul Doell	National Air Carrier Association (NACA)
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division (AFS–200)
Scott Foose	RAA
Jordan Frohlinger	Atlas Air
Theo Kessaris	FAA, AFS–260
Bob Klothe	OST, C–50 (attended August 11 and 12, 2009, only)

Record of Meeting

August 11, 12, and 13, 2009

Washington, D.C.

Name	Affiliation(s)
Tracy Lee	CAL, Systems Operation Center
Rich Lewis	FedEx (attended August 11 and 12, 2009, only)
Scott Lindsay	Atlas Air
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute (CAMI)
Michael Price	DOT OST, Air Carrier Fitness Division (attended in the morning, August 12 and 13, 2009, only)
Roger Quinn	ATA, UPS
Paul Railsback	ATA
Brian Randow	RAA, Compass Airlines
Matt Rettig	ALPA
Bart Roberts	ATA, American Airlines
Yvette Rose	CAA (attended August 11 and 12, 2009, only)
Tom Smith	FAA, Office of Policy and Plans (APO–230)
Larry Youngblut	FAA, AFS–200 (attended August 11 and 12, 2009, only)

BACKGROUND

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for pilots in operations under parts 121 and 135 of Title 14, Code of Federal Regulations (14 CFR). Recently, the ARC held meetings on July 7, 15, 16, 21, 22, 28, and 29, and August 4 and 5, 2009.

The ARC discussed some issues on multiple days of this week's meeting. For this reason, this record of meeting is not divided into 3 days, but instead addresses the issues and topics discussed at the meeting.

On Wednesday, August 12, 2009, for part of the scheduled meeting time, the ARC broke out into separate working groups to discuss the issues of reserve duty, long-range flying recovery rest, and definitions. While the working groups' discussions are not captured in this record of meeting, the presentations of the results of their respective discussions are addressed.

PURPOSE OF THIS MEETING

This meeting was held to continue discussing substantive topics related to the ARC's mission.

Record of Meeting

August 11, 12, and 13, 2009
Washington, D.C.

ADMINISTRATIVE ITEMS

Co-chair Mr. Don Wykoff reminded the ARC members that the ARC would be meeting at L'Enfant Plaza on the morning of Thursday, August 13, 2009, and noted that he does not anticipate at this point that additional Thursday sessions will take place.

DISCUSSION

The co-chairs noted that the ARC had made significant progress during the previous week's meeting. It was stated that, moving forward, there will be less discussion and more substantive decisionmaking. It was also noted that additional caucusing or working group sessions are expected.

Global Operations Subgroup

It was noted that some operators, such as long-haul supplemental and all-cargo carriers that operate in geographical areas outside the United States, conduct operations that differ greatly from other U.S. network carriers, especially in number and length of positioning flights. It was proposed that, for some issues, different rules be applied to such carriers. It was stated that a subgroup would break out from the ARC to develop proposed rules for such operations and present the proposal to the full ARC. It was noted that the proposed rules must address maximum flight duty period (FDP) issues as well as pilot positioning/deadheading issues.

Reserve Duty

A new proposal regarding reserve duty time was presented to the ARC. The proposal for a Predictable Reserve System with Circadian Stability (Predictable System) is based on three prongs: science, circadian stability, and adequate rest. The proposal incorporates provisions from the Civil Aviation Department (CAD)[1],CAD 371, The Avoidance of Fatigue in Aircrews, and provides some recommendations from a reserve rest ARC that convened in 1999. A copy of the proposal has been posted on the SharePoint site.

The key points of the presentation are as follows:

- Definitions
    - Protected time period (PTP)—time free from all duty and contact.
    - Reserve availability period (RAP)—time from end of PTP until time assigned FDP must be completed.
    - Physiological night's rest—continuous 10 hours including 0100–0600 at domicile or acclimated location.

[1] The CAD regulates civil aviation activities in Hong Kong.

- Scheme
  - Maximum on-call—12 hours.
  - Reserve duty for a crewmember called ends when he or she reports for an FDP.
  - FDP.
    - For airport standby, includes entire on-call period.
    - Otherwise—
      - Maximum FDP will be more limiting of determined FDP (using the appropriate FDP limits table) or **14 hours from start of RAP.**
      - FDP begins at earlier of actual report time or 4 hours from start of RAP.
    - FDP may be assigned without restriction if there is at least 12 hours' notice, including a physiological night's rest, with no duty.
  - Minimum prior PTP
    - At least 10 hours if window of circadian low (WOCL) fully encompassed.
    - At least 12 hours if WOCL infringed.
    - Must be at least 12 hours' notice, including a physiological night's rest, before initial scheduling of RAP.
    - Crewmember returning from flight assignment requires rest based on FDP flown.
  - RAP start time
    - Changes in start time between consecutive days and within a block of days are limited.
    - Rest period containing at least 2 local nights' rest permits different start time.

Following the presentation, there was a discussion involving various scenarios under the proposed scheme, particularly discussions of the maximum FDP based on various RAP start times, call times, and report times. It was suggested and agreed that standby under this scheme should be called reserve duty to avoid confusion with airport standby. It was also noted that crew augmentation could also affect the length of the maximum FDP. The members also discussed at length the limited shifting of a reserve's RAP forward or backward in time within a block of consecutive reserve availability days to keep the pilot on a stable circadian rhythm.

There was some debate over the proposed provision, which would impose a limit on FDP based on the start of the RAP. It was noted that because the limits on reserve crewmembers are more stringent than those on lineholders, in many scenarios, two reserve pilots would be needed to cover one lineholder's trip. In response, it was argued that greater restrictions are needed for reserve pilots because they are unable to predict when they will be called to fly and to rest accordingly. It was further asserted that being on reserve duty affects the quality of sleep.

It was proposed that the system take into account when during the RAP and during the physiological day a pilot is called. It was argued that if, for example, two pilots start their RAPs at 0300, a pilot actually called at 1100 should not have the same duty limit as a pilot called at 0500, because the pilot called later would get more sleep. In response to this position, it was noted that there is an apparent conflict between pilots being expected to be on call but asleep during the WOCL. It was suggested that, instead, RAP start times be staggered to make some pilots available early and others later.

It was suggested that the new proposal and the WOCL Aware Reserve System (WOCL Aware), a proposal presented during the previous week's ARC meeting, be synthesized. Three concerns were expressed regarding the WOCL Aware proposal:

- Concerns were expressed regarding individuals on phone availability being called during the WOCL. However, it was noted that based on scientific modeling, for a reserve called during the WOCL, a 4-hour lookback (the period in which the carrier must contact the reserve from the start of the RAP to use the entire available FDP) actually would be better than the 6-hour lookback originally proposed in paragraph b under WOCL Aware.

- It was proposed that the FDP limit increase to 18 hours from start of RAP, not 14 hours as noted in the Predictable System. It was pointed out that existing rules include a 16-hour limit. In response, it was argued that the 16-hour limit is not scientifically based.

- It was proposed to relax the limitations on changing RAP start times to allow large shifts twice per week, but not consecutively. This sparked discussion over the effect of multiple shifts in start time, and over the impact on pilots who are called for a trip and then placed back on reserve.

There was additional discussion of multiple scenarios under the Predictable System and WOCL Aware proposals. It was noted that the Predictable System proposal tended to be more limiting, but changing the maximum duty limit of both systems to 16 hours from start of RAP (from 14 and 18 hours, respectively) would eliminate most of the differences. It was noted that, in comparing the two systems, the Predictable System addresses circadian issues slightly better, but it is also more complicated and would likely generate interpretation requests if made part of the new rule.

The co-chairs requested that the proponents of the two proposals revise them based on the discussions. A scenario was again posed of a pilot with a RAP starting during the WOCL, but not called until after the WOCL. It was proposed that some credit be given for the sleep obtained before being called. After brief discussion, the ARC decided to move forward with a maximum FDP limit of 16 hours after the start of the RAP.

During working group sessions, the reserve duty working group was able to reach consensus on several issues, which were presented to the full ARC. The results from the working group's sessions are posted on the SharePoint site as a PowerPoint document named *ARC Reserve Concept—ARC 081209*. The key points are discussed below.

The working group defined RAP, reserve duty period, long-call reserve, and short-call reserve. The working group also defined a maximum reserve duty day (a combination of phone availability and FDP) as the appropriate limit determined from the FDP table, plus 4 hours. For nonaugmented operations, the maximum FDP must not exceed 16 hours. The working group's proposal also gives half credit for time on reserve duty during the WOCL, to the extent that crewmembers are not called. (For example, for a pilot on reserve from 0300, but not called until 0700, the limit on the length of the pilot's FDP would be determined based on the start of the RAP plus half of his reserve time during the WOCL, or 1.5 hours.) This credit provision recognizes that a pilot may be sleeping on reserve duty but not sleeping normally. The working group also agreed on a scheme for shifting a reserve RAP. Following the working group's presentation, the ARC reviewed several examples to become familiar with the details of the proposal.

Augmentation

The ARC revisited the area of augmented flightcrew operations and sought to address three key areas:

- Rest after crossing multiple time zones,
- Augmentation requirements for multiple flights, and
- International resets needed for around-the-world flying.

A table addressing augmented operations was submitted to the ARC for discussion. The table shows a block hour maximum for nonaugmented operations, based on report time. If the planned block hours for a trip exceed the block hours shown in the table, augmentation is needed, and a separate table must be consulted to decide the maximum FDP, which depends on the size of the crew and the onboard crew rest facilities available. The rest opportunity in the table is the maximum nonaugmented FDP minus 2.5 hours to account for climb and descent times and nonsleep rest time. It also was assumed the pilot is acclimated. The ARC reviewed several scenarios to see how FDP was affected by augmentation under the table.

It was suggested that necessary augmentation be driven by factors other than block time. An example was cited of a 7.5-hour pairing involving multiple short flights at night. This would not normally require augmentation but presents a situation in which required augmentation might be desirable. It was proposed that any planned pairing with greater than 6.5 block hours where the FDP infringes on the normal sleep cycle should require augmentation. It was also proposed that the maximum FDP for nonaugmented operations be increased with a fatigue risk management system (FRMS) in place.

There was some discussion over whether augmentation could be used for domestic operations and if it would be worthwhile. It was generally accepted that augmentation of domestic operations is a possibility. There were concerns that operations that would appear to work on paper would require crewmembers to obtain rest in unreasonably small amounts, or that operators would use augmentation to schedule crews to long, multiple-leg FDPs, rather than its current use, to permit long, single-leg operations that could not otherwise be operated.

There was some discussion regarding use of international relief officers (IRO), and whether the augmentation rule needs to prescribe when IROs are used to ensure the best rested crew at landing. It was noted that captains and crews generally have discretion to decide their own rest periods during augmented operations.

Cumulative Fatigue Limits

The ARC next discussed cumulative fatigue limits, and reviewed a previously made proposal for cumulative duty limits within rolling windows of 168, 336, and 672 hours, and for flight time limits within rolling 90-day and 365-day windows. The proposed limits were based on those in CAP 371 and European Union Regulations, subpart Q.

The question was raised of whether multiple duty limit windows are necessary or if only the lowest window would suffice. It was noted that the progression of the limits through the windows is a declining one, to allow short periods with large amounts of duty, but to prevent them from continuing for long periods.

The ARC members discussed research they did outside the meeting, applying the proposal to their respective operations. Some members reported that their existing operations would not be workable with the proposed limits.

There was some discussion of what will be included in duty for purposes of the limits. For example, it was argued that positioning flights preceding reporting for flight duty should be considered part of duty. A suggestion was made that only half of the time for positioning flights is considered duty if the crewmember being positioned is seated in a business class seat or better accommodation. The question was raised of how simulator training should be treated. The position that simulator training constitutes FDP time was advanced. It was also unclear if administrative work should be considered part of duty. It was noted that this could preclude management pilots from flying trips occasionally. The question was raised of how to accommodate flights operated under 14 CFR part 91. It was noted that such flying would be aircraft positioning and part of an FDP.

It was questioned whether FDP limitations, rather than total duty limitations, would be more appropriate. The idea of limiting block hours, FDP hours, and total duty hours was considered. It was noted that the current block hour limitation does not address issues such as positioning and administrative work.

The ARC members began discussing cumulative FDP limits. A proposal was made for limits of 60 hours in a rolling 168-hour window (7 days), 100 hours in a rolling 336-hour window (14 days), and 190 hours in a rolling 672-hour window (28 days). It was stated that similar cumulative duty period limitations would be recommended as well. Cumulative flight time limits of 270 hours in a rolling 90-day window, and 1,000 hours in a rolling 365-day window were also proposed.

An idea was proposed to address the concerns previously addressed regarding positioning pilots. The idea was to use a higher set of total duty time limits for pilots spending significant time on positioning flights, provided the crewmembers were seated in a business class seat (TNO Class II) or better accommodations for those flights. There was also some discussion of only counting 75 percent of time on such flights toward duty. There was a proposal to require screening of positioning crewmembers from passengers, but the idea was rejected because pilots positioning on commercial flights could not expect to be screened from passengers.

The question was raised of what to do if a portion of the positioning is on an aircraft without business class seats available. It was proposed that the business class seat requirement be eliminated for segments shorter than a certain number of hours within the continental United States.

The question was again raised of whether administrative work is included in duty time. Some ARC members felt that it should not be included at all; others felt that it should be subject to the extended duty time limitations proposed for positioning flights, or that the proposed standard duty time limits should be increased. It was pointed out that pilots completing both administrative work and flying for operators should be responsible for ensuring that they report for flight duty adequately rested and alert. After some discussion, the ARC reached consensus that administrative duties should fall within the definition of duty time and should not be eligible for the proposed extended duty time limits applicable to positioning flights. *[After review by the ARC membership, whether consensus was reached on this point has been called into question.]*

The question was also raised of how to address reserve time with a lookback period, because not all reserve time constitutes duty. It was noted that cumulative fatigue limits for reserves should be addressed through a separate provision in the proposed rule section on reserves.

There was discussion regarding whether a 336-hour limitation is necessary, in addition to the 168-hour and 672-hour limitations and the daily FDP limitations. It was argued that the other limitations adequately protect safety, and a 336-hour limitation unduly limits operators, without offering significant protection to pilots. In response, it was argued that the 336-hour limit prevents pilots from manipulating their schedules to time out, and protects against consecutive weeks with reduced rest. The ARC reached consensus that the 336-hour limitation should be eliminated.

The ARC discussed what would constitute rest sufficient to act as a restorative rest reset for the 168-hour rolling window. It was proposed that such rest incorporate a minimum of 2 physiological nights' rest. There was a desire to fix a number of hours for restorative rest, rather than specify 2 physiological nights' rest. Various proposals were made, ranging from 30 to 48 hours. Following discussion of other matters, the ARC reached consensus that a 30-hour rest during the prior 168 hours constitutes a restorative rest period, although it was noted that different restorative rest requirements would apply to crewmembers completing international trips where multiple time zone shifts are involved (see Long-range Flying Recovery Rest below). *[After review by the ARC membership, whether consensus was reached on this point has been called into question.]*

There was also discussion over the relationship between administrative work, training, and the restorative rest period. Consensus was reached that a full restorative rest period is not needed after a trip before undertaking administrative work or ground training, but is needed before simulator training. *[After review by the ARC membership, whether consensus was reached on this point has been called into question.]* It was clarified that administrative work may not conflict with needed rest before reporting for flight duty.

The ARC also reached consensus that a crewmember be permitted to exceed the duty limit in the 168-hour window for the purpose of a positioning flight back to his or her domicile at the end of a trip.

It was proposed that a crewmember be permitted to exceed the 168-hour limit for a positioning flight before a trip, provided he or she received the needed restorative rest before reporting for an FDP. Alternatively, it was proposed that the restorative rest be defined as time free from an FDP, rather than time free from duty. Concerns were expressed that these proposals would permit operators to schedule crewmembers for extremely long positioning flights, therefore contributing to fatigue. In response, it was noted that other limits, such as weekly and monthly cumulative duty limits, would prevent operators from abusive scheduling.

There was also discussion of whether the lookback for restorative rest should take place at the beginning of each FDP, and whether it should contemplate the scheduled and anticipated actual FDP. The scenario was posed of a pilot who has 30 hours of rest in the past 168 hours at the start of an FDP, but will not have that much rest at the anticipated end of the FDP because of weather delays. It was agreed that that pilot could not fly the leg. *[After review by the ARC membership, whether agreement was reached on this point has been called into question.]*

The ARC also reached consensus on some cumulative flight time limits. It was agreed that a quarterly limit on flight hours is unnecessary. The ARC agreed that flight time should be limited to 100 hours in the previous 28 calendar days and 1,000 hours in 365 calendar days. *[After review by the ARC membership, whether agreement was reached on this point has been called into question.]* The ARC discussed eliminating a weekly limit on flight hours, on the rationale that daily FDP and duty limits offer sufficient protection against fatigue. Concern was expressed, however, that eliminating such a limit could be perceived as damaging to safety.

Long-range Flying Recovery Rest

The working group addressing long-range flying recovery rest presented its recommendations to the ARC. The working group's recommendations are posted on the SharePoint site as a PowerPoint document titled *Team Predmore*.

The working group noted that an FDP table applicable to nonacclimated crewmembers must be developed. This table would be used for crewmembers not given an international reset rest and operating in a geographical area outside of the United States other than their domicile.

There was some discussion regarding the rest needed for crewmembers returning to their domicile after becoming acclimated in another geographical area outside of the United States. It was noted that such a crewmember is not truly acclimated to the new geographical area, but is no longer acclimated to his or her domicile either. The options are to give the crewmember domicile reset rest, to use the nonacclimated FDP chart, or to use the acclimated FDP chart, but use the local time in the time zone where the crewmember last had an international reset rest period to decide FDP. It was pointed out that domicile reset rest was intended for crewmembers who have been away from their domicile for at least 96 hours.

The question posed was if international operations include operations within North America. It was pointed out that an international reset only occurs with a change of more than four time zones, but it was suggested that an international reset also occur after a certain number of block hours to account for long trips to South America that do not involve shifts of more than four time zones.

Acclimated/Nonacclimated Definition

The working group developing definitions made a slide presentation on the definitions of acclimated and nonacclimated. The working group's presentation is posted on the SharePoint site as a Powerpoint document titled *Acclimated non-acclimated concept.*

The working group developed the following factors to determine if a flight crewmember is acclimated: the United States is one time zone, the basic FDP table is used, and the operator has to have a designated flight crewmember base. The working group defined nonacclimated as flying more than 4 hours and across five time zones. The working group then presented a scheme for calculating FDP based on different amounts of layover rest.

The working group concluded to reset from nonacclimated to acclimated with 3 consecutive local nights' sleep (can be on duty during period encompassing 3 local nights, but not during local sleep hours), or a 36-hour layover. *[After review by the ARC membership, whether a conclusion was reached on this point has been called into question.]*

A question raised was if the international reset rest of 36 hours is reasonable in cases where, for example, the time zone difference between the domicile and the geographical area outside of the United States where the flight crewmember is operating is 11 hours. The alternate reset of 3 local nights' sleep was also discussed. It was suggested that a local night's sleep be defined to include a 10-hour period encompassing the entire WOCL.

Fatigue Risk Management System

The ARC next discussed the proposed parts of an FRMS. An example was presented to the ARC in the form of requirements for an extended FDP of 22 hours using a four-pilot crew. The hypothetical provisions included requirements and restrictions about the segment to be extended, rest and duty before the FDP, post-duty rest, training, and unanticipated delays.

The ARC members discussed the philosophy behind an FRMS, and some of the key concepts, from the standpoints of both operators and crewmembers. Slides detailing the FRMS discussion can be found in a PowerPoint document titled *ARC Concept deck 8-13-09*, posted in the Working Documents section on the SharePoint site.

It was stated that the ARC's recommendations should include rule language enabling development and approval of a basic FRMS process under an operator's operations specifications. It was noted that advisory circulars could be developed offering operators guidance on creating an FRMS. It was envisioned that these would be interim steps in the development of a comprehensive, fully matured FRMS.

It was noted that an FRMS would initially be developed around long-range international operations, although modeling shows that domestic operations pose a greater fatigue risk. From long-range operations, development would extend to all operations, and would eventually reach a point where all schedules are vetted through an FRMS.

A question posed was whether development and implementation of an FRMS would be voluntary or mandatory. It was stated that developing and implementing an FRMS should eventually be mandatory, although at first, expanded operational capability may be an incentive to development. FRMS requirements are envisioned to describe what constitutes an FRMS. It is desired that approval of an FRMS be standardized and administered through FAA Headquarters. Comparisons were drawn between an FRMS and an advanced qualification program (AQP).

The ARC discussed some of the concepts that will be included in an FRMS, such as high-level management involvement, feedback and continuous improvement, and an intrinsic safety culture. It is anticipated that an FRMS will include the definition of baseline fatigue, identification and implementation of mitigation measures, and data collection to evaluate effectiveness, which will be fed back into the system in a repetitive process. It was noted that a data collection effort similar to that used to support AQP and extended twin-engine overwater operations would be necessary. It was noted that three operators are currently gathering fatigue data under an independently funded voluntary program.

Next Meeting

It was noted that the ARC has extremely limited time to complete its task. As a result, it is anticipated that the ARC will continue to break out into working groups for discussions of augmentation, definitions, and FRMS issues next week.

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS
AVIATION RULEMAKING COMMITTEE

Record of Meeting

August 18 and 19, 2009

Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association (CAA), Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Pete Davis	ALPA, Atlantic Southeast Airlines (attended on behalf of Bill Soer on August 19, 2009, in the afternoon only)
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings (attended August 19, 2009, only)
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
Bill Soer	ALPA, FedEx (attended August 18 and 19, 2009, in the morning only)
Jim Starley	ATA, CAL
George Villalobos	CAPA, Southwest Airline Pilots Association (permanent replacement for John Gadzinski)
Greg Whiting	ALPA, United Airlines
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
J Barnes	United Parcel Service (UPS)
Joe Burns	United Airlines
Pete Davis	ALPA, Atlantic Southeast Airlines
Lisa DeFrancesco	PAI Consulting (PAI)
Mike Derrick	PAI
Paul Doell	National Air Carrier Association
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division (AFS–200)
Scott Foose	RAA
Jordan Frohlinger	Atlas Air
Tracy Lee	CAL, Systems Operation Center
Rich Lewis	FedEx
Scott Lindsay	Atlas Air
Rebecca MacPherson	FAA, Office of Chief Counsel
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute

Name	Affiliation(s)
Paul Onorato	CAPA
Michael Price	U.S. Department of Transportation, Office of the Secretary of Transportation, Air Carrier Fitness Division (attended August 18, 2009, only)
Roger Quinn	ATA, UPS
Paul Railsback	ATA
Brian Randow	RAA, Compass Airlines
Matt Rettig	ALPA
Bart Roberts	ATA, American Airlines
Tom Smith	FAA, Office of Policy and Plans (APO–230)
George Wilson	World Airways
Larry Youngblut	FAA, AFS–200 (attended August 19, 2009, only)

BACKGROUND

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for flightcrew members in operations under parts 121 and 135 of Title 14, Code of Federal Regulations. Recently, the ARC held meetings on July 7, 15, 16, 21, 22, 28, and 29, 2009, and August 4, 5, 11, 12, and 13, 2009.

The ARC discussed some issues on both days of this week's meeting. For this reason, this record of meeting is not divided into 2 days, but instead addresses the issues and topics discussed at the meeting.

At different times during the meeting, the ARC membership broke out into separate working groups to discuss issues before the ARC. While the working groups' discussions are not captured in this record of meeting, the presentations of the results from their respective discussions are addressed.

PURPOSE OF THIS MEETING

This meeting was held to continue discussing substantive topics related to the ARC's mission.

ADMINISTRATIVE ITEMS

The ARC co-chairs announced that on Monday, August 24, 2009, operator and labor representatives from the cargo industry would meet to document their agreements and disagreements. They also noted that on Tuesday, August 25, 2009, part of the ARC would meet at ATA in the morning, and the full ARC would convene at 1:00 p.m. at the same location.

One ARC member indicated a desire to present a paper on supplemental operations to the ARC for review. It was stated that the ARC would discuss supplemental operations the following Tuesday, August 25, 2009.

DISCUSSION

Some ARC members reported that they had conferred with their respective organizations, and their organizations were not in agreement with positions on which the ARC had reached consensus during the prior meeting.

The ARC co-chairs acknowledged that it would not be possible to reach consensus on every issue, but stressed the need to remain rational and to reach consensus on as much as possible. They reminded the ARC membership that their work must be completed by September 1, 2009, and set a goal of completing the flight duty period (FDP) chart during the next week's meetings.

Cumulative Fatigue Limits

The ARC revisited the issue of cumulative duty time. It was suggested that the yearly flight time limit of 1,000 hours is restrictive and has no scientific basis, and a proposal was made to increase the yearly limit to 1,200 hours. It was pointed out that without a yearly flight time limit, a flightcrew member could fly 2,000 hours while still observing the FDP limit. In response, it was noted that United Kingdom Civil Aviation Authority's Civil Aviation Publication 371 imposes a 900-hour yearly limit. It was also pointed out that the ratio between flight time limits and the time period they govern progressively decreases as periods get larger. It was argued that this is necessary to avoid burnout in operations involving demanding workloads.

The question was raised of how commercial flying for other employers or for the military should be handled. It was noted that the ARC could not regulate military flying, but it was suggested that hours flown as a military reservist should be counted toward a flightcrew member's yearly hourly limit. The ARC determined that it would not address military flight time because it is a complex issue; the ARC tabled the discussion.

In-Flight Rest

The ARC reviewed a presentation on in-flight rest. There was a discussion on how crew rest facilities should be rated. It was noted that a report prepared by TNO Human Factors for the Ministry of Transport of the Netherlands (TNO Report) does not account for all types of facilities used by U.S. certificate holders. It was discussed that there could be up to 20 different combinations of rest facilities. The ARC also discussed factors affecting rest, such as how horizontal a crew rest seat or bunk is, the lighting conditions, noise, temperature, and time off task. The proposal in the presentation calls for the various attributes of individual rest facilities to be scored and assigned a value. Ranges of scores would then be translated into a level corresponding to the type I, II, and III facilities contemplated by the TNO Report. There was some discussion over whether the rating of facilities would be accomplished by a certificate holder's principal operations inspector, or some other authority. There was also discussion of how best to use international relief officers to have the best rested flightcrew members available for landing.

Working Group Breakouts

The ARC broke out into working groups on each day of the meeting to address definitions, acclimation and long-range flying, and augmentation. Following the working group meetings, each working group presented the results of its discussions to the full ARC. Although the groups presented their findings for ARC discussion on both days of the meeting, and, in some cases, more than once per day, the summary of presentations and discussions has been consolidated in this record.

Definitions Working Group

The definitions working group presented a definitions list to the ARC. The definitions list has been posted to the SharePoint site in an Excel document titled *ARC Definitions Master 08-19-09 draft*. The ARC discussed several of the definitions presented, as well as issues impacted by the definitions, such as—

- Whether home-based training and distance learning should be part of duty time and, if so, what constitutes home-based training.
- How to best define home base/domicile.
- Whether reserve and nonreserve flightcrew members should be specifically defined.
- Whether and to what extent contact is permitted during rest periods.
- The impact of class definitions for crew rest facilities on existing aircraft and operations.

The definitions working group proposed a definition for schedule reliability or robustness to the ARC, but neither the working group nor the ARC could reach consensus on the specific metric to be used to define reliability.

The definitions working group was also unable to reach consensus on the definition for FDP, because of disagreement over whether simulator training sessions should be considered FDP time or merely duty time.

Acclimation/Long-range Flying Working Group

The acclimation/long-range flying working group presented revised international rest recommendations to the ARC. The working group's recommendations are posted on the SharePoint site as a PowerPoint document titled *ARC Team Predmore v3*.

One issue the ARC did not reach consensus on is the amount of rest required for acclimation or reset upon arriving in a new theater. Some ARC members advocate a minimum of 36 hours of rest, while others advocate a minimum of 30 hours of rest.

A new concept introduced in the revised recommendations is to impose restrictions that would prevent "flip-flop" pairings where three-person augmented flightcrews fly repeated long legs between their domiciles and an international destination, with approximately 24 hours of time off between legs. The proposed restrictions prescribe restorative rest and severely limit a flightcrew member's maximum FDP after he or she has completed one round trip. Some ARC members expressed concerns regarding the specific details of these proposed restrictions and their impact on some operations. It was agreed that these members would conduct some modeling based on the recommended restrictions and report back to the ARC.

The revised recommendations also define a domicile night's rest as rest in a flightcrew member's domicile, which includes the hours from 0100 through 0700. The ARC agreed to harmonize the definition of domicile rest with the definition of physiological night's rest.

The ARC also discussed concerns particular to international flights. It was noted that there is often a longer time between the end of the FDP and when flightcrew members arrive at a hotel at international destinations, because of the requirements to clear customs and immigration. The ARC members discussed the best way to address international rest, including how to address situations where time from FDP to accommodations is longer than planned for. The working group recommendations prescribe a minimum rest in international destinations of 12 hours, which may be reduced to 11 hours under the same conditions established for reduction of domestic rest.

The ARC members discussed some international flight scenarios and how they would function under the working group's recommendations. The ARC also discussed the amount of rest necessary during long trips away from a flightcrew's home base, where flightcrew members become nonacclimated from their home base time zone, but do not truly become acclimated to the local time zone.

Augmentation Working Group

The augmentation working group presented a basic outline for ultra long-range (ULR) operations using a complement of four flightcrew members and class 1 crew rest facilities. The working group's outline is contained in a PowerPoint presentation titled *ARC Beyond 4-Man and Split-Duty*, which has been posted to the SharePoint site. The ARC discussed several aspects of the working group's outline, including—

- Whether extended ULR operations should be approved on a city pair basis, or only a theater basis. The ARC reached consensus that such operations could be approved on a theater basis.

- Noting that data gathering and feedback should have greater emphasis.

The working group's outline was expanded into a more detailed proposal for ULR operations. This outline is contained in a PowerPoint presentation titled *ARC Concept deck 8-13-09 with FRMS slides*, which is posted on the SharePoint site. This document also presents a basic outline for a fatigue risk management system.

The working group also presented the ARC with some proposals and options regarding triggers for augmentation. The ARC discussed the following issues:

- *Triggers*. It was proposed that there be several different triggers requiring augmentation:
  - Scheduled flights exceeding the maximum FDP for an unaugmented flightcrew.
  - Scheduled block hours exceeding the maximum block time for an unaugmented flightcrew.
  - Window of circadian low intrusion.
- *Multiple segment flights*. It was recommended that augmentation be used strictly for long pairings of no more than two to three segments, and not to extend the FDP for pairings involving multiple short segments.
- *Flightcrew member qualifications*. There was discussion about the minimum number of current and qualified flightcrew members (in particular, type-rated flight crewmembers) on board and how many type rated flightcrew members should be on the flight deck at any given time. There was concern that a flight engineer not current and qualified as a pilot on an aircraft would be used as a relief flightcrew member.

Split Duty

The ARC also discussed special requirements to be applied to split duty or continuous duty overnight operations. It was suggested that flightcrew member rest obtained during such operations could be used to extend the maximum FDP, in much the same way that flightcrew member rest in onboard facilities during augmented operations is used to extend the FDP.

There was some discussion of how much sleep opportunity should be credited toward extending the FDP, and how suitable sleep accommodations could be defined, rated, or regulated. The definitions contained in the *ARC Definitions Master 08-19-09 draft* document reflect the ARC's discussions.

There was also some discussion comparing treatment of onboard rest during augmented crew operations with rest during split duty operations. It was suggested that rest in a ground facility should be at least as valuable as rest obtained in an onboard rest facility, but it was also pointed out that onboard facilities do not require travel time between the facility and the aircraft like ground facilities do. It was agreed that final versions of augmentation and split duty provisions would be compared and reconciled before the issuance of the ARC's draft notice of proposed rulemaking.

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS AVIATION RULEMAKING COMMITTEE

Record of Meeting

August 25, 2009

Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association (CAA), Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
George Villalobos	CAPA, Southwest Airline Pilots Association (permanent replacement for John Gadzinski)
Greg Whiting	ALPA, United Airlines
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
J Barnes	United Parcel Service (UPS)
Trevor Bulger	IBT Airline Division, Horizon Air
Joe Burns	United Airlines
Pete Davis	ALPA, Atlantic Southeast Airlines
Lisa DeFrancesco	PAI Consulting (PAI)
Mike Derrick	PAI
Paul Doell	National Air Carrier Association
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division (AFS–200)
Scott Foose	RAA
Jordan Frohlinger	Atlas Air
Rich Hughey	ALPA, FedEx
Theo Kessaris	FAA Flight Standards Service (AFS-260)
Tracy Lee	CAL, Systems Operation Center
Rich Lewis	FedEx
Scott Lindsay	Atlas Air
Rebecca MacPherson	FAA, Office of Chief Counsel
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute

Record of Meeting

August 25, 2009

Washington, D.C.

Name	Affiliation(s)
Paul Onorato	CAPA
Michael Price	U.S. Department of Transportation (DOT), Office of the Secretary of Transportation, Air Carrier Fitness Division
Roger Quinn	ATA, UPS
Paul Railsback	ATA
Matt Rettig	ALPA
Bart Roberts	ATA, American Airlines
Dale Roberts	FAA, AFS–200
Sherry Schleigh	UPS
Tom Smith	FAA, Office of Policy and Plans (APO–230)
Kevin West	FAA Flight Standards Service (AFS-260)
George Wilson	World Airways
Larry Youngblut	FAA, AFS–200

BACKGROUND

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for flightcrew members in operations under parts 121 and 135 of Title 14, Code of Federal Regulations (14 CFR). Recently, the ARC held meetings on July 7, 15, 16, 21, 22, 28, and 29, 2009, and August 4, 5, 11, 12, 13, 18, and 19, 2009.

PURPOSE OF THIS MEETING

This meeting was held to continue discussion of substantive topics related to the ARC's mission.

ADMINISTRATIVE ITEMS

The ARC members discussed the expected timing of publication of a notice of proposed rulemaking (NPRM) and a final rule. It is anticipated that an NPRM will be published by January 1, 2010, with a final rule published by January 2011.

A question was raised of whether ARC members could provide the FAA with additional information after the ARC completes its work on September 1, 2009. Ms. Rebecca MacPherson advised that the information could be submitted, but any information received after September 15, 2009, would likely be discarded, because of the time constraints.

Record of Meeting

August 25, 2009
Washington, D.C.

ADMINISTRATOR REMARKS

Mr. J. Randolph Babbitt, FAA Administrator, briefly addressed the ARC. He expressed appreciation for the ARC's work, especially given the demanding timeline. Mr. Babbitt noted that the DOT Secretary has expressed interest in the ARC's work, and he urged the ARC members to reach consensus on any remaining issues. He stressed that compromise would be necessary to reach a regulation that all parties can accept.

DISCUSSION

Commuting Policy

The ARC discussed a proposed policy toward commuting. The policy is contained in a Word document titled *ARC Commuting Policy*, which is posted to the SharePoint site. There was consensus among the ARC membership that regulations should impose a responsibility upon flightcrew members to report for duty in a fit condition, but not otherwise regulate conduct while free from duty. The ARC members also agreed that regulations should impose a duty on the certificate holder. It was noted that the ARC's recommended policy is in line with international standards.

Cargo Operations

The ARC next discussed a presentation by the CAA proposing a separate fatigue prevention and mitigation scheme for CAA cargo operators. The presentation is contained in a PowerPoint document titled *ARC-CAA Flight Duty Proposal Aug 24 1330*, which has been posted to the SharePoint site.

The CAA's position in proposing separate requirements is based on the fact that cargo operations are subject to different operational and competitive factors than passenger operations, including flight delays and schedule changes that are outside the control of the certificate holder. In response, it was noted that fatigue affects all flightcrew members equally, and the "one level of safety" concept therefore dictates that the same limitations and requirements apply to all certificate holders. As a result, some ARC members expressed objection to the relaxation of any proposed requirements based on operational differences.

Supplemental Operations

Following the ARC's discussion of cargo operations, the question was raised of whether supplemental operations should be exempt from some provisions of crew rest and duty regulations, or if the regulations should provide for such supplemental operations. The ARC discussed details and difficulties particular to several types of operations, such as Air Mobility Command (AMC) or Civil Reserve Air Fleet (CRAF) operations (military charters, including armed troop movements), and operations into hostile or politically unstable areas. Issues discussed included the following:

- Military charters
    - Last minute delays outside of certificate holder control

  - Severe consequences of cancellation or delay of military charters caused by crew timeout
    - Inability to secure accommodations for armed military passengers
    - Cannot deplane uniformed military personnel at some airports
  - Lack of crew rest facilities on aircraft used for charters
- U.S. Department of State charters
- U.S. Department of Homeland Security, Federal Emergency Management Agency, Immigration and Customs Enforcement charters
  - Humanitarian relief
  - Immigration (cannot stop with certain detainees on board)
- U.S. Federal Bureau of Investigation charters
- Hostile/politically unstable areas
  - Too dangerous to keep aircraft/crew on ground in areas subject to attack
  - Flightcrew members are restricted from leaving aircraft in some locations
- Long duty days
  - Relatively low number of flight hours flown (approximately 35 flight hours per month)
  - Ample time off between each trip

It was suggested that perhaps such supplemental operations should be subject to a different risk assessment than conventional operations. It was also argued that, although high risk operations such as war zone flights warrant relaxed requirements or exemptions, such treatment should be reserved for situations where, as a matter of necessity and not convenience, flightcrew members cannot be replaced and/or obtain rest. It was suggested that where such situations force violation of rest and duty time requirements, certificate holders must be required to report the incident to the FAA for a followup investigation and enforcement evaluation. It was also suggested that certificate holders be required to declare an emergency when deviating from requirements.

Some concern was expressed that certificate holders would obtain exemptions to rest and duty time requirements. There was also a request for clarification on what would specifically constitute an inability to meet requirements. It was noted, for example, that certificate holders that choose for economic reasons to not equip aircraft with suitable crew rest facilities should not be able to claim an inability to comply with requirements because of a lack of such facilities. The question was also raised of whether an inability to meet requirements could be claimed because of delays on the first leg of a multiple-leg trip, where hostile areas would not be encountered until later in the trip.

It was suggested that 14 CFR §§ 119.55 and 119.57 already address the situations discussed, and that no further regulatory treatment is necessary. In response, it was noted that rest and duty time regulations should provide for recovery rest following a deviation from requirements under those sections.

Open ARC Items

Following a break, the ARC reviewed a presentation on unresolved critical areas. The presentation is posted on the SharePoint site as a PowerPoint document titled *ARC Open Discussion Points 20090825*. The ARC discussed the items addressed in the presentation, which include the following:

- Night flight duty period (FDP) limits and sector limits
  - It was noted that United Kingdom Civil Aviation Authority's Civil Aviation Publication 371 handles this through a split duty concept, and this type of flying is not common in Europe.
  - It was proposed that post- and pre-duty rest requirements should be established for consecutive night duty operations. It was suggested that multiple days free from duty, such as in a week on/week off schedule, are necessary to recover from such operations and prepare for future trips.
  - It was noted that naps may be helpful in mitigating fatigue (but do not substitute for rest), particularly in connection with the fourth and fifth consecutive night of duty.
  - It was suggested that night FDP operations be limited to 4 consecutive nights.
  - There was discussion of whether a fatigue risk management system (FRMS) is necessary to operate for 5 consecutive nights. There was also discussion of whether techniques such as split sleep or controlled rest on the flight deck could effectively mitigate fatigue.
  - The ARC considered that night FDP operations would be limited to 3 consecutive nights without additional factors, but that a methodology could be devised to permit up to 5 consecutive nights.
- International acclimation
  - The question was raised of what time zone or FDP table should be used for flightcrew members making multiple time zone shifts within one trip. It was suggested that, unless a flightcrew member has had acclimation rest, the most conservative table (unacclimated) should be used.

  - The question was raised of whether the entire United States should be considered a single time zone for purposes of acclimation, and, if so, what impact this has on operations to and from Alaska and Hawaii.

- Augmentation

  - It was discussed that the FDP for a two-leg augmented operations trip should be shorter than that for a one-leg trip, but it was not decided what the specific reduction should be.

  - The question was raised of whether more than two legs should be permitted in augmented operations, and, if so, whether an FRMS should be required.

- Deadheading — The question was raised of whether there should be a daily duty day limit that would be applicable to deadhead (positioning) flights either on their own or following an FDP. It was suggested that weekly cumulative duty limits adequately address the issue, but ARC members were encouraged to submit alternative concepts.

Closing Remarks

The ARC co-chairs urged the ARC members to review the open items in preparation for the meeting the next day, which would be the ARC's last opportunity to discuss proposals before its review of a draft NPRM on September 1, 2009. The ARC was notified that a Word document summarizing ARC positions (including a range of positions) to date and open items, titled *ARC Consensus Table v2*, had been posted to the SharePoint site to facilitate review.

PILOT FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS
AVIATION RULEMAKING COMMITTEE
Record of Meeting
August 26, 2009
Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association (CAA), Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings (Scott Foose attended this meeting for Wayne Heller)
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division (Trevor Bulger attended this meeting for Russ Leighton)
Jim Mangie, *Co-Chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
George Villalobos	CAPA, Southwest Airline Pilots Association (permanent replacement for John Gadzinski)
Greg Whiting	ALPA, United Airlines
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-Chair*	ALPA
Selected Additional Attendees	
J Barnes	United Parcel Service (UPS)
Trevor Bulger	IBT Airline Division, Horizon Air
Joe Burns	United Airlines
Vinnie Civitello	United Airlines
Pete Davis	ALPA, Atlantic Southeast Airlines
Lisa DeFrancesco	PAI Consulting (PAI)
Mike Derrick	PAI
Paul Doell	National Air Carrier Association (NACA)
John Duncan	Federal Aviation Administration (FAA), Air Transportation Division (AFS–200)
Scott Foose	RAA
Rich Hughey	ALPA, FedEx
Theo Kessaris	FAA Flight Standards Service (AFS-260)
Tracy Lee	CAL, Systems Operation Center
Rich Lewis	FedEx

Record of Meeting

August 26, 2009

Washington, D.C.

Name	Affiliation(s)
Scott Lindsay	Atlas Air
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute
Paul Onorato	CAPA
Michael Price	U.S. Department of Transportation (DOT), Office of the Secretary of Transportation, Air Carrier Fitness Division
Roger Quinn	ATA, UPS
Paul Railsback	ATA
Matt Rettig	ALPA
Bart Roberts	ATA, American Airlines
Dale Roberts	FAA, AFS–200
Yvette Rose	CAA
Sherry Schleigh	UPS
Tom Smith	FAA, Office of Policy and Plans (APO–230)
Kevin West	FAA Flight Standards Service (AFS-260)
George Wilson	World Airways
Larry Youngblut	FAA, AFS–200

BACKGROUND

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for flightcrew members in operations under parts 121 and 135 of Title 14, Code of Federal Regulations (14 CFR). Recently, the ARC held meetings on July 7, 15, 16, 21, 22, 28, and 29, 2009, and August 4, 5, 11, 12, 13, 18, 19, and 25, 2009.

PURPOSE OF THIS MEETING

This meeting was held to complete discussion of substantive topics related to the ARC's mission.

DISCUSSION

Supplemental Operations

The ARC began the meeting by resuming its discussion of supplemental operations from the previous day. NACA submitted to the ARC recommended duty time and flightcrew member rest requirements for unscheduled certificate holders, as well as scheduled certificate holders. NACA's recommendations are contained in a Word document titled *ARC NACA Recommendations*, and an Excel document titled *ARC NACA FDP Proposal*. Both documents have been uploaded to the SharePoint site.

In summary, NACA calls for existing flightcrew member rest and duty time requirements in subpart S of part 121 to continue to apply to unscheduled certificate holders with an additional requirement that such certificate holders develop and implement fatigue risk management systems (FRMS). NACA also proposes that the FAA establish a working group or ARC to examine fatigue and rest issues for unscheduled certificate holders. NACA's position is founded on operational differences between unscheduled operations and scheduled passenger operations.

In response, several ARC members expressed opposition to the proposed variable rest and duty time requirements. ARC members opposing NACA's proposal noted that human physiology is not affected by the nature of the operations involved. The members conveyed a "one level of safety" approach to fatigue and rest issues, except where circumstances such as war or natural disaster necessitate otherwise.

Data Call

Ms. Rebecca MacPherson noted a need for real data on air carrier operations and how they would be affected by proposed requirements. She urged certificate holders to respond to requests for data from GRA, Incorporated, an FAA contractor, so that requirements could be validated. She assured the ARC members that data would be deidentified and aggregated in the regulatory evaluation.

A question was raised of whether information submitted would be protected under 14 CFR part 193. Ms. MacPherson advised that part 193 protection involves a lengthy and complicated process, but AGC would assert a confidential business information exception in response to Freedom of Information Act requests.

Open ARC Items

The ARC revisited some of the open items it had discussed the previous day. The open items are contained in a PowerPoint document titled *ARC Open Discussion Points 20090825*, which has been uploaded to the SharePoint site. The items and issues discussed include the following:

- Night split-duty flight duty period (FDP) limits and sector limits
    - The ARC members discussed various scenarios, both real and hypothetical, involving consecutive night split-duty or continuous duty overnight (CDO) operations. It was suggested that 5 consecutive nights of such operations are possible if flightcrew members obtain some sleep during the window of circadian low (WOCL), particularly later in the trip, and obtain the balance of sleep during the day, including a nap in the afternoon. It was argued that certificate holders could not rely on flightcrew members taking naps during the WOCL, and should not count on the naps when planning.
    - A question was raised of whether a split-sleep scenario had been validated with actigraphs and it was found that it had not. It was noted that split-sleep studies conducted by scientific experts had not been geared toward night flying, and were of questionable value in setting definitive requirements and limits for flightcrew member rest and duty time, respectively.

- There was some discussion of whether flightcrew members could operate up to 5 consecutive night split-duty operations if sleep was obtained only during the day, with no sleep during the WOCL. It was argued that it is not possible to get 8 hours of quality sleep during the daytime. It was also noted that the scientists' presentations stated that day sleep was not of the same quality as night sleep.

- The RAA submitted a proposed outline of split-duty limitations. The RAA's proposal is contained in a PowerPoint document titled *ARC RAA on CDOs*, which has been uploaded to the SharePoint site. In summary, the RAA proposal calls for up to four consecutive CDOs, with a fifth possible with an FRMS. The proposal provides for an extension of the FDP, up to the maximum daylight limit, by 75 percent of actual time spent "behind the door" at the flightcrew member's accommodations. The proposal also calls for a 30-hour restorative rest period after a series of CDOs, before returning to daylight duty. The proposal elicited several responses, including the following:

    - There is a very distinct difference between the CDOs flown by regional and network operators, versus the night cargo operators.

    - One alternate ARC member suggested that four or five consecutive CDOs is unsafe, with anecdotal support based on a certificate holder that used to do four consecutive CDOs stopped due to complaints from flightcrew members. (*In a subsequent review of the notes, it has been questioned whether the term "unsafe" was actually used, or if the intent was to say "demanding")*

    - It was noted that, at times, flightcrews are not able to obtain sleep during CDOs because of delays. In response, it was submitted that such circumstances are not the norm, and that flightcrew members are often able to obtain in excess of 4 hours of sleep. It was also noted that the extension is based on the actual time spent at an accommodation, not what was scheduled.

    - It was stated that the concept of extending duty time based on napping during the WOCL is sound, but it was suggested that a minimum quality of crew accommodations must be defined.

    - It was suggested that the 30-hour restorative rest provision does not adequately address cumulative sleep debt and should be defined as a minimum of 2 physiological nights' rest.

    - It was submitted that CDO proposals involving sleep during the WOCL do not differ significantly from augmented flightcrew operations with onboard rest facilities. In response, it was pointed out that CDO scenarios do not include additional flightcrew members, like augmented flights do.

    - It was suggested that 50 percent, rather than 75 percent, of sleep obtained during CDOs be credited toward extending the FDP.

        - The question was raised of whether the maximum daylight limit to which CDO FDPs could be extended included the 2-hour extension for irregular operations. It was suggested that the irregular operations extension could only be used if circumstances justifying irregular operations were present.

- International acclimation

    - In addition to the open items presentation, a second presentation addressing international acclimation was reviewed by the ARC. The proposal is contained in a PowerPoint document titled *ARC JM slide 3*, which has been posted to the SharePoint site.

        - The proposal provides for acclimation after 3 consecutive local nights' rest (during which the flightcrew member can work during the day) or 30 consecutive hours free from duty.

            - It was stated that 30 hours is insufficient for acclimation. It was pointed out that scientific opinion is that 1 day per hour of time zone difference is necessary to acclimate when traveling west, and 1½ days per hour of difference is required when traveling east. It was added that, as a practical matter, these guidelines are excessive, but that 3 local nights' rest are necessary.

            - There was also discussion regarding the proposal of 30 hours free from duty to acclimate. Some ARC members argued that time free from duty was to be used as a reset and could not be used to accelerate acclimation. Other ARC members argued that such a period free from duty assists acclimation by allowing flightcrew members to sleep naturally, but that 30 hours is inadequate and a minimum of 36 hours free from duty is necessary.

            - Some ARC members believed that the 3 local nights' rest requirement was too long, and a flightcrew member would be acclimated sooner

            - It was suggested that ARC members have mixed three separate topics:

                - Required time off duty every 168 hours/reset rest

                - Time required for acclimation

                - Recovery rest necessary after a duty period from origin to an international destination

            - It was argued that requiring 3 consecutive local nights off will impact certificate holders who fly scheduled operations and that intend to keep flightcrew members on their domicile time, rather than acclimating to local time. In response, it was pointed out that eventual acclimation is inevitable in response to daylight cues.

    - The new proposal also discussed the "flip-flop" rule, which addresses consecutive circadian disruptive layovers that are applicable to repeated long, augmented three flightcrew member operations, with approximately 24 hours off between flight segments. It was noted that an earlier proposal had called for the rule to apply when the combined flight time of the round trip was greater than 22 hours, and that this had been changed to 24 hours in the current proposal. It was stated that the 22-hour restriction would have eliminated some pairings involving Western European cities, where the impact of repeated trips is not as severe as pairings involving destinations such as Moscow, Russia. It was pointed out that, even with the less severe impact, by the end of three round trips to such destinations, flightcrew members still experience fatigue. It was suggested that flightcrew members be limited to two round trips to such destinations. Opposition to increasing the combined flight limit from 22 to 24 hours was noted. Also, some ARC members pointed out that three round trips would likely be prohibited by another duty time limit, such as the requirement for 30 hours off in a 168 hour lookback.

- Deadheading (positioning)

  - It was suggested that there should be some limitations on deadheading other than weekly or larger cumulative duty time limits. In response, it was argued that deadheading flightcrew members are not operating an aircraft, so safety is not directly implicated. It was pointed out, however, that such flightcrew members were only required to have international rest of 12 hours before beginning an FDP. The scenario was posed of a 30-hour positioning flight, followed by only 12 hours of rest. It was argued that a recovery rest is necessary after such a long positioning flight, and a suggestion was made that rest equal to the length of the positioning flight be required.

  - It was noted that the ARC had considered on the previous day a provision limiting single-sector positioning to 21 hours, if a TNO Class 2 rest facility is available.

  - The ARC members were asked to bring any proposals regarding deadheading limitations to the ARC's final meeting on September 1, 2009.

- Augmentation

  - The ARC reviewed a proposed FDP chart to be used for augmented crew operations.

    - It was noted that, unlike previous proposals, which included FDP caps, the current proposal calls for FDPs as long as 19 hours and 20 minutes, with an acclimated four-person crew and TNO Class 1 rest facilities. It was also noted that the proposal calls for irregular operations extensions of up to 3 hours. It was observed that having a sleep opportunity does not guarantee sleep, particularly in turbulence, and concern was expressed that flightcrew members could be awake for approximately 24 hours at landing.

- Some ARC members noted that the purpose of the additional flightcrew member on augmented flights is solely for fatigue mitigation

- It was noted that there is a potential conflict between the proposed definition of flightcrew member rest facility classes and the advisory circular (AC) on onboard rest facilities. It was stated that the proposed classification must be reconciled with the AC.

- Consensus was sought, but not reached, on the proposed FDP times for augmented flightcrew members.

- The ARC also reviewed an augmentation proposal contained in a PowerPoint document titled *ARC JM slides*, which has been posted to the SharePoint site. This proposal would require a minimum available rest time for flightcrew members to be able to fly multiple legs in augmented operations.

FDP Tables

The ARC reviewed two proposals for basic FDP tables: one roughly aligned with the labor representatives on the ARC and the other roughly aligned with industry representatives. It was noted that the differences between the two tables are limited to differences in the maximum block hours permitted and in the maximum FDP for some early morning report times.

Some concern was expressed regarding the outer limits of the 9 block hour section in the labor chart. It was noted that the chart provided for a 13-hour, four-segment FDP with 9 block hours, and it was suggested that this would be excessive. In response, it was noted that such FDPs could only be started in the middle of the day, when flightcrew members should be well rested.

Additional discussions focused on maximum permissible block hours and maximum permissible extensions. A maximum permissible block hour limit of 8 hours and a maximum permissible extension of 1 hour was proposed. In opposition, it was noted that with a 2-hour maximum permissible extension for irregular operations, the maximum FDP would still be 15 hours, which is shorter than the 16 hours permitted under the existing regulations.

It was argued that a 15-hour FDP equates to being awake for approximately 17 hours, and it was suggested that performance would be degraded. It was pointed out that such a scenario would be infrequent because of the FAA monitoring the certificate holder's use of irregular operations extensions. This led to a discussion regarding what frequency of exceeding scheduled FDPs would trigger action by the FAA. There were various proposals for schedule reliability made, ranging from 50 percent to 85 percent. The ARC generally settled on a range of 70 to 85 percent, but this was left open with a request for proposals at the final meeting on September 1, 2009.

It was stated that a maximum extension of 2 hours would be acceptable, provided fatigue policies and an adequate mechanism for tracking extensions are in place.

"One Level of Safety" Presentation

The ARC next reviewed a presentation titled "One Level of Safety." This presentation proposed ARC positions on a large number of open issues. The presentation is contained in a PowerPoint document titled *ARC OneLevelofSafety20090826*, which has been uploaded to the SharePoint site. The ARC discussed the issues covered in the presentation as follows:

- Duty period limit — The presentation proposes duty period limits based on the included FDP, and proposes a minimum of 8 hours of sleep opportunity every 24 hours.

- Positioning (deadheading)

    - The presentation proposes that after a duty period containing a positioning flight, the minimum rest period is 1½ times the length of the positioning flight, but not less than the minimum rest period otherwise prescribed.

    - It was noted that this provision could only be used where a duty period consists solely of a positioning flight. The provision is not to be used to permit a positioning flight after an FDP that would result in a duty period longer than the FDP, plus the irregular operations extension.

- 14 CFR part 91 add-on flying

    - The presentation proposes that all flying for a certificate holder, including operations conducted under part 91, count toward flight time and duty period limits. It was noted that this provision does not include pleasure flying on the flightcrew member's personal time, only operations conducted by the certificate holder under part 91.

    - It was suggested that part 135 certificate holders may object to this provision.

- Disruptive recovery rest

    - The presentation proposed minimum recovery rest periods of 30 hours for domestic operations and 36 hours for international operations, within a rolling 168-hour window.

    - The presentation also proposed rest to include 2 true physiological nights' rest upon the occurrence of certain events.

    - A number of questions were raised and discussed, including the following:

        - The question was raised of what constitutes international operations. It was responded that operations outside the 48 contiguous United States would be considered international operations.

        - A request to define physiological night was made.

- Time zone issue — The presentation noted that the 48 contiguous United States have four time zones, and recommended consideration of circadian factors for domestic operations.

- Domicile night's rest — The presentation proposed a new definition for domicile night's rest as a period of 10 consecutive hours free from duty and disturbance between 2200 and 1000.

- International rest — The presentation proposed new minimum rest requirements following an FDP impinging upon the WOCL, as well as providing for increased duty periods based on excessive travel times or other delays in obtaining accommodations. It was pointed out that activities such as clearing customs should be part of duty time, not rest.

- "Flip-flop" rule

  - The presentation proposed essentially the same rule proposed previously regarding consecutive circadian disruptive layover operations.

  - The presentation calls for the rule to apply where the combined flight time of a round trip exceeds 22 hours. It was again argued that the rule should only apply where the combined flight time exceeds 24 hours.

- Non-punitive fatigue policy — The presentation calls for a policy allowing flightcrew members to declare themselves unfit because of fatigue without threat of discipline, penalty, or punitive action.

- Normal rest periods — The presentation proposed a minimum rest of 10 hours domestically and 12 hours internationally, or the length of the preceding duty period, whichever is longer. There was opposition to the second requirement. It was noted that the ARC had reached consensus on 10 hours of rest reducible to 9 hours.

- Rest following extended duty — It was proposed that following an extended duty period, rest could not be reduced.

  - It was pointed out that this rule could have significant consequences in terms of delays the following day, particularly in locations where departure opportunities are limited by traffic volume.

  - It was also noted that frequent extensions of duty and reductions of rest are addressed by the 168-hour lookback requirement..

- Allowable extensions to FDPs — The presentation proposed that unforeseeable circumstances be defined as those beyond the control of the certificate holder and related directly to and affecting the FDP in question. This would preclude the use of a late inbound flight to extend duty of the outbound connecting flight.

- Reliability requirements — The presentation proposed an 85-percent ontime reliability requirement, taking all known and foreseeable factors into account, and requiring schedule adjustment within one cycle of new or forecast variations.
    - It was suggested that a 60-day lookback requirement would be appropriate to examine reliability. In response, it was suggested that 30 days would be more appropriate to prevent certificate holders from continuing with an inadequate schedule.
    - It was pointed out that, because of scheduling cycles, it could take 3 to 4 months to address an identified problem.
    - The ARC membership agreed to tentatively place the provision in the draft notice of proposed rulemaking (NPRM), but to reconsider it at the final meeting. It was agreed that 95 percent systemwide schedule reliability is appropriate; proposals for individual scheduled FDP liability ranged from 70 percent to 85 percent.
- Delayed departure
    - The presentation proposed provisions addressing impact on FDP and minimum rest requirements under different departure delay scenarios.
    - It was noted that this issue is particularly difficult, because even if intervening rest can be obtained, flightcrew members can begin acclimating to the local time, resulting in subsequent problems.
- Circadian “flip-flop” — The presentation proposed recovery rest requirements applicable to flightcrew members transitioning from night operations to day operations, or vice versa.

Consensus Table

The ARC concluded the meeting by reviewing a consensus table that outlined the ARC’s proposed requirements to date. The ARC updated the table to reflect if members agreed on a proposed position or wished to express a range of positions on a given area. The revised table is contained in a Word document titled *ARC Consensus Table v2*, which has been posted to the SharePoint site.

Closing Remarks

The ARC co-chairs reminded the ARC that the final meeting would be devoted to reviewing the draft NPRM, including the preamble. The co-chairs noted that the purpose of the review is not to wordsmith the document, but to ensure all of the ARC’s discussions have been accurately captured and included in the draft NPRM, which will represent the ARC’s recommendations to the FAA for updated duty and rest requirements.

Record of Meeting

September 1, 2009
Washington, D.C.

ATTENDEES

Name	Affiliation(s)
Aviation Rulemaking Committee Members	
Jim Bowman	Air Transport Association (ATA), FedEx
Jeff Carlson	Cargo Airline Association (CAA), Atlas Air
Darrell Cox	Air Line Pilots Association, Int'l (ALPA), Mesa Airlines
Lauri Esposito	Coalition of Airline Pilots Associations (CAPA), Independent Pilots Association
Wayne Heller	Regional Airline Association (RAA), Republic Airways Holdings
Michael Hynes	ALPA, Continental Airlines (CAL)
Russ Leighton	International Brotherhood of Teamsters, Airline Division
Jim Mangie, *Co-chair*	ATA, Delta Air Lines
Chip Mayer	ATA, US Airways
Doug Pinion	CAPA, Allied Pilots Association
Steve Predmore	ATA, JetBlue
David Rose	National Air Carrier Association (NACA), Omni Air International
Bill Soer	ALPA, FedEx
Jim Starley	ATA, CAL
George Villalobos	CAPA, Southwest Airline Pilots Association
Greg Whiting	ALPA, United Airlines
Jim Winkley	RAA, American Eagle Airlines
Don Wykoff, *Co-chair*	ALPA
Selected Additional Attendees	
Trevor Bulger	IBT Airline Division, Horizon Air
Joe Burns	United Airlines
Pete Davis	ALPA, Atlantic Southeast Airlines
Lisa DeFrancesco	PAI Consulting (PAI)
Maryanne DeMarco	CAPA
Mike Derrick	PAI
Scott Foose	RAA
Theo Kessaris	FAA Flight Standards Service (AFS–260)
Bob Klothe	Department of Transportation, Office of the Secretary (C–50)

Record of Meeting

September 1, 2009

Washington, D.C.

Name	Affiliation(s)
Tracy Lee	CAL, Systems Operation Center
Rich Lewis	FedEx
Rebecca MacPherson	FAA, Office of Chief Counsel (AGC)
Tom Nesthus, Ph.D.	FAA Civil Aeromedical Institute
Paul Onorato	CAPA
Ty Prettyman	NACA
Ron Priddy	NACA
Roger Quinn	ATA, UPS
Paul Railsback	ATA
Matt Rettig	ALPA
Bart Roberts	ATA, American Airlines
Dale Roberts	FAA, AFS–200
Tom Smith	FAA, Office of Policy and Plans (APO–230)
Shirley Stroman	FAA, Office of Rulemaking
Kevin West	FAA Flight Standards Service (AFS–260)
George Wilson	World Airways
Larry Youngblut	FAA, AFS–200

BACKGROUND

The aviation rulemaking committee (ARC) was chartered to develop recommendations for rulemaking on flight time limitations, duty period limits, and rest requirements for flightcrew members in operations under parts 121 and 135 of Title 14, Code of Federal Regulations (14 CFR). Recently, the ARC held meetings on July 7, 15, 16, 21, 22, 28, and 29, 2009, and August 4, 5, 11, 12, 13, 18, 19, 25, and 26, 2009.

PURPOSE OF THIS MEETING

This meeting was held to complete discussion of substantive topics related to the ARC's mission and to review the regulatory language to be included in the ARC's draft NPRM.

Record of Meeting

September 1, 2009
Washington, D.C.

ADMINISTRATIVE MATTERS

Mr. Michael Derrick (PAI) noted that some of the records of meeting and Quick Notes documents posted to the SharePoint site were amended to reflect feedback from ARC members. He stated that in some cases, whether the ARC had reached consensus or agreement on a point had been called into question. He explained that in those cases, parenthetical notes indicating the questioned status of the issues were added to the documents.

Co-chair Mr. Don Wykoff cautioned the ARC members that, although this was the ARC's last meeting and it would be turning its work over to the FAA, its work product is not yet public, and will not be until the FAA publishes a notice of proposed rulemaking (NPRM). He urged the ARC members not to disclose ARC business to outside parties, and to be alert for the presence of press when discussing ARC business outside the meeting room.

DISCUSSION

It was stated that the ARC would begin its meeting by discussing several substantive issues requiring resolution, and would spend the remainder of the meeting reviewing the regulatory language prepared for the ARC's draft NPRM.

Maximum Duty Limitations

The question was raised of whether there should be a limitation or other provision addressing how long a flightcrew member is required to continuously be on duty. It was stated that of particular concern were extremely long deadhead segments and their impact on subsequent flight duty periods (FDPs).

Proposals and comments were solicited on how to address such duty time. A number of points were raised, as follows:

- It was suggested that a minimum rest related to the length of preceding duty could be required before any subsequent FDP.

- It was noted that there is already a limit of 75 hours of duty within a rolling window of 168 hours. It was proposed that, although a flightcrew member should certainly receive minimum rest (12 hours for international operations) before reporting for an FDP, it is not necessary to place a limit on continuous duty time. In response, it was pointed out that a flightcrew member beginning a trip with a long deadhead could be fatigued before reporting for his or her first FDP, and with much less than 75 hours of duty. It was also noted the minimum rest requirements discussed by the ARC are to be driven by the prior FDP. There was concern that no requirement is in place to ensure a flightcrew member receives adequate rest following non-FDP duty. It was also questioned whether the standard international rest of 12 hours would constitute sufficient recovery following, for example, a 24-hour deadhead.

- One ARC member expressed concern that, regardless of the rest obtained afterward, long deadheads are extremely taxing. It was pointed out that, when ground transportation is considered, it is possible that a flightcrew member being positioned could be in transit for 30 hours or more.

- An ARC member stated that deadheads can contribute to cumulative sleep debt. The ARC member proposed that, following a deadhead segment, flightcrew members receive minimum rest equal to 1.5 hours for every hour of the deadhead, but not less than minimum required rest. It was noted that deadhead segments in excess of 24 hours are not frequent, so the longest rest anticipated would not likely exceed 36 hours. A similar proposal called for rest equal to the length of the preceding deadhead. It was cautioned that using such a prescribed approach could result in a flightcrew member's eligibility to report for an FDP at an unfavorable point in his or her circadian cycle. In response, it was noted that the proposals would only prescribe a minimum rest, and that longer rests appropriate to a flightcrew member's circadian cycle could be scheduled.

- It was proposed that normal minimum rest requirements apply, except where a deadhead exceeds the length of the maximum FDP; in this case, a deadheading flightcrew member could fly under the same circumstances. For example, if a flightcrew member flies a 13-hour FDP, only normal rest is required after a 12-hour deadhead, but a 20-hour deadhead would trigger a requirement for a longer rest before flight duty. A subsequent proposal was to place the triggering point at the length of the possible FDP, including any extension for irregular operations.

- It was cautioned that the requirements recommended by the ARC should not provide more rest for a deadheading flightcrew member than for the flightcrew members actually flying the same flight. It was also suggested that deadheading is not as fatiguing as flying a live leg. It was stated that the type of seat or rest facility can significantly affect the amount of fatigue induced by a deadhead segment.

Multiple-Segment Augmented Operations

The ARC discussed augmented flightcrew operations involving FDPs with more than one flight segment. It was noted that augmentation has traditionally been used for long international flight segments that could not be completed within current flight hour limitations. It was stated that there is interest in pursuing other types of operations, including those with multiple segments, some of which would not need augmentation under current limitations. The question was raised whether these operations should be allowed, and, if so, to what extent the parameters of such operations, such as a minimum leg length, should be limited.

One ARC member offered a presentation on the subject. The presentation is contained in a PowerPoint document titled *ARC minimum leg length*, which has been posted to the SharePoint site. The presenter expressed the position that the minimum time away from the flight deck for flightcrew members conducting augmented operations should be 2 hours. The rationale was that 2 hours would provide a 1.5-hour sleep opportunity, with time on either end for getting to sleep and recovering before resuming duties. The presenter proposed that the minimum flight segment eligible for augmentation be 2 hours and 15 minutes, which would provide 15 minutes for takeoff and landing in addition to the 2 hours away from the flight deck. The presenter further expressed the position that a 1.5-hour sleep opportunity could extend performance up to 3 hours for the resting flightcrew member. This position was based on extrapolation of data from a National Aeronautics and Space Administration (NASA) cockpit napping study conducted by Curtis Graeber, Ph.D. In the NASA study, pilots asleep for 40 minutes during breaks maintained performance levels for 90 minutes longer than pilots who did not sleep.

Following the presentation, a number of comments, questions, and issues were raised, as follows:

- One ARC member related that a certificate holder operating between islands in the South Pacific has used augmented operations for 16-hour FDPs involving six short legs for approximately 40 years, without significant difficulties. Another ARC member stated that his company operates a 16.5-hour FDP involving two segments of 2 hours and 55 minutes each, and one 5-hour leg, with 3 hours on the ground between legs.

- Some ARC members questioned the extrapolation of the NASA study data, and stated that the opinion of a scientific expert would be necessary to validate the conclusion in the presentation. The ARC member that offered the presentation stated that the conclusions in the presentation were reached in consultation with Dr. Graeber.

- Several ARC members felt that the 2 hours of sleep opportunity discussed in the study was valid, but that the 15 minutes for takeoff and landing was unrealistic. It was suggested that any in-flight rest not begin until at least top of climb. It was noted that taxi data and reliability studies were considered when formulating the 2-hour-and-15-minute proposal.

- One ARC member noted that in operations between islands in the South Pacific, on shorter legs, the additional flightcrew member spends the entire flight resting in the passenger cabin and is not present on the flight deck during the flight. Another ARC member expressed skepticism at the amount of rest that could be obtained by a flightcrew member during ground operations. It was also noted that the prevailing fair weather in the South Pacific and the timing of the trips may mitigate difficulties involved in multiple-leg operations, and experience from the referenced operations might not translate well to multiple-leg operations in other parts of the world.

- It was pointed out that cockpit napping has, in the past, been discussed as a performance-enhancing mitigation, not as a planning tool.

- It was pointed out that there has been a history of flying multiple segments over a 14-hour FDP with a two-person flightcrew, so a 14-hour FDP with an augmented flightcrew should not represent a significant challenge.

- It was noted that the value of a sleep opportunity is dependent on the flightcrew member actually sleeping, and that timing of augmented operations must be such that a flightcrew member receives sleep opportunities at times when he or she is able to sleep.

- The question of which flightcrew member would rest during a leg was raised. In response, it was stated that the flightcrew member needing rest the most would be the best candidate.

- An ARC member noted that augmentation has historically been used to complete long, single-segment international flights that could not be flown without an additional flightcrew member onboard to provide an in-flight rest opportunity for other flightcrew members. It was suggested that the uses of augmentation being discussed differ from the original intent of augmentation.

This last point led to a brief presentation by another ARC member on the purpose of augmentation. The presentation is contained in a PowerPoint document titled *ARC augmentation2*, which has been posted to the SharePoint site. The presentation advocated against augmented operations that involve multiple short legs. The presentation defined the intent of augmentation as allowing a flight series to be completed, where a flightcrew change is impractical, through the addition of a qualified flightcrew member and an opportunity for adequate in-flight rest. The presenter stated that domestic augmentation should not be permitted as it is, in his opinion, almost always practical to position flightcrew members domestically, and fatigue is better mitigated by use of a fresh flightcrew, rather than the augmentation of a flightcrew.

Following the presentation, a number of comments, questions, and issues were raised, as follows:

- A question was raised of what constitutes impracticality. An ARC member noted that his carrier often augments flightcrews when forecasted weather conditions are anticipated to make operations difficult.

- Several ARC members expressed agreement with the spirit of the presentation, noting that augmentation serves a purpose, and, though safe, is less effective than a rested conventional flightcrew. Some ARC members disagreed that augmentation properly administered would be less effective. One ARC member stated that past history is not a reason to avoid augmentation to achieve new purposes. The ARC member asked why an operation should not be undertaken if the goal of fatigue mitigation is satisfied. Along the same lines, another ARC member noted as an example a European to U.S. flight could stop and replace the crew in Shannon rather than augment, which doesn't make sense and isn't optimal for anyone.

- Some ARC members stated that using augmentation to extend a multiple-segment domestic FDP beyond what would be permitted with a conventional flightcrew did not serve the ARC's purposes to identify and recommend mitigations for fatigue. While objecting to the use of augmentation without limitations, some ARC members acknowledged that, under some circumstances, such as forecasted inclement weather, augmentation of domestic operations might be appropriate. The question was raised of whether long domestic pairings, with legs several hours long, could be operated with augmented flightcrews. An example given was a once weekly roundtrip operated from Newark, New Jersey, to a ski resort area in Wyoming. It was stated the remoteness of the destination and the once weekly schedule would make it impractical to position a flightcrew, particularly if the aircraft used on the deadhead segments do not permit suitable rest for a deadheading flightcrew. It was observed that such operations would be in the spirit of existing augmentation of international flights. The question was raised of how to differentiate between such operations and operations that abuse the ability to augment at the expense of safety. The ARC member offering the presentation stated that augmented operations should be limited to legs exceeding 7 hours, so all flightcrew members can rest. Some ARC members suggested that augmented operations that involve multiple legs of relatively short duration should only be permitted if a fatigue risk management system (FRMS) is in place.

- The question was raised of whether augmentation of flightcrews for operations to and from Alaska and Hawaii would be appropriate.

- It was suggested that because augmentation increases the maximum FDP, the minimum rest following an augmented FDP should be increased as well.

- There was discussion of whether rest should be structured to permit the entire flightcrew, including the relief flightcrew member, to rest during a flight. It was pointed out that, because of security concerns or other circumstances, a relief flightcrew member might need to be part of the landing crew. Some ARC members pointed out that the methodology used today at many carriers to divide available break time might not be optimum for mitigating fatigue and needs rethinking.

Schedule Reliability

The ARC discussed what schedule reliability metrics should be used to ensure certificate holders do not create schedules with artificially short block times to meet FDP limitations. A number of proposed provisions and concerns were discussed, as follows:

- It was proposed that no more than 5 percent of all of a certificate holder's system-wide FDPs exceed their scheduled time. One ARC member suggested that the metric should only examine FDPs scheduled close to the maximum allowable time, because otherwise, operators could simply schedule shorter FDPs for longer times, which would skew downward the percentage of FDPs exceeding the schedule.

- It was proposed that no more than either 15 or 30 percent of individual FDPs exceed the scheduled time. This elicited a number of comments:

  - It was noted that in some cases, an FDP is built that is unique; in that case either zero or 100 percent of the FDPs with that combination of flights would exceed the scheduled time.

  - It was argued that FDP reliability should be examined on a city-pair segment basis, to identify problem city-pairs. It was asserted that the effect of such city-pairs would be masked if other segments in the same FDP were operated in less than the scheduled time. In response, it was noted that as long as the overall FDP does not exceed the scheduled time, it should not make a difference. It was argued that a segment that consistently exceeds its scheduled time might affect individual pilots infrequently if their lines are structured so they do not fly it every day, but that such segments are nevertheless addressed.

- It was pointed out that each individual flightcrew member's FDP needs evaluation, because different flightcrew members on the same flight might be on different FDPs.

- There was debate over what lookback period should be used to determine reliability. Some ARC members suggested that 2 months of data is used to calculate reliability, but it was pointed out that this could mean a noncompliant schedule could be in place for up to 4 months, because schedules are typically created 2 months in advance. In response, it was noted that mitigations could be added to a complete schedule to address identified reliability issues. Other ARC members felt that 2 months was too little time to give a statistically relevant sample, and felt 4 months of data should be used.

- One ARC member recommended that annual trends be considered to prevent the same schedule overruns every year because of, for example, seasonal wind variations.

- It was suggested that a similar metric also evaluate block time reliability, because maximum block time could be repeatedly exceeded without exceeding maximum FDP. This could result in flights that should have been augmented based on historical actual block times lacking a relief flightcrew member.

- The question was raised of what would happen if an operator exceeded the prescribed reliability percentages. Ms. Rebecca MacPherson, AGC, noted that frequent violations would result in enforcement action.

- There was debate over whether 15 or 30 percent is the appropriate reliability limitation. It was noted that the FAA will be performing statistical analysis of certificate holders' operations to complete the regulatory economic evaluation for the proposed rule, and the data gleaned from the analysis may be useful to establish the appropriate requirement.

Post-trip Recovery Time

The ARC discussed the rest needed for a flightcrew member upon returning to his or her home base after a trip involving demanding circumstances. One ARC member described circumstances that might trigger increased rest:

- Trips involving flying during the WOCL because of schedule disruptions on at least 3 nights.

- Trips exceeding 168 hours in duration in which there are time zone changes of greater than 4 hours.

The ARC member suggested that in such cases, rest greater than the standard 30 or 36 hours free from duty in the 168 hours preceding the flightcrew member's next FDP is necessary. Other ARC members concurred, noting that additional rest after a long trip involving time zone changes would be in line with the longer daily rest periods given during international trips.

In determining what amount of recovery rest would be appropriate following such a trip, the ARC considered proposals including a provision similar to the "double-out" provision of § 121.485(b) applied to the minimum international rest requirements, and proposals for a minimum of 2 or 3 physiological nights, depending on the triggering circumstances. With respect to the proposals for 2 or 3 physiological nights' sleep, one ARC member stated that in his experience, a minimum of 3 days' rest is necessary to recover after long trips crossing multiple time zones.

Consecutive Nights on Duty

Two ARC members offered presentations on flightcrew members flying multiple consecutive night FDPs. The presentations are contained in a Word document titled *ARC Consecutive WOCLPeriods– response to FedEx presentation*, and a PowerPoint document titled *ARC nightside alertness*. Both documents have been posted to the SharePoint site.

The two presentations offered differing analysis of the effects of flying a schedule involving a night FDP for 5 consecutive nights. Following the presentations, a number of questions, concerns, and issues were raised. Several ARC members noted differences in the assumptions used for each analysis. The validity of some assumptions by both presenters was discussed.

Assumptions addressed include the following:

- Rest a flightcrew member receives before duty.
- The extent of a flightcrew member's commute before duty.
- Availability of rest facilities between flights during the WOCL.
- Ability of a flightcrew member to use rest facilities during a duty period.
- The amount and timing of sleep a flightcrew member receives.

Following the presentations and discussion, two ARC members observed that both presentations have some level of validity, depending on actual circumstances. One ARC member stated that at least one air carrier that conducts consecutive overnight operations has implemented mitigations similar to FRMS components, and recommended that air carriers scheduling consecutive nighttime operations should implement similar mitigations, including a minimum 14-hour rest before reporting for a fourth consecutive night FDP.

Review of Recommended Regulations

The ARC spent the remainder of its time reviewing draft recommended regulatory language prepared outside of the ARC's meetings by a writing committee created as an ARC subgroup. The purpose of the review was to ensure the draft language accurately captured the concepts discussed during ARC meetings. The results of the review discussions are captured in the draft regulatory language, which was amended during the meeting to address concerns ARC members raised.

In response to a question about submission of additional information, Ms. MacPherson stated that any ARC member may submit additional data before September 15, 2009, to clarify or expand on their positions, or to provide data they believe would be useful to the FAA in the rulemaking process.

TAB 3

U.S. Department of Transportation

FEDERAL AVIATION ADMINISTRATION
Office of Aviation Policy and Plans
Washington, D.C. 20591

REGULATORY IMPACT ANALYSIS

Flightcrew Member Duty and Rest Requirements
PART 117

NOTICE OF PROPOSED RULEMAKING

OFFICE OF AVIATION POLICY AND PLANS

September 3, 2010

Table of Contents

Executive Summary

This report documents a benefit/cost analysis of FAA's proposed amendments to its flight, duty and rest regulations applicable to certificate holders and their flight crew members. The proposal recognizes the growing similarities between the types of operations and the universality of factors that lead to fatigue in most individuals. Fatigue threatens aviation safety because it increases the risk of pilot error that can lead to an accident. The proposed requirements would eliminate the current distinctions between domestic, flag and supplemental operations. The proposal provides different requirements based on the time of day, whether an individual is acclimated to a new time zone, and the likelihood of being able to sleep under different circumstances.

FAA has determined the proposed rule: (1) has benefits that justify its costs, (2) is an economically "significant regulatory action" as defined in section 3(f) of Executive Order 12866, (3) is "significant" as defined in DOT's Regulatory Policies and Procedures; (4) would have a significant economic impact on a substantial number of small entities; (5) would not create unnecessary obstacles to the foreign commerce of the United States; and (6) would impose an unfunded mandate on the private sector.

Based on the FAA safety effectiveness assessment for this proposed rule to prevent pilot fatigue accidents, we estimate a total benefit of $659 million ($ million at present value, over 10 years). Our rule requirements began with the recommendation from labor and industry and we then applied fatigue science to maximize benefits relative to costs. The total estimated costs of the proposed rule over 10 years are $1.25 billion

($804 million at present value). There is over a 7 percent probability that undiscounted benefits of averting passenger airplane accidents would exceed $1.25 billion and over a 10 percent probability the present value of the benefits of averting cargo airplane accidents would exceed $804 million. The benefits from a single near-term prevented catastrophic accident of a common 150-passenger airplane with an average load factor would exceed the present value cost of this rule. If the value of an averted fatality were increased to $12.6 million, the present value of the benefits would equal the present value of compliance costs. The FAA invites comments on the methodology, data, and assumptions employed in this analysis.

	Nominal Costs	**PV Costs**
	(millions)	**(millions)**
Total Costs (over 10 years)	$1,254.1	$803.5
Benefits	**Nominal Benefits (millions)**	**PV Benefits**
		(millions)
$6.0 million VSL	$659.40	$463.80
$8.4 million VSL	$837	$589

Benefits Analysis

Background & History

The NTSB's list of Most Wanted Transportation Safety Improvements includes safety recommendations about pilot fatigue. These recommendations are based on accident investigations and an NTSB safety study on commuter airline safety. The first

NTSB recommendations to the FAA about pilot fatigue rulemaking occurred after the Guantanamo Bay, Cuba, accident on August 18, 1993. In that accident, three flight crew members were seriously injured and the airplane was destroyed. The captain lost control of the airplane while on approach to the U.S Naval Air Station at Guantanamo. The NTSB listed as a probable cause of the accident the impaired judgment, decision-making, and flying abilities of the captain and flight crew because of fatigue. The flight crew had been on duty for 18 hours and had flown for 9 hours. The NTSB recommended the FAA revise part 121 to require that “tail end” ferry flights be included in flight crews’ flight time and duty time (A-94-105). The NTSB also recommended the FAA revise the flight/duty time limitations in its regulations to ensure the regulations incorporate the results of the latest research on fatigue and sleep issues (A-94-106).

The NTSB’s list of Most Wanted Transportation Safety Improvements includes another safety recommendation on pilot fatigue and ferry flights conducted under 14 CFR part 91. On February 19, 1995, three flight crew members died after a Douglas DC–8–63 operated by Air Transport International was destroyed by ground impact and fire during an attempted three engine takeoff at Kansas City International Airport in Kansas City, Missouri. The NTSB noted the flight crew conducted the flight as a maintenance ferry flight under part 91 after a shortened rest break following a demanding round-trip flight to Europe that crossed multiple time zones. The NTSB further noted the international flight, conducted under part 121, involved multiple legs flown at night following daytime rest periods. In addition, the NTSB found the captain’s last rest period before the accident was repeatedly interrupted by the certificate holder.

In issuing its 1995 recommendations, the NTSB stated the flight time limits and rest requirements under part 121 that applied to the flight crew before the ferry flight did not apply to the ferry flight operated under part 91. The NTSB found the regulations allowed a substantially reduced flight crew rest period for the nonrevenue ferry flight. Because of the investigation, the NTSB reiterated earlier recommendations to (1) finalize the review of current flight and duty time limitations to ensure the limitations consider research findings in fatigue and sleep issues and (2) prohibit certificate holders from assigning a flight crew to flights conducted under part 91 unless the flight crew meets the flight and duty time limits under part 121 or other applicable regulations (A–95–113). Since this recommendation there have been additional accidents in which flight crew fatigue was a contributing factor in the accident.

On July 26, 2002, a Federal Express flight 1478, B727-232F, struck trees on approach and crashed short on the runway at the Tallahassee Regional Airport, Tallahassee, FL. The NTSB determined that the probable cause of the accident was the flight crew's failure to establish and maintain a proper glidepath during the night visual approach to landing. The NTSB also determined that the captain's and first officer's fatigue contributed to the accident. Three flight crew members were seriously injured and the airplane was destroyed. The NTSB mentioned flightcrew fatigue as a factor contributing to the accident. In February 2006, the NTSB issued safety recommendations after a BAE–J3201 operated under part 121 by Corporate Airline struck trees on final approach and crashed short of the runway at Kirksville Regional Airport, Kirksville, Missouri. The captain, first officer, and 11 of the 13 passengers were fatally injured. The

NTSB determined that the probable cause of the accident was the pilots' failure to follow established procedures and properly conduct a nonprecision instrument approach at night in instrument meteorological conditions. The NTSB concluded that fatigue likely contributed to the pilots' performance and decision making based on the less than optimal overnight rest time available to the pilots, the early reporting time for duty, the number of flight legs, and the demanding conditions faced during the long duty day.

Because of these accidents, the NTSB issued the following safety recommendations related to flight and duty time limitations: (1) modify and simplify the flight crew hours-of-service regulations to consider factors such as length of duty day, starting time, workload, and other factors shown by recent research, scientific evidence, and current industry experience to affect crew alertness (A–06–10); and (2) require all part 121 and part 135 certificate holders to incorporate fatigue-related information similar to the information being developed by the DOT Operator Fatigue Management Program into initial and recurrent pilot training programs. The recommendation notes that this training should address the detrimental effects of fatigue and include strategies for avoiding fatigue and countering its effects (A–06–11).

There have also been some incidents in which the NTSB cited flight crew fatigue as a cause. On February 18, 2007, Delta Connection flight 6448, operated by Shuttle America, Inc., overran the runway at Cleveland-Hopkins International Airport, Cleveland, OH (no fatalities and no serious injuries). On April 12, 2007, Pinnacle Airlines flight 4712 overran the runway at Cherry Capital Airport, Traverse City, Michigan (no fatalities and no serious injuries). On February 13, 2008, Go! Flight 1002, operated by Mesa Airlines, flew past its destination airport at Hilo, Hawaii – the flight crew fell asleep while in-flight (no fatalities and no serious injuries).

The current FAA rules in part 121 do not prescribe duty limits; rather they focus on flight time limits and rest requirements. Flight time limits and rest requirements vary based on the type of operation. The requirements in these subparts apply to domestic, flag, and supplemental operations. Under the current rules for domestic operations, flightcrew members must receive at least an 8-hour rest period during the 24-hour period before the end of each flight. Flightcrew members conducting flights under part 121 for domestic operations are limited to 30 hours of flight time in any seven consecutive days. The 7-consecutive-day limit for flag operations is 32 flight hours, and there is no 7-consecutive-day limit for supplemental operations. In addition, part 121 limits the flight time of flightcrew members engaged in domestic operations to 1,000 hours in any calendar year. Flightcrew members engaged in flag and supplemental operations are limited to 1,000 hours in any 12-calendar-month period. There is a quarterly and semi-annual limit of 500 hours and 800 hours, respectively, for unscheduled operations. Operators are required to provide each crewmember a minimum of 24 consecutive hours of rest during any seven consecutive days for all domestic, flag, and supplemental operations conducted under part 121.

On June 10, 2009, Federal Aviation Administration (FAA) Administrator J. Randolph Babbitt testified before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Aviation Operations, Safety, and Security on Aviation Safety on the FAA's role in the oversight of certificate holders. He addressed issues on flightcrew member training and qualifications, flightcrew fatigue, and consistency of safety standards and compliance between air transportation certificate holders. He also committed to assess the safety of the air transportation system and to take appropriate steps to improve it.

In June 2009, the FAA convened the Flight and Duty Time Limitations and Rest Requirements Aviation Rulemaking Committee (ARC). The FAA tasked the ARC to develop recommendations for an FAA rule based on current fatigue science and a review of international approaches to the issue. The ARC submitted its recommendations to the FAA on September 10, 2009.

Summary of Scientific Presentations

To achieve the goal of developing proposed rules to enhance flightcrew member alertness and employ fatigue mitigation strategies, the ARC reviewed scientific information presented by experts in sleep, fatigue, and human performance research. Below is a summary of the scientific presentations:

1. Fatigue

Fatigue is characterized by a general lack of alertness and degradation in mental and physical performance. There are three types of fatigue: transient, cumulative, and circadian. Transient fatigue is acute fatigue brought on by extreme sleep restriction or extended hours awake within 1 or 2 days. Cumulative fatigue is fatigue brought on by repeated mild sleep restrictions or extended hours awake across a series of days.

Circadian fatigue refers to the reduced performance during nighttime hours, particularly during the window of circadian low (WOCL).

There is no direct measure or physiological marker that shows when a person is fatigued, although biomedical data may indicate physiological conditions favorable to fatigue. Fatigue is often accompanied by drowsiness but is more than just being sleepy or tired. Common symptoms of fatigue include:

- Measurable decrease in speed and accuracy of performance,
- Lapses of attention and vigilance,
- Delayed reactions,
- Impaired logical reasoning and decision making, including a reduced ability to assess risk or understand effects of actions,
- Reduced situational awareness, and
- Low motivation to perform optional activities.

Various factors contribute to whether an individual experiences fatigue and the severity of fatigue experienced. The major factors affecting fatigue include:

- *Time of day*. Fatigue is, in part, a function of circadian rhythms. Human waking and sleep cycles follow a 24-hour cyclical wave pattern known as the internal body clock (circadian rhythm). The circadian rhythm is closely correlated to core body temperatures. All other factors being equal, fatigue is most likely, and, when present, most severe, during the WOCL, when body temperatures are at their lowest, during a four hour period between the hours of 12:00 AM and 6:00 AM. Studies have found that subjects remaining awake through the WOCL and into the daytime hours experience improvements in performance once past the WOCL, relative to their performance during the WOCL.
- *Amount of recent sleep.* If a person has had significantly less than 8 hours of sleep in the past 24 hours, he or she is more likely to be fatigued.
- *Time awake.* A person who has been continuously awake more than 17 hours since his or her last major sleep period is more likely to be fatigued.
- *Cumulative sleep debt.* Sleep debt refers to the impact of receiving less than a full night's sleep for multiple days. For the average person, cumulative sleep debt is the difference between the sleep a person has received over the past several days, and the sleep they would have received if they obtained 8 hours

of sleep per night. For example, a person who has received 10 hours of sleep over the past 2 nights has a cumulative sleep debt of 6 hours. A person with a cumulative sleep debt of more than 8 hours since his or her last full night of sleep is more likely to be fatigued.

- *Time on task.* The longer a person has continuously been doing a job without a break, the more likely he or she is to be fatigued.
- *Individual variation*. Different individuals will respond to fatigue factors differently. Different individuals may become fatigued at different times, and to different degrees of severity, under the same circumstances.

There often is interplay between various factors contributing to fatigue. For example, the performance of a person working night and early morning shifts is impacted by the time of day. Also, because of difficulty in obtaining normal sleep during other than nighttime hours, such a person is more likely to have a cumulative sleep debt or to not have obtained a full night's sleep within the past 24 hours.

2. Fatigue in Aviation

Several aviation-specific work schedule factors[1] can affect sleep and subsequent alertness. These include early start times, extended work periods, insufficient time off between work periods, insufficient recovery time off between consecutive work periods, amount of work time within a shift or duty period, insufficient time off between work periods, number of consecutive work periods, night work through one's window of circadian low, daytime sleep periods, and day-to-night or night-to-day transitions.

[1] Rosekind, MR. Managing work schedules: an alertness and safety perspective. In: Kryger MH, Roth T, Dement WC, editors. Principles and Practice of Sleep Medicine; 2005:682.

3. Preventing and Mitigating Sleep Debt

Scientific research and experimentation has consistently showed that adequate sleep sustains performance. For most people, 8 hours of sleep in each 24 hours sustains performance indefinitely. Sleep opportunities during the WOCL are preferable, although some research suggests the total amount of sleep obtained is more important than the timing of sleep within the day. When a person has accumulated a sleep debt, recovery sleep is necessary. Recovery sleep requires an opportunity to obtain enough sleep to fully restore the person's "sleep reservoir." Recovery sleep should include at least one physiological night, that is, one sleep period during nighttime hours in the time zone in which the individual is acclimated. Recovery sleep does not require additional sleep equal to the cumulative sleep debt; that is, an 8-hour sleep debt does not require 8 additional hours of sleep. However, sleep on recovery days should be extended beyond the usual sleep amount. The average person needs over 9 hours of sleep per night to recover from a sleep debt.

This analysis looks at the projected costs and benefits of the FAA's NPRM on flight duty and rest requirements for flightcrew members of air carriers in part 121. The proposal is primarily based upon the work and discussions within the ARC along with the NTSB recommendations. For the detailed discussion of the proposal and the discussion of the exact requirements the reader should see the NPRM that is filed in the docket.

Benefits

The scientific community recognizes there is a complex relationship between pilot performance and safety risk, and how the performance is impacted by pilot schedules. Investigations of pilot work variables have explored how they affect crewmember alertness, how alertness affects crew performance under differing workloads and operational environments, and how pilot work variables and alertness combine to affect safety performance that is measured by accidents and incidents.[2]

In 1980, in response to a congressional request, the NASA Ames Research Center created a Fatigue/Jet Lag Program to study fatigue. In a Technical Memorandum in 1995, the Center concluded the average sleep requirement is 8 hours in a 24-hour period.[3] As another example, a study by Rosekind and others states that most humans need about eight hours of sleep per night.[4] In addition, Battelle Memorial Institute reviewed the scientific literature on fatigue in a study for the FAA. This review found that most researchers recommend an adult needs an average of 7.5 to 8 hours sleep a day. The available scientific literature has identified several symptoms that indicate the presence of fatigue, including: increased anxiety, decreased short-term memory, slowed reaction time, decreased work efficiency, decreased vigilance, and increased errors.

---

[2] Battelle Memorial Institute, JIL Information Systems, " An Overview of the Scientific Literature Concerning Fatigue, Sleep, and the Circadian Cycle," January, 1998, prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, Federal Aviation Administration.

[3] Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation, NASA Technical Memorandum, 1995.

[4] Rosekind, Neri and Dinges, "From Laboratory to Flightdeck: Promoting Operational Alertness" in Fatigue and Duty Limitations—An International Review, (download 1-25-99, http/olicas.arc.nasa.gov/Zteam/FCP/subs/raes.html), page 1.

Benefit Overview

The approach of this benefits analysis begins with a search of the historical record of accidents to establish the extent of the fatigue problem. First, there is some evidence that pilots are knowingly flying tired or should know that they are flying tired. Since 1990, the NTSB has identified five pilot error accidents in which lack of adequate sleep was a contributing factor in causing the accident. Second, comparing pilot error accidents to length of pilot duty periods indicates that pilot error accidents are more likely to occur after long periods on duty. We have calculated the increased accidents occurring late in duty periods. Third, if the duty period begins late in day, then pilots might be tired even though they are at the beginning of their duty period. We have found accidents where this was the case. Fourth, there is also evidence in the accident record where chronic fatigue may have been a contributing factor to the accident. Last, the accident rate for takeoffs and landings that occur between midnight and 6:00 am is much higher than the accident rate for those operations that occur during the day time. We have calculated the increased accidents that occur between midnight and 6:00 am.

Having projected the possible extent of fatigue based on the historical record, we estimate the likelihood of accidents happening in the future using simulation techniques. We also use simulation techniques to estimate future casualties, which we monetize. In this way, we estimate the potential benefits of the proposed rule.

. Finally, we model risk of fatigue for current pilot schedules, and compute the number of hours in higher risk categories with and without the rule. The projected reduction in fatigue exposure is corroborating evidence supporting this proposal.

Receive Adequate Rest (Sleep) Between Duty Periods

One of the goals of this rulemaking is to require part 121 operators to provide flightcrew members the opportunity to acquire an adequate rest before the start of their flight duty period. In the past 20 years, there have been at least five accidents where the flightcrew members did not have an adequate amount of sleep prior to the start of their flight duty period.

The first accident in the 20-year analysis period occurred at Pine Bluff, AR at 3:55 PM on April 29, 1993. An Embraer EMB120 RT, Brasilia, N24706, (operated by Continental Express, Inc.) was substantially damaged when it collided with rough terrain during an overrun following a forced landing. The forced landing was executed following a stall and loss of control at 17,412 feet during climb. After regaining control of the airplane the flightcrew noticed that the left engine nacelle was damaged and that three propeller blades were missing. The airplane was unable to maintain level flight. After the flightcrew landed the airplane, it hydroplaned off the wet runway. The airplane was substantially damaged as a result of overrunning the runway. There were three crewmembers and 27 passengers on board the airplane. The flight attendant and 12 passengers received minor injuries; the others were uninjured. The NTSB determined that pilot error was the cause of the accident.

Contributing to the accident was fatigue induced by the flightcrew's failure to properly manage their provided rest periods. The flightcrew got off duty at 11:30 AM the day before the accident. The captain went to bed between midnight and 12:30 AM and awoke about 5:00 AM (receiving only 4 ½ to 5 hours sleep) for a departure at 6:30 AM. The first officer went to bed between 11:00 PM and midnight and woke up about 4:30 AM (receiving between 5 and 5 1/2 hours sleep). Both pilots claimed they felt well rested prior to starting their flight duty for that day. The accident flight occurred during the seventh and last flight of the day.

The second accident occurred at 10:27 PM on February 16, 1995 at Kansas City, MO. A Douglas DC-8-63, N782AL, operated by Air Transport International (ATI), was destroyed by ground impact and fire. The accident occurred during a three-engine takeoff for a ferry flight under Part 91. Three crew members were fatally injured. The NTSB determined that the accident was due to pilot error.

In addition to being inadequately trained, the flightcrew was suffering from fatigue as a result of limited opportunities for rest, disruption of their circadian rhythms, and lack of sleep in the days prior to the accident. Before their assignment to the accident trip, the flightcrew had completed a demanding round-trip to Europe. The flights crossed multiple time zones (12 in all) in a short period of time. The Dover-Ramstein-Gander-Dover legs were flown at night following daytime rest periods, which disrupted the flightcrew's circadian rhythms. On the day of the accident, the flightcrew had checked into a hotel in Dover, DE, at 2:40 AM EST. The captain placed a short call from his room at 3:14 AM. At 8:02 AM (receiving not quite 5 hours sleep), he called home and spoke to his wife for 25 minutes. ATI Scheduling called the captain at 10:30 AM. There were other calls between ATI and the captain throughout the day (10:45 AM, 12:44 PM, 2:00 PM, and 2:10 PM). The flightcrew departed Dover at 3:18 PM EST and arrived at Kansas City at 5:39 PM CST.

The flightcrew was required to take a 16 hour rest period before they could be assigned any additional part 121 duties. However, there are no flight time limits or rest requirements for Part 91 ferry flights that follow Part 121 revenue flights. So 12 hours after checking into a hotel at Dover, the flightcrew checked out to assume duty under Part 91 ferry flight rules.

The third accident in the 20-year analysis period occurred on May 8, 1999 at 7:01 AM EST. A Saab-Scania AB (Saab), N232AE, operated by American Eagle Airlines, INC., overran the runway at John F Kennedy International Airport, Jamaica, NY. The captain conducted an ILS approach with excessive altitude, airspeed, and rate of descent, while remaining above the glide slope. The airplane landed 7,000 feet beyond the approach end of the runway, at excessive speed (157 knots), and overran the runway. One passenger was seriously injured while exiting the airplane, the other passengers and crewmembers were uninjured. The airplane was substantial damaged by the accident.

The NTSB determined that pilot error caused the accident. During the post accident interviews, both pilots stated that they were fatigued. The flightcrew was working a continuous duty overnight schedule. The previous day, they both woke up during the morning, did not sleep during the day, and reported for duty at 11:00 PM for a flight scheduled at 11:46 PM. The day before the accident, the flight was delayed and arrived at BWI around 1:00 AM. They got to sleep around 1:30 AM and awoke at 4:45 AM for the accident flight, which was scheduled to depart at 6:10 AM.

The fourth accident occurred at Tallahassee, FL on July 26, 2002 at 5:37 AM EST. A Boeing 727-23F, N497FE, operated by Federal Express (FedEx) struck some trees and landed short of the runway. All three flightcrew members were seriously injured. The airplane was destroyed by impact and the resulting fire. The NTSB determined that the accident was caused by pilot error. Both the captain and the first officer were fatigued at the time of the accident. The captain had only 3 ½ hours of sleep prior to the accident. He had disturbed, interrupted sleep on the two previous nights. The first officer, who was on reserve duty, reported that he was having difficulty adjusting his sleep cycle to the reserve-duty schedule. His reserve-duty schedule caused him to frequently change his sleep pattern between sleeping during daytime hours and night hours. He had approximately 5 to 6 hours sleep before reporting for duty. The flight engineer had received about 6 ½ hours sleep before he began his duty and had taken two naps (30 minutes on a commute to Memphis, TN, and 30 to 60 minutes at FedEx's crew rest facility at Memphis airport).

The fifth accident occurred at 3:06 PM EST on February 18, 2007 at Cleveland, Ohio. An Embraer ERJ-170, N862RW, operated by Shuttle America, Inc. as Delta Connection flight 6448, landed during snow conditions and overran the end of the runway. Three passengers received minor injuries; the remaining 68 passengers and 4 crew members were uninjured. The NTSB determined that the accident was caused by pilot error. Contributing to the accident was the captain's fatigue.

On the day of the accident the captain had received only 45 minutes to an hour of sleep. The captain had reported that he was too tired to fly on July 30, 2006. The Shuttle America chief pilot and ERJ-170 program manager told him fatigue calls made outside duty times would result in an unavailable attendance mark. On January 16, 2007 Shuttle America notified the pilot in writing that his attendance had reached an unacceptable level – nine absences occurrences (seven sick and two unavailable attendance marks) totaling 18 days within the previous 12 months – and that future occurrences would result in corrective action, which could include termination from the company. According to company policy eight absence occurrences would result in termination. Since the captain had not received any previous notification from Shuttle America about his attendance record he had not yet been terminated. The captain stated that he did not cancel his trip due to fatigue because he thought he would be fired.

In the five accidents discussed above, the captains (and sometimes the other flightcrew members) were operating their airplanes while they were fatigued and they knew that they were fatigued (or should have known that that they were fatigued). The new requirements of this rulemaking, including increased training, would prevent these accidents from happening in the future.

Duty Time Limits

In analyzing this rulemaking action, the FAA conducted an assessment of the risks of pilot work practices and the risk of a part 121 accident.[5] Human factors-related accidents from the 1990 to 2009 time period were identified that involved, at a minimum, substantial damage to the aircraft or serious injuries to those on-board. All turbulence-related accidents were excluded, as were accidents that did not have a 72-hour history of pilot activities before the accident. There were 43 accidents where the needed data were available (sometimes slightly more or fewer than 43 accidents depending on the schedule-related risk factor of interest). The FAA believes that these accidents are representative of all the major human factor-caused accidents that occurred during the period, including all accidents where fatigue was a factor.

As part of the analysis for this rulemaking, the FAA obtained data on pilot work patterns from six carriers covering two months of actual flight activity during 2009. The six carriers that provided flight crew duty schedule data included three large legacy passenger carriers that conduct both international and domestic operations (one of which includes elements of a low cost domestic carrier and two large cargo carriers that conduct both international and domestic air cargo services. For the following analysis, these data were used to create profiles of the work patterns of the pilots from these six airlines. The data were converted (for each month) into one record for each pilot with a line of actual flying for one or both of the months. Each pilot record tracked a pilot's activity for every

[5] GRA, Incorporated, "Flight and Rest Time Safety and Cost Analyses (Phase 3)," October 30, 2000, prepared for FAA, Office of Aviation Policy and Plans under Work Order No. 1, Contract No. DTFA01-98-C-00096.

hour in the entire month that the pilot was on duty. The beginning and end of each trip segment were recorded for each pilot and put into a database. Parameters of interest were then calculated such as the length of duty periods, the day within a duty trip on which duty hours take place and the numbers of takeoffs and landings within a duty period. The analysis tracked these activities in base time (defined as the time at the location where the pilot began a multi-day trip, which is often the pilot's crew base). The analyses provide support for regulatory proposals to govern duty time.[6] Specifically, it was found that the

---

6

It is important to note that pilots are only at risk of suffering an air accident during those duty hours when they are actually operating an aircraft. Therefore, the first hour of a pilot's duty day – spent (as indicated by industry practice and the data provided by carriers for this analysis) engaged in ground activities such as check in, flight and schedule information acquisition and pre-departure inspections of aircraft – does not represent duty time "at risk" of an air accident. Similarly, once each pilot has concluded the first flight segment of his or her duty day, some percentage of the pilot's duty time is spent on the ground between actual flight segments. This time spent on duty but on the ground is also duty time that is not "at risk" of an air accident. After adjusting for the first duty hour, about 75 percent of pilot duty hours are spent operating an aircraft and thus "at risk" of an air accident. For the statistical analyses presented below, the pilot duty time data has been adjusted to reflect this. Adjustments are done on the reported pilot duty data in the following way.

- The first hour of the pilot duty day is excluded, since it is not an hour of duty "at risk" of an air accident
- After this first hour each pilot begins his or her first flight segment of the day. The length of this first flight segment varies from pilot to pilot, depending on the day's itinerary. Therefore the second duty hour of each pilot's duty period is treated as if it is an "at risk" duty hour for each pilot, so the total number of second duty hours is not adjusted in any way.
- During the third through eighth duty hours, some pilots are at times on the ground between segments (and thus are not "at risk"), some have resumed flying their second, third, fourth or greater flight segment of the day (and are therefore "at risk"), some continue to fly throughout a long first flight segment of the day (and are therefore "at risk"), and so forth. Over these hours of the duty period, individual pilots spend some duty time on the ground and not "at risk" and the remainder of the duty time operating an aircraft and therefore "at risk." It is not possible to capture the actual variability in

proportion of accidents is higher for more lengthy duty periods than is the proportion of lengthy duty periods in the pilot sample. This is illustrated in Table 1 where about 6 percent of pilot duty hours are in the 11th or greater hour of a duty period while 16 percent of accidents that occur happen in the 11th or greater hour of the pilot's duty period. Similarly, nine percent of the accidents occur when a pilot has been on duty for 13 or more hours whereas just a little over one percent of pilot duty hours occur during that time. This analysis points to increased accident risk with increased duty time, even though pilot scheduling was not cited as a factor in all 43 accidents.

This analysis is also consistent with a study of pilot deviations by duty time within the past 24-hours (see Appendix A). In this study the portion of pilot deviations was greater than the exposure portion when duty time exceeded 6 hours during the past 24-hours. These findings and the analysis above suggest that more stringent limits on pilot duty time would be appropriate.[7]

---

the pilot duty data, so for the third, fourth, fifth, sixth, seventh and eighth duty hours, the reported duty hour counts are reduced by 30 percent to account for this "sometimes 'at risk,' sometimes not 'at risk'" nature of this portion of the duty day. (This 30 percent adjustment factor for those hours of the duty period exceeds the observed 25 percent difference between flight time and duty time because no adjustment is made to the duty hours observed in the final hours of pilot duty periods.)

- For the ninth and greater duty hours in the pilot duty day, it is assumed that all pilots still on duty have commenced and are completing their final flight segment of the day, and are therefore "at risk" of an air accident during these duty hours.

The adjusted exposure data set is reported in Table 1 and is used for calculations reported in Table 2.

[7] It also should be noted that many union contracts today require periods of flight time, duty time, and rest time which are more stringent than the requirements established by the existing, and in some cases the proposed, Federal Aviation Regulations. However, our analysis is based on a mix of carriers including those with more stringent contracts.

Table 1: Captain Duty Hours and Accidents by Hour in Duty Period

Hour in Duty Period	Captains' Hours	Exposure Percentage	Accidents	Accident Percentage	Accident Proportion Relative Exposure Proportion
2nd	192,786	19%	7	16%	0.88
3rd – 4th	310,045	30%	8	19%	0.62
5th – 6th	211,474	20%	6	14%	0.69
7th – 8th	152,671	15%	11	26%	1.74
9th – 10th	108,084	10%	4	9%	0.89
11th – 12th	53,611	5%	3	7%	1.40
13th – 14th	10,010	1%	1	2%	2.33
15th +	1,003	<1%	3	7%	72.32
Total	***1,039,684***		***43***		

It is possible to estimate the number of accidents that could have been avoided by limiting the duty time of pilots using the information in Table 2. If fatigue was not a contributing factor in the 36 accidents that occurred during one of the first ten hours of pilot duty, then the relationship between the exposure data compiled for captains and the "normal" frequency of occurrence of serious accidents can be estimated as 3.69 accidents per 100,000 hours of duty time.[8] There were 53,611 hours of duty in the exposure data set that occurred during the 11th and 12th duty hour of a pilot's duty period; and based on

[8] To calculate the factor for accidents per 100,000 hours of exposure data, the total number of duty hours in the exposure data in the tenth hour of a duty period and earlier is calculated, as [(192,786 + 310,045 + 211,474 + 152,671 + 108,084) = 975,060 duty hours] . Of the accidents, 36 occurred while the pilot was in the tenth or earlier hour of a duty period. This accident number of 36 divided by the exposure total of 975,060 hours results in an accidents-per-100,000 exposure hours ratio of 3.69.

the calculated frequency relationship (3.69 accidents per 100,000 hours of duty time) 1.98 accidents would be expected to occur, and three accidents did occur during those hours of a pilot's duty period. In the 13th and 14th duty hour there were only 10,010 hours of duty. The expected number of accidents at the above rate would be 0.4 for that time period, while one accident occurred involving a pilot in that range of the duty period length. Since there were only 1,003 hours of duty occurring in the 15th and greater hours of duty, only 0.1 accidents would be expected during those hours of the duty period. In the dataset there are three accidents involving a pilot with a duty period of this length.

Table 2 shows the projected number of accidents estimated in this way in comparison with the actual number of accidents. The difference between the actual number of accidents and the projected number of accidents would be the number of accidents that may be avoided for that time in duty period category. For example, in the 11th and 12th hour, there were three accidents,[9] and 1.98 was projected to occur; so there is a difference of 1.02 accidents. Similarly, in the 13th and 14th hour, there was one accident,[10] while only 0.4 were projected to occur; the difference (or possible number of accidents avoided) is 0.6 accidents. Finally, in the 15th and greater hours of duty, there were three accidents,[11] while only 0.1 were projected to occur based on the distribution of duty hours; the difference (or possible number of accidents avoided) is 2.9 accidents.

[9] Hyannis, MA (1/23/99), Oshawa, Canada (12/16/2004 and Laramie, WY (2/18/07).

[10] Little Rock, AR (6/1/99).

[11] Guantanomo Bay (8/18/93), Kirksville, MO (10/19/04), and Traverse City, MI (4/12/07).

Table 2: Projected Number of Accidents Avoided by Limiting Duty Time

Hour in Duty Period	**Projected Number of Accidents**	**Actual Number of Accidents**	**Possible Accidents Avoided**
2nd	7.12	7	
3rd – 4th	11.45	8	
5th – 6th	7.81	6	
7th – 8th	5.64	11	
9th – 10th	3.99	4	
11th – 12th	1.98	3	1.02
13th – 14th	0.37	1	0.63
15th +	0.04	3	2.96
Total	***36.4***	***43***	***4.61***

A rule that limits duty time to 14 hours could avoid 2.96 accidents. If the limit on duty time were set at 12 hours, then 3.6 accidents could be avoided. If the limit on duty time were set at 10 hours, then 4.6 accidents could be avoided.

In Appendix B, two methods were used to test the statistical significance of the relationship between length of duty time and accidents. Both tests showed that the relationship was statistically significant. The FAA requests comments on the content of Appendix B.

Since 1990, there have been seven serious accidents where pilot fatigue due to a long duty period was a contributing factor. These accidents resulted in 24 fatalities to passengers and crew members, 52 serious injuries to passengers and crew members, and

65 minor injuries to passengers and crew members. There were also 76 passengers and crew members in these seven accidents who were not injured.

The first accident occurred on August 18, 1993, when a Douglas DC-8-61 freighter operated by American International Airways collided with level terrain short of the runway at Leeward Point Airfield, Guantanamo. The accident happened at 1656 EDT when the pilot lost control of the airplane while on approach. All three crew members were seriously injured and the airplane was destroyed. The NTSB determined that pilot error was the probable cause of the accident and that pilot fatigue was a contributing factor.

This is the first Part 121 accident where NTSB cited pilot fatigue as a contributing factor. At the time of the accident, the flight crew had been on duty for about 18 hours. On the day of the accident, the captain had been awake for over 23 hours with only five hours of sleep prior to waking up. The first officer had been awake 19 hours with 8 hours of sleep, and the flight engineer had been awake 21 hours with 6 hours of sleep. The day before the accident, the captain and first office had only two hours of sleep prior to being awake for over 17 hours.

The second accident occurred on January 22, 1999, when a Beech 1900D operated by Colgan Air, Inc. was substantially damaged while landing at Barnstable Airport, Hyannis, MA. The accident happened at 1719 EST. There were no injuries to the two crew members and the two passengers. The NTSB determined that pilot error was the probable cause. On the day of the accident the captain had reported for duty at 535 EST. At the time of the accident the captain had been on duty almost 12 hours.

The third accident occurred on June 1, 1999, when a McDonnell Douglas DC- 9-82 (MD-82) operated by American Airlines crashed after it overran the end of runway during a landing at Little Rock National Airport, Little Rock, AR. The accident happened at 2350 CDT. At the time of the accident there were thunderstorms in the airport area and the runway was wet. The captain and 10 passengers were fatally injured; four crew members and 41 passengers were seriously injured, one crew member and 64 passengers received minor injuries; and 24 passengers were uninjured. The airplane was destroyed by impact and a postcrash fire. The NTSB determined that pilot error was the probable cause and that fatigue was a contributing factor.

On the day of the accident, the captain awoke at 715 and reported for duty at 1038. At the time of the accident he had been awake for over 16 hours and had been on duty for over 13 hours. The first officer had also been awake for over 16 hours and on duty for over 13 hours.

The fourth accident occurred on October 19, 2004, when a BAE-J3201 operated by Corporate Airlines as an American Connection struck some trees on final approach to Kirksville Regional Airport, Kirksville, MO and crashed short of the runway. The accident occurred at 1937 CDT. The crew and 11 passengers were fatally injured and two passengers received serious injuries. The airplane was destroyed by impact and post crash fire. The NTSB determined that pilot error was the probable cause of this accident and that fatigue was a contributing factor.

On the day of the accident, the pilots were flying their sixth flight of the day and had flown 6 hours and 14 minutes when the accident occurred. They had also been on duty for 14 hours and 31 minutes at the time of the accident. The night before the accident, the captain had not slept well and awoke with a headache, according to his fiancée who talked with him during the morning by telephone.

The fifth accident occurred on December 16, 2004, when a Short Brothers SD3-60 aircraft operated by Air Cargo Carriers, Inc. as a chartered cargo flight attempted a landing at the Oshawa Municipal Airport, Oshawa, Canada. The crew rejected the landing after noticing poor breaking action and tried to conduct a go-around. After becoming airborne the aircraft crashed after striking the airport boundary fence. The accident happened about 2000 EST. The two pilots received serious injuries and the aircraft was substantially damaged. The Transportation Safety Board of Canada determined that pilot error was the probable cause of the accident.

The captain of the aircraft had been awake for 13 hours and had been performing duties as a flight crewmember for 10 hours before the accident. The captain was flying the aircraft at the time of the accident. The first officer had been awake for 12 hours and had been performing the duties as a flight crewmember for nine hours.

The sixth accident occurred on April 12, 2007, when a Bombardier/Canadair Regional Jet (CRJ) CL600-2B19 operated by Pinnacle Airlines ran off the departure end of runway 28 after landing at Cherry Capital Airport, Traverse City, MI. The accident occurred at 0043 EDT. There were no injuries, but the airplane was substantially damaged. The NTSB determined that pilot error was the probable cause of the accident and that fatigue was a contributing factor.

On April 11, the captain awoke about 0700 CDT and ate breakfast at the hotel. Both the captain and first officer left the hotel at 0800 CDT taking a shuttle to the airport. Both started their duty day at 0900 CDT on April 11, 2007. At the time of the accident both crew members had been on duty for 15 hours and 43 minutes (and the captain had been awake for over 17 hours.

The seventh accident occurred on June 20, 2007, when a Beech 1900D operated by Great Lakes Air ran off the runway after landing at Laramie Regional Airport, Laramie, WY. The accident occurred at 1620 MDT. There were no injuries, but the aircraft was substantially damaged. The NTSB determined that pilot error was the probable cause of the accident.

On the day of the accident, the captain and first officer were on the third day of a three day trip. The crew started their duty period at 0520 MDT. At the time of the accident, they had been on duty for 11 hours.

These seven accidents resulted in 24 fatalities to passengers and crew members, 52 serious injuries to passengers and crew members, and 65 minor injuries to passengers and crew members. There were also 76 passengers and crew members in these seven accidents who were not injured.

Time Awake

While being on duty a long time can be fatiguing, simply being awake a long time (approximately 17 hours or more) can also be fatiguing. In some accidents, the pilots had been on duty less than 10 hours, but those hours occurred late in the day and one or more of the flight crewmembers had been awake close to 17 hours or more. In the three accidents described below, statements of probable cause indicated crew performance but in each case one or more of the flight crewmembers had been awake a long time. These three accidents resulted in 245 fatalities on board the airplane and one fatality on the ground. There were also 20 seriously injured passenger and crew members, and three crew members and a passenger that received minor injuries.

The first accident occurred on July 2, 1994, when a DC-9-31 airplane operated by USAir, Inc. collided with tree and a private residence near Charotte/Douglas International Airport. This accident occurred at about 1843 EDT shortly after the flightcrew executed a missed ILS approach. There were 37 passenger fatalities, 16 passenger and crew received serious injuries, and 4 crew and a passenger received minor injuries. The airplane was destroyed by impact and a postcrash fire. The NTSB determined that pilot error was the probable cause of the accident.

Fatigue likely affected the performance of the first officer, who was the pilot-flying on the accident leg. The captain, who was off-duty the preceding 3 days, was less vulnerable to fatigue, but he too had already had a long day. The accident occurred 14 hours into the captain's day. He had risen at 0455, drove to Dayton from his home, then flew to Pittsburgh to begin his duty day. The accident occurred at 1843, at the end of the third of 4 scheduled legs.

The first officer was more vulnerable to fatigue. He was on a four-day trip. On July 30, he ended his duty day at Tri-City Regional Airport, Biountville, Tennessee, where he had arrived at 2230. The NTSB report does not state when that duty day began, nor when the first officer awoke that day. However, after having a light meal, he went to bed at 0130. On July 1, he awoke at 0900. His duty day ended July 1 in Saint Louis at 2040 EDT. He went to bed at 2230 and awoke at 0615 on the accident day. He reported for duty at St. Louis for a flight to Pittsburgh. That flight, with the first officer as the pilot flying, departed at 0810. At Pittsburgh, the first officer joined the captain and they began their pairing. Like the captain, the first officer was nearly 14 hours into his day when the accident occurred. He was the pilot flying on the PIT-LGA leg and on the accident flight from CAE.

The second accident occurred on December 20, 1995, when a Boeing 757-223 operated by American Airlines crashed into mountainous terrain while on descent from cruise altitude in an attempt to land at Alfonso Bonilla Aragon International Airport in Cali, Columbia. The accident occurred at 2142 EST. There were 160 passenger and crew fatalities; only four passengers survived the accident with serious injuries. The airplane was destroyed by impact. The Aeronautica Civil of the Republic of Columbia determined that the probable cause was pilot error.

The accident flight was the first flight for both pilots after several days off. The captain arose at 0500 after a bit more than 7 hours of sleep. The first officer awoke at 0700. Both pilots appeared well rested. Both pilots reported to the operations manager at Miami more than an hour before their scheduled departure time of 1640. However, departure from the gate was delayed until 1714, followed by a lengthy ground delay due to ramp congestion.

It is reasonable to assume that the crew would have been tired at the time of the accident, despite this flight's being the first of their duty tour. The captain had been awake close to 17 hours, while the first officer had been awake 15 hours.

The third accident occurred on February 12, 2009, when a Bombardier DHC-8-400 operated by Colgan Air, Inc. as a Continental Connection flight crashed into a residence in Clarence Center, NY while on approach to Buffalo-Niagara International Airport, Buffalo, NY. The accident occurred at 2217 EST. The crew and passengers (49 people) were all killed and one person on the ground was also killed. The airplane was destroyed by impact and a postcrash fire. The NTSB identified probable cause and contributing factors as follows:

Both pilots performance was likely to have been impaired due to fatigue. Both pilots were based at Newark and both commuted. The captain lived near Tampa, FL and the first officer lived near Seattle, WA. Neither had a "crash pad" in Newark and both regularly used the crew room for sleeping. The captain often tried to bid trips that would ensure some nights in hotels at out-stations. In Newark, he sometimes stayed with a friend but usually slept in the crew room. The first officer always slept in the crew room when in Newark and told several people she had no need for a crash pad because "one of the sofas in the crew room has my name on it."

The duty tour began on February 10 for the recently upgraded captain. He commuted to EWR on February 9 from his home near Tampa, arriving at EWR at 2005. He apparently spent the night in the crew room. Multiple phone records and log-ins to the company's crew tracking system indicate he got little sleep before reporting for duty at 0530 on February 10. The captain then flew 3 flights and arrived at BUF at 1300. He spent the rest of the day in a hotel. On February 11, he left the hotel at 0515 to report for duty at 0615. Again the captain flew 3 flights and terminated his duty day at EWR at 1544. He apparently spent the rest of the day and that night in the crew room, where he was seen sleeping at 0630 on February 12, the day of the accident. Again, however, multiple phone records, log-ins to the crew tracking system, and contact with other employees indicate he got very limited sleep before reporting for duty at 1300.

The first officer commuted to EWR from SEA the day before the accident. She awoke on February 11 at 0900 and arrived at the airport at 1730 for a FedEx flight to MEM. The aircraft arrived in MEM at 0230 EST (2230 PST). She was said to have had about 90 minutes of sleep on the flight. She then took another flight to EWR, departing MEM at 0418 and arriving at EWR at 0623. She apparently slept for much of that two-hour flight. Upon reaching EWR, she spent the day in crew room, where she was seen napping. However, multiple phone records and log-ins to the company's crew tracking system indicate she got little sleep before reporting for duty at 1300.

The NTSB did not cite fatigue as a cause or as a factor. However, in its findings and conclusions, NTSB noted that the performance of both pilots "was likely impaired because of fatigue, but the extent of their impairment and the degree to which it contributed to the performance deficiencies that occurred during the flight cannot be conclusively determined."

NTSB added that both pilots failed to manage their off-duty time and commute responsibly and both failed to ensure that they remained "fit for duty."

The Captain was near the end of his fourth day since awakening on February 9. He had the opportunity for quality sleep only on the night of February 10, and that was cut short with a departure from the hotel at 0515 the next morning. Both pilots essentially stayed up all night on February 11, with no opportunities for deep sleep, and then found themselves operating a late-night flight after a day of cancellations and delays.

These three accidents resulted in 245 fatalities on board the airplane and one fatality on the ground. There were also 20 seriously injured passenger and crew members, and three crew members and a passenger that received minor injuries.

Chronic Fatigue

Chronic fatigue can happen to a flight crewmember, if his or her duty periods covers several days of night flying, or several days of multiple time zone changes, or several days with a heavy schedule. Chronic fatigue could be a contributing factor to accidents where pilot error was the probable cause of the accident. In the two accidents described below, the NTSB determined that pilot error was the probable cause, but in each case one or more of the flight crewmembers was subject to chronic fatigue. These two accidents resulted in two passengers who were seriously injured, and 38 crew members and a passenger who received minor injuries.

The first accident occurred on April 14, 1993, when a DC-10-30 operated by American Airlines overran runway 17L following a landing at Dallas/Fort Worth International Airport. The accident happened at 0659 CDT. It was raining at the time of the accident and there were numerous thunderstorms in the airport area. The airplane sustained substantial damage. There were no fatalities, but two passengers received serious injuries, and 38 passengers and crew members received minor injuries. The NTSB determined that the probable cause was "the failure of the captain to use proper directional control techniques to maintain the airplane on the runway."

Though the accident occurred just 46 hours into the crew's duty tour, the crew was completing its second consecutive day of disrupted circadian rhythms. The crew likely had awoken no later than 0600 CDT in order to reach DFW and report for duty in advance of their first flight at 0900 from DFW to Honolulu (HNL). After a 10-hour duty day, the crew arrived at HNL at about 1900 CDT (1400 HAST) and began their sleep period around 2200 HAST, awakening around 0700 HAST, with additional naps of various lengths from 1600 to 2100 Local. Then the crew reported for duty and flew for more than 8 hours through the night to DFW.

The first officer told investigators that he felt tired twice during the flight and briefly used oxygen to "perk-up." The captain and the flight engineer said they did not feel tired during the flight, but the literature on sleep indicates that people often fail to recognize when their performance deteriorates due to fatigue and disrupted circadian rhythms.

The second accident occurred on August 25, 1996, when a Lockheed L-1011-100 operated by Trans World Airlines was substantially damaged when the tail struck the runway while landing at John F. Kennedy International Airport. The accident occurred at 0710 EDT. None of the crew or passengers were injured. The NTSB determined the probable cause of the accident was pilot error.

Pilot fatigue was also a probable contributing factor in this accident. The crew's trip sequence began with an evening flight on August 23 from JFK to Las Vegas (LAS). The NTSB report is unclear about the time the crew arrived in LAS, but they appear to have reached their hotel around 2200 local time (0100 EDT), at which time the crew started a 24-hour rest period. The crew's itinerary resumed at 2130 (PDT) the next night when they were picked up at the hotel. The crew therefore would have been awake at least since about 2000 (2300 EDT). Though the crew had an ostensibly adequate rest period, they had arrived at their hotel late on the preceding night and were resuming their itinerary on the back side of the clock for a 5-hour red-eye to New York.

These two accidents resulted in two passengers who were seriously injured, and 38 crew members and a passenger who received minor injuries.

Late Night Duty Fatigue

Aviation accidents can also be examined how they vary through out the day. As can be seen in Table 3 showing the 43 accidents in our analysis by time of day, accidents are more likely to occur in the late afternoon and early evening (4:00 pm to 8:00 pm) than any other time of the day. During the rest of the day accidents are spread out fairly evenly among the four-hour categories. Throughout most of the day there is a close relationship between the percentage of accidents that occurred during each four-hour period and the percentage of operations that occurred during the same four-hour period. However, between midnight and 4:00 AM, the percentage of accidents (14%) greatly exceed the percentage of operations (3%).

Table 3 Accidents by Time of Day

Time Period	Number of Human Factors Accidents	Percentage of Human Factors Accidents	Number of Operations	Percentage of Operations
mid to 4	6	14.0%	708,610	3.0%
4 to 8	6	14.0%	2,535,742	10.8%
8 to noon	7	16.3%	5,383,139	22.8%
noon to 4pm	6	14.0%	5,557,144	23.6%
4 to 8pm	11	25.6%	5,746,663	24.4%
8 to mid	7	16.3%	3,649,924	15.5%
	43		23,581,222	

This analysis is also consistent with a study of pilot deviations by time-of-day (see Appendix C). In this study the portion of pilot deviations was greater than the exposure portion between midnight and 4:00 am. Both this study and the above analysis suggest that should be regulated to reduce the number of pilot error accidents where pilot fatigue was a contributing factor.

It is possible to estimate the number of accidents that could have been avoided by regulating operations during the window of circadian low between 12:00 midnight and 4:00 am using the information in Table 3. If fatigue was not a contributing factor in the 13 accidents that occurred between 8:00 am and 4:00 pm, then the relationship between the exposure data compiled for captains and the "normal" frequency of occurrence of serious accidents can be estimated as 1.19 accidents per million operations. There were 708,610 operations between midnight and 4:00 am; and based on the calculated frequency relationship (1.19 accidents per million operations) 0.8 accidents would be expected to occur, and six accidents occurred during those hours. Between 4:00 am and 8:00 am there were 2.536 million operations. The expected number of accidents at the above rate would be 3.0 accidents during those hours, but there were six accidents. The excess accidents that occur in the late afternoon and evening have already been taken into account the earlier discussion in the sections preceding this section.

Table 4 shows the projected number of accidents estimated in this way in comparison with the actual number of accidents. The difference between the actual number of accidents and the projected number of accidents would be the number of accidents that may be avoided by regulating operations during those hours. For example, between midnight and 4:00 am, there were six accidents,[12] and 0.8 were projected to

[12] Cleveland, OH (2/17/1991), Swanton, OH (2/15/1992), East Garnby, CT (11/12/1995), Newark, NJ (7/31/1997), Florence, KY (8/13/2004) and Traverse City (4/12/2007).

occur; so there is a difference of 5.2 accidents. Similarly, between 4:00 am and 8:00 am, there were six accidents,[13] while 3.0 were projected to occur; the difference (or possible number of accidents avoided) is 2.98 accidents.

Table 4

Hour of Day	Accidents	Projected Accidents	Difference
mid to 4	6	0.8	5.2
4 to 8	6	3.0	3.0
8 to noon	7	6.4	
noon to 4pm	6	6.6	
4 to 8pm	11	6.8	
8 to mid	7	4.3	
	43		

A rule that regulated operations during the period of circadian low between midnight and 4:00 am could avoid 5.2 accidents. If the time was extended to 6:00 am, then possibly 3.0 accidents could be avoided. As it turns out, one of the accidents that occurred between midnight and 4:00 am, Traverse City (4/12/2007), has already been accounted for in the above analysis of length of duty time accidents, so it will not be claimed in this analysis. Concerning the time between 4:00 am and 8:00 am, only one of the six accidents occurred when the window of circadian low was possible (between 4:00 am and 6:00 am). That accident happened at Tallahassee (7/26/2002), and it also was discussed above. None of the accidents between 4:00 am and 8:00 am will be claimed in this analysis.

[13] Dallas/Ft Worth (4/14/1993), Nashville, TN (7/08/1996), Jamaica, NY (8/25/1996), Jamaica, NY (5/8/1999), Tallahassee, FL (7/26/2002), and Lexington, KY (8/27/2006) .

Operating an aircraft during the window of circadian low can be fatiguing. The five accidents described below all occurred between midnight and 6:00 am. These five accidents resulted in seven fatalities. There were also 7 minor injuries passengers and crew members, and 77 crew members and a passenger that received minor injuries.

The first accident occurred on February 17, 1991, when a McDonnell Douglas DC-9-15 freighter operated by Ryan International Airlines flew through weather conducive to airframe ice contaminations 40 minutes prior to descending toward Cleveland, OH. During the 35 minute turnaround at Cleveland, the crew did not exit the airplane to conduct a preflight inspection of the airplane even though it was snowing at the time. The airplane stalled on the takeoff and crashed. The accident happened at 00:19 EST. Both flight crewmembers were fatally injured. The NTSB determined that pilot error was the probable cause of the accident.

The second accident occurred February 15, 1992, when a Douglas DC-8-63 operated by Air Transport International crashed on approach to the airport at Toledo, OH. The first officer had attempted two ILS approaches but failed to capture the ILS localizer and/or glideslope. During the second approach the captain assumed control of the airplane. The captain apparently became spatially disoriented and failed to properly recognize and recover from an unusual aircraft attitude. The second officer assumed control of the aircraft but was unable to recover the airplane before it crashed. The accident occurred at 3:27 EST. The captain, first officer, and two other people were fatally injured. The NTSB determined that pilot error was the probable cause of the accident.

The third accident occurred on November 12, 1995, when a McDonnell Douglas MD-83 operated by American Airlines, Inc. struck some trees and then an ILS antenna as it landed short of the runway on approach to Bradley International Airport, Windsor Locks, CT. The accident happened at 00:57 EST. Only one passenger received minor injuries. The other 77 passengers and crew members were uninjured. The NTSB determined that pilot error was the probable cause of the accident.

The fourth accident occurred on July 31, 1997, when McDonnell Douglas MD-11 operated by Federal Express, Inc. made a hard landing at Newark International Airport, Newark, NJ. The airplane bounced and made another hard landing. When the airplane came to a stop, a fire broke out and destroyed the airplane. The accident occurred 01:30 EDT. The two flight crewmembers and three company personnel received minor injuries. The NTSB determined that pilot error was the probable cause of the accident.

The fifth accident occurred on August 13, 2004, when a Convair 580 crashed on approach to Cincinnati/Northern Kentucky International Airport, Covington, KY. The accident happened at 00:49 EDT. The accident was the result of fuel starvation because the flight crew did follow approved procedures. The first office received fatal injuries while the captain received minor injuries. The airplane was destroyed by the impact. The NTSB determined that pilot error was the probable cause of the accident.

These five accidents resulted in seven fatalities. There were also 7 minor injuries passengers and crew members, and 77 crew members and a passenger that received minor injuries.

Summary of Above Analyses

Pilot fatigue is a serious problem. If nothing is done about this problem, we can expect about one aviation accident a year (possibly over six accidents) where pilot fatigue will be a contributing factor. Pilot fatigue will be a contributing factor in many accidents that could potentially cost billions of dollars.

During the past 20 years, there have been over 18 aviation accidents caused by pilot error where pilot fatigue was a factor. NTSB has identified five accidents where the flight crew started the day in a state of fatigue. We statistically identified 4.6 accidents where the flight crew became fatigued during a long flight-duty period (NTSB cited pilot fatigue as a contributing factor in three of those accidents). We have also statistically estimated that some of the 6.2 accidents that occurred between midnight and 6:00 am involved pilot fatigue. Two of these have already been accounted for in the previously discussed analyses. There were also three accidents where the pilot became fatigued due to being awake for many hours. Lastly, there were two accidents were chronic fatigue was a contributing factor. In summary, we project there would be at least 18.8 accidents (13 passenger airplane accidents and 5.8 cargo airplane accidents) during the next 20 years where pilot fatigue would be a contributing factor to the accident.

Simulation Results

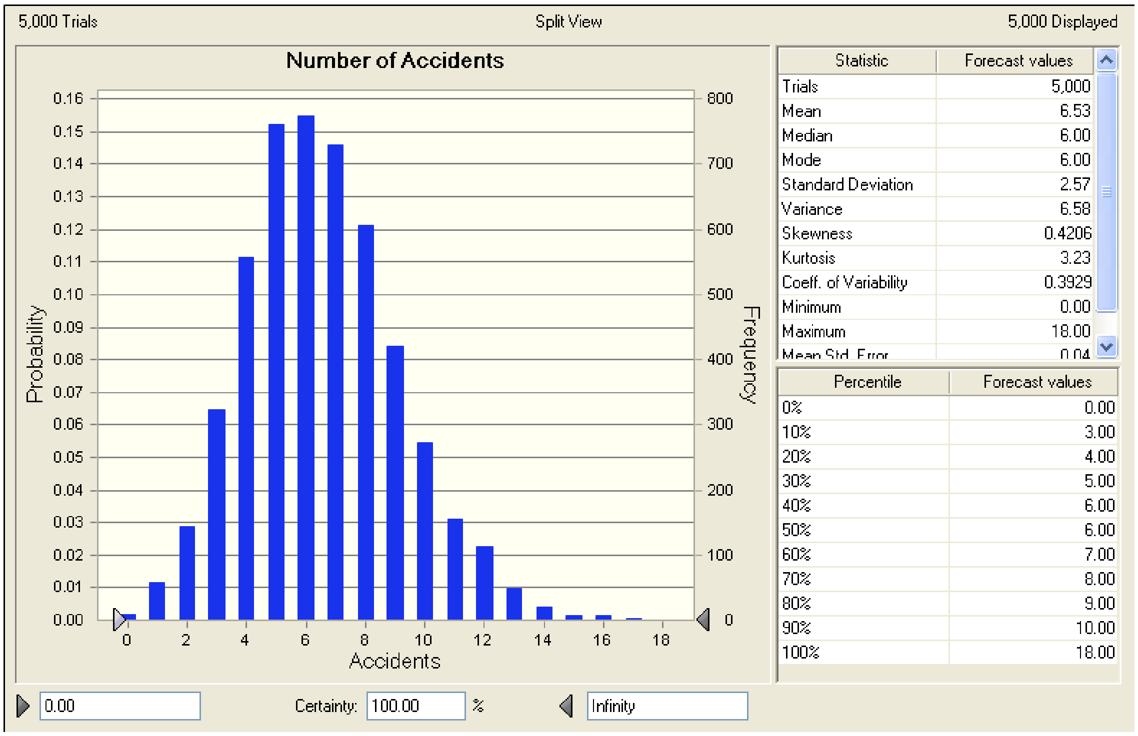
Simulation is a tool that we can use to study how many future accidents might occur and how severe these future accidents might be. The passenger and crew casualties in the simulated accidents will be different from those in the past. The casualty estimates are based on 278 aviation accidents that occurred during the past 20 years because of pilot error. The exact pilot error that will cause these future accidents could be any one of the pilot errors that have occurred during the past 20 years, and need not be the same as those errors that caused the above 18.8 accidents. The aircraft in the simulated future accidents could also be different from those in the above accidents.

Lower Estimated Results

Projected Passenger Airplane Accidents

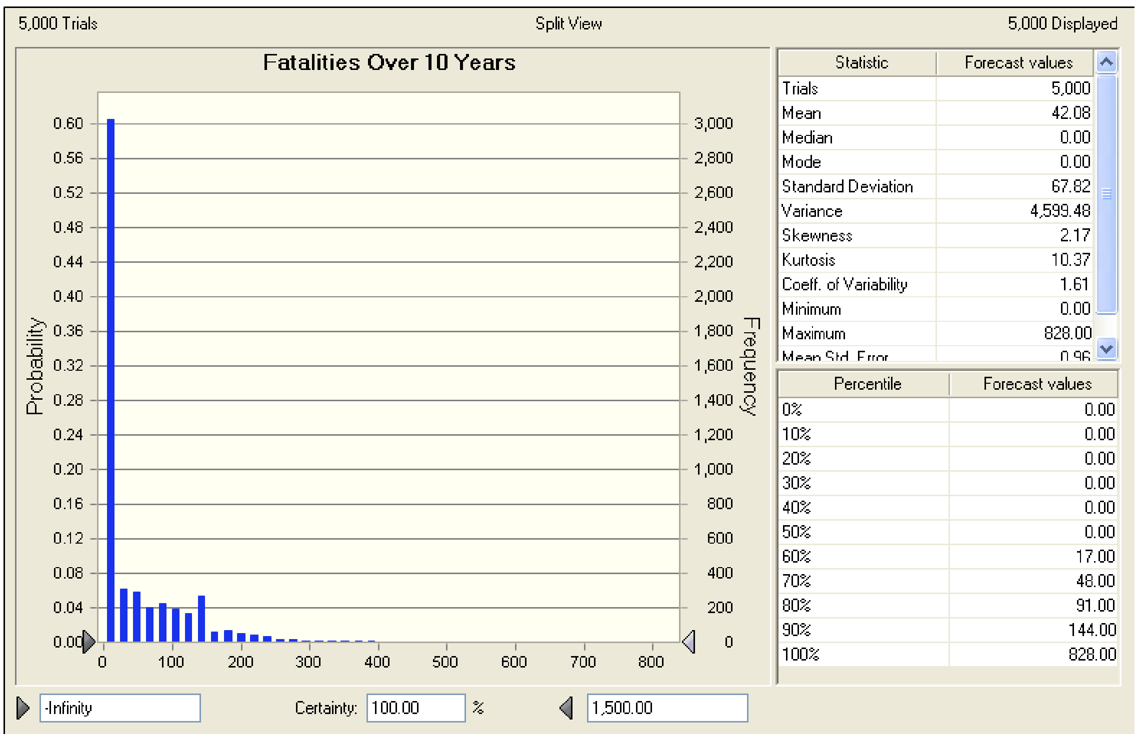
From the above analysis, 13 passenger airplane accidents are expected to occur every 20 years, or 0.65 accidents a year. A 5,000 trial simulation analysis was run with a mean value of 0.65 to provide a distribution of the possible outcomes over any future 10-year period. The median was 6 accidents; the mean was 6.5 accidents; and the range was from no accidents to 18 accidents.

Figure 1.Distribution of Possible Future Passenger Airplane Accidents



On the other hand, the distribution of future fatalities is not a normal distribution, but is skewed to the right (see figure 2). For at least 50 percent of the simulation trials there were no fatalities during any 10-year period. This is not surprising, since in over 90 percent of the accidents used to develop the simulation model, there were no fatalities. However, the right tail of this distribution is long and heavy. There could be as many as 828 fatalities during a future 10-year period – a catastrophic collision involving two fully loaded wide-body airplanes and one other catastrophic accident also involving a fully loaded wide-body airplane could produce this number of fatalities. The mean of the simulation distribution of possible future fatalities was 42. The simulation results suggest there is a 30 percent chance there could be 48 or more fatalities during a future 10-year period, a 20 percent chance there could be 91 or more fatalities, and a 10 percent chance there could be 144 or more fatalities.

Figure 2. Distribution of Possible Future Fatalities



The distribution of the undiscounted costs of the possible future passenger airplane accidents is shown in figure 3. The distribution of the costs, like the distribution for possible future fatalities, is heavily skewed to the right. The median for the costs is $158.9 million, while the mean is $352.5 million. The minimum cost is zero and the maximum cost is $5.080 billion. There is a 30 percent chance that costs would exceed

$402 million; there is a 20 percent chance that costs would exceed $661 million; and a 10 percent chance that costs would exceed $951 million.

Figure 3 Distribution of Benefits of Avoiding Possible Future Passenger Airplane Accidents

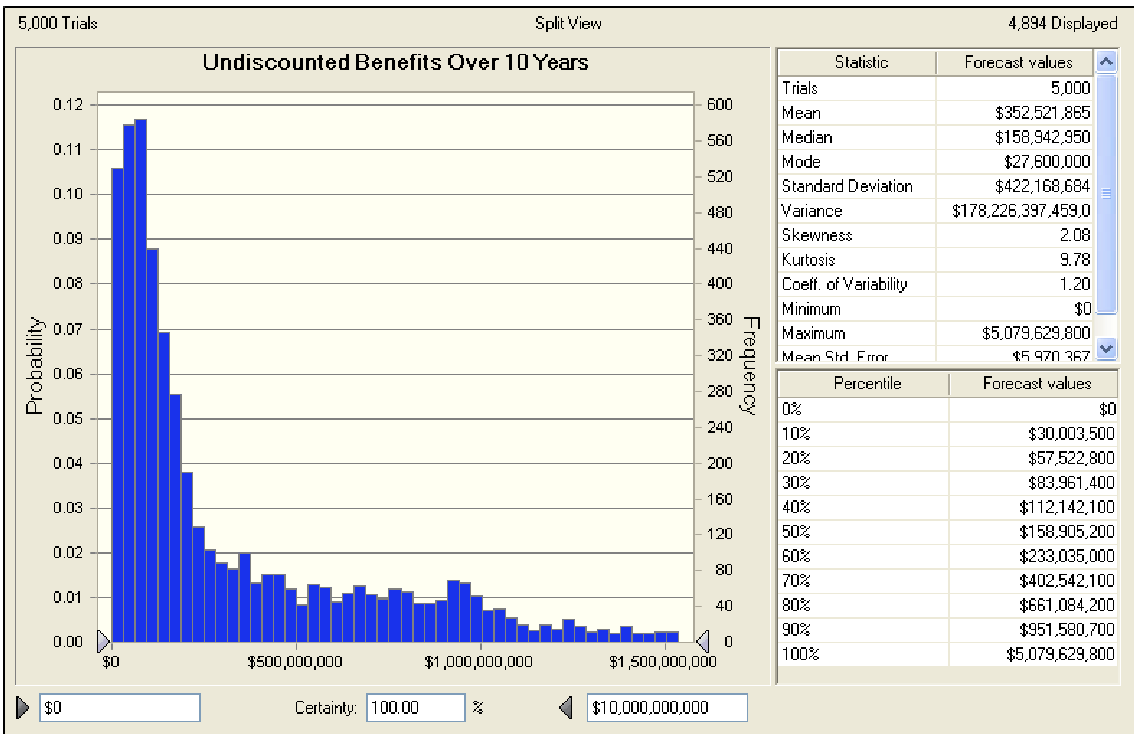
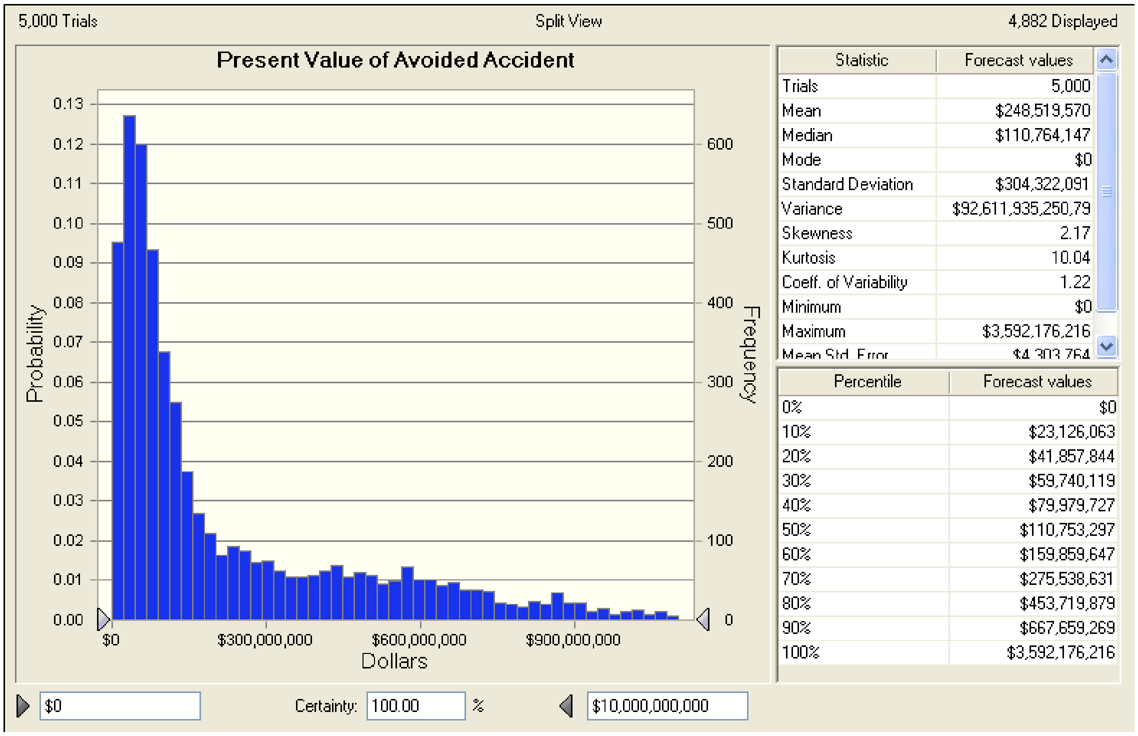


Figure 4 shows the distribution of the present value of the possible future accidents. It is similar to figure 3 though the values are a little lower. The median value is $110.8 million; mean value is $248.5 million; and the maximum value is $3.592 billion.

Figure 4 Distribution of the Present Value of the Costs of Possible Future Passenger Airplane Accidents



<u>Projected Cargo Airplane Accidents</u>

Based on the accident analysis above, 5.8 cargo airplane accidents are expected to occur every 10 years, or 0.29 accidents a year. A 5,000 trial simulation analysis using a Poisson distribution with a mean value of 0.29 was run to provide a distribution of the possible outcomes over any future 10-year period. In this case, the distribution of possible future number of passenger airplane accidents during any 10-year period (see figure 5) had almost a normal distribution, though slightly skewed to the right. The median is 3 accidents; the mean was 2.9 accidents; and the range was from no accidents to 11 accidents.

Figure 5 Distribution of Possible Future Cargo Airplane Accidents

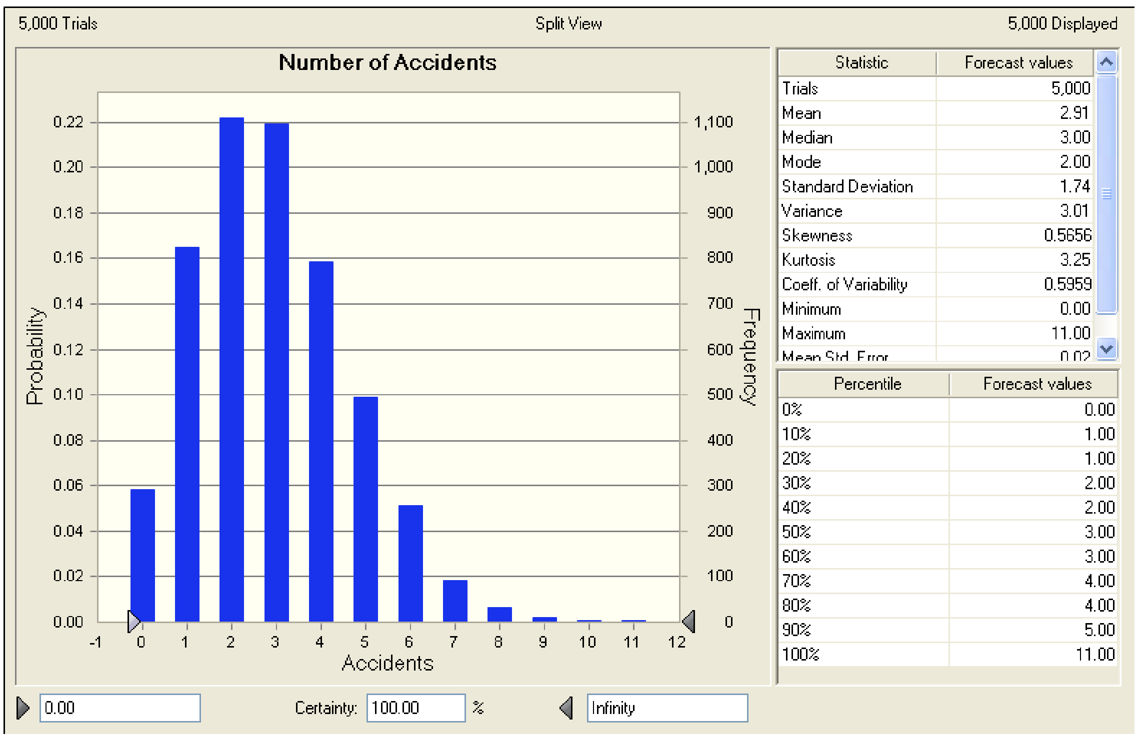
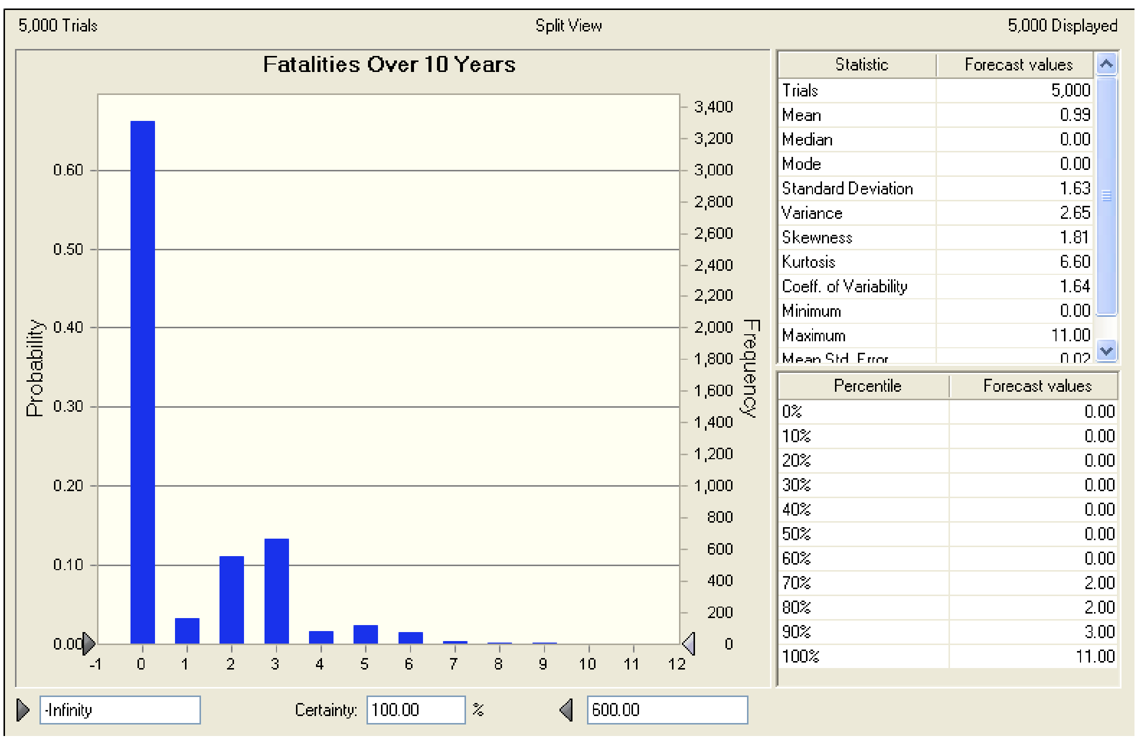


Figure 6 shows the distribution of fatalities for possible future cargo accidents. This simulation run projects few fatalities in cargo airplane accidents than for passenger airplane accidents. Over 60 percent of the simulation trials result in no fatalities during any 10-year period. Under 40 percent of the trail result in fatalities. The mean for this distribution is one fatality during a 10-year period. There could be as many as 11 fatalities during a future 10-year period. The simulation results suggest there is a 30 percent chance there could be 2 or more fatalities during a future 10-year period, and a 20 percent chance there could be 3 or more fatalities.

Figure 6 Distribution of Fatalities from Possible Future Cargo Airplane Accidents



The undiscounted costs of these simulated future cargo accidents are shown in Figure 7. Since there few casualties, most of the cost will be the result damage to the airplane and to the cargo carried. The distribution of the costs is still skewed to the right. The median for the costs is $31.5 million, while the mean is $51.5 million. The minimum cost is zero and the maximum cost is $368.2 million. There is a 30 percent chance that costs would exceed $74 million; there is a 20 percent chance that costs would exceed $90 million; and a 10 percent chance that costs would exceed $118 million.

Figure 7 Distribution of the Undiscounted Benefits from Avoiding Possible Future Cargo Airplane Accidents

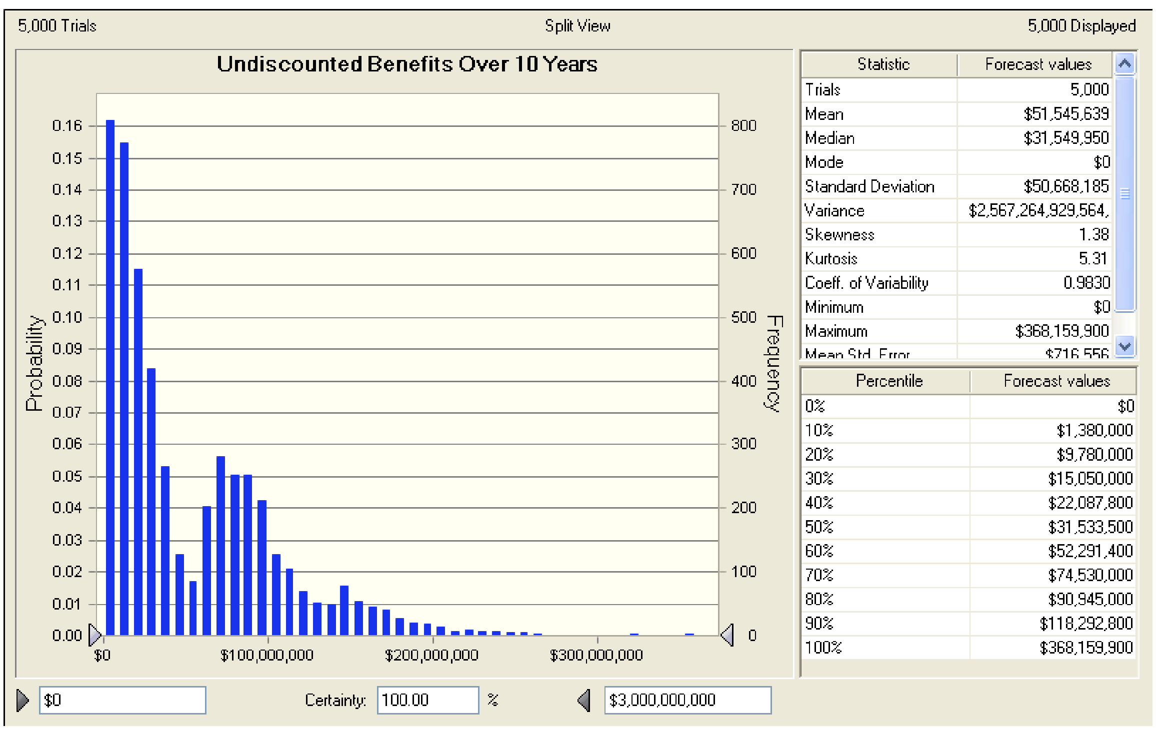
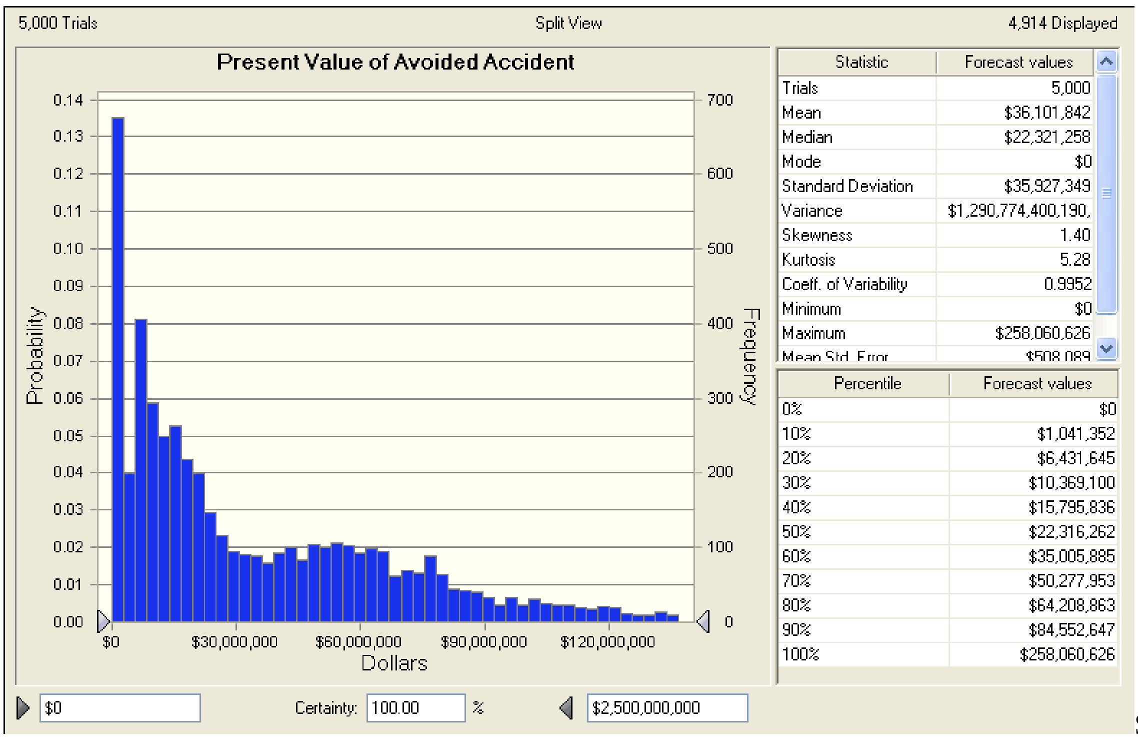


Figure 8 shows the distribution of the present value of the possible future accidents. It is similar to figure 7 though the values are a little lower. The median value is $22.3 million; mean value is $36.1 million; and the maximum value is $258.1 million.

Figure 8 Distribution of the Present Value of the Costs of Possible Future Cargo Accidents



Summary

If the simulation study is limited to just the number of possible accidents identified in the past 20-year period (which would be about 1.0 accidents per year), then there would be a mean of 9.4 airplane accidents in a 10-year period. These accidents would result in a mean of 43.1 deaths. The total estimated benefit from avoiding these simulated accidents has a mean value of $404.0 million ($284.6 million, present value).

Upper Estimate Results

Passenger Airplane Accidents

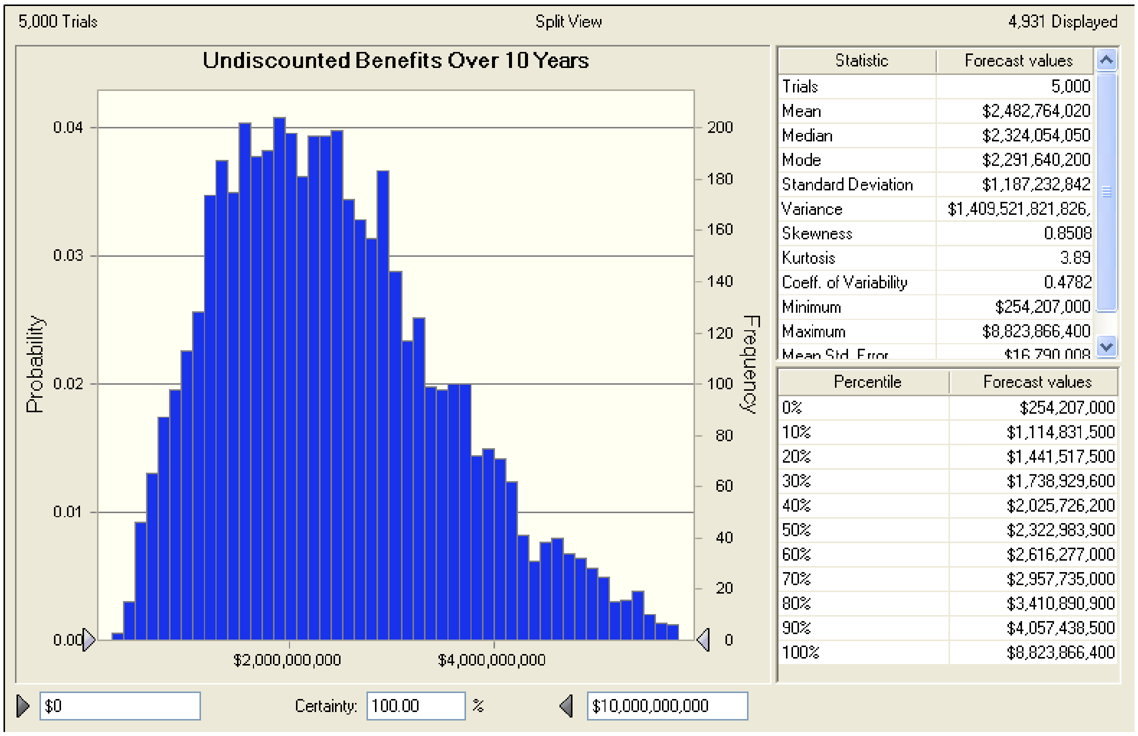
The passenger airplane accidents results above are based on the 33 passenger accidents where we have enough information in the accident report to make a judgment about the presence or absence of pilot fatigue. Pilot fatigue was present in 13 (or 39.4 percent) of those accidents. There are, however, 196 additional pilot error accidents involving passenger airplanes where that information is not available. If the same ratio (39.4 percent) of these 196 accidents were in part due to pilot fatigue, then there would be an additional 77.2 accidents where pilot fatigue was a contributing factor. Including the additional accidents would mean there could be over 90 passenger airplane accidents during the past 20 years where pilot fatigue would be a contributing factor. If the future is like the past, then the expected number of passenger airplane accidents would be 4.51 per year.

A 5,000 trial simulation analysis using a Poisson distribution with a mean value of 4.51 was run to provide a distribution of the possible outcomes of passenger airplane accidents over any future 10-year period. The distribution of possible future number of passenger airplane accidents during any 10-year period has almost a normal distribution. The mean is 45.15 accidents; and the standard deviation is 6.71 accidents. The range was from 22 accidents to 70 accidents.

Once again, the distribution of future fatalities is not a normal distribution, but is skewed to the right. This time, there are almost always some fatalities in each the simulation trial. There could be as many as 1,357 fatalities during a future 10-year period. The mean of the simulation distribution of possible future fatalities was 298. The simulation results suggest there is a 30 percent chance there could be 375 or more fatalities during a future 10-year period, a 20 percent chance there could be 448 or more fatalities, and a 10 percent chance there could be 551 or more fatalities.

The distribution of the undiscounted costs of the possible future passenger airplane accidents has a lognormal distribution (see figure 9). The median for the costs is $2.324 billion, while the mean is $2.483 billion. The minimum cost is $254.2 million and the maximum cost is $8.824 billion. There is a 30 percent chance that costs would exceed $2.957 billion; there is a 20 percent chance that costs would exceed $3.410 billion; and there is a 10 percent chance that costs would exceed $4.057 billion.

Figure 9 Distribution of Undiscounted Benefits of Avoiding Possible Future Passenger Airplane Accidents



The distribution of the present value of the cost of the possible future accidents has a lognormal shape similar to that for undiscounted costs. However, the costs projections are a little lower. The mean value is $1.746 billion; and the maximum value is $6.839 billion. There is a 30 percent chance that costs would exceed $2.085 billion; there is a 20 percent chance that costs would exceed $2.406 billion; and a 10 percent chance that costs would exceed $2.875 billion.

Projected Cargo Airplane Accidents

The cargo airplane accidents results above are based on the 10 cargo airplane accidents where we have enough information in the accident report to make a judgment about the presence or absence of pilot fatigue. Pilot fatigue was present in 5.8 (or 58.0 percent) of those accidents. There are, however, 39 additional pilot error accidents involving passenger airplanes where that information is not available. If the same ratio (58.0 percent) of these 39 accidents were in part due to pilot fatigue, then there would be an additional 22.6 accidents where pilot fatigue was a contributing factor. Including the additional accidents would mean there could be over 28 cargo airplane accidents during the past 20 years where pilot fatigue would be a contributing factor. If the future is like the past, then the expected number of cargo airplane accidents would be 1.42 per year

A 5,000 trial simulation analysis using a Poisson distribution with a mean value of 1.42 was run to provide a distribution of the possible outcomes over any future 10-year period. The distribution of possible future number of cargo airplane accidents during any 10-year period had almost a normal distribution. The mean was 14.22 accidents; and the standard deviation is 3.83 accidents. The range is from three accidents to 31 accidents.

This simulation run projects more fatalities in cargo airplane accidents than was the previous case for cargo airplane accidents. This time over 80 percent of the trails resulted in fatalities. The mean for this distribution is 4.8 fatalities during a 10-year period. There could possibly be as many as 22 fatalities during a future 10-year period. The simulation results suggest there is a 30 percent chance there could be 6 or more fatalities during a future 10-year period, a 20 percent chance there could be 8 or more fatalities, and a 10 percent chance there could be 10 fatalities.

The distribution of undiscounted costs of these simulated future cargo accidents has a lognormal shape. Once again, most of the cost will be the result damage to the airplane and to the cargo carried due to the low number of casualties in cargo airplane accidents. The mean is $251.8 million. The minimum cost is $12.4 million and the maximum cost is $752.2 million. There is a 30 percent chance that costs would exceed $299 million; there is a 20 percent chance that costs would exceed $339 million; and a 10 percent chance that costs would exceed $398 million.

The distribution of the present value of the costs of the possible future accidents is similar to that for undiscounted costs, but the values are a little lower. The mean value is $176.6 million; and the maximum value is $533.4 million.

Summary

When the simulation study is expanded to include all the additional accidents, the expected number of accidents would be 59.4 airplane accidents in a ten-year period. These accidents would result in a mean of 303 deaths. The total estimated benefit from avoiding these simulated accidents has a mean value of $2.735 billion ($1.923 billion, present value).

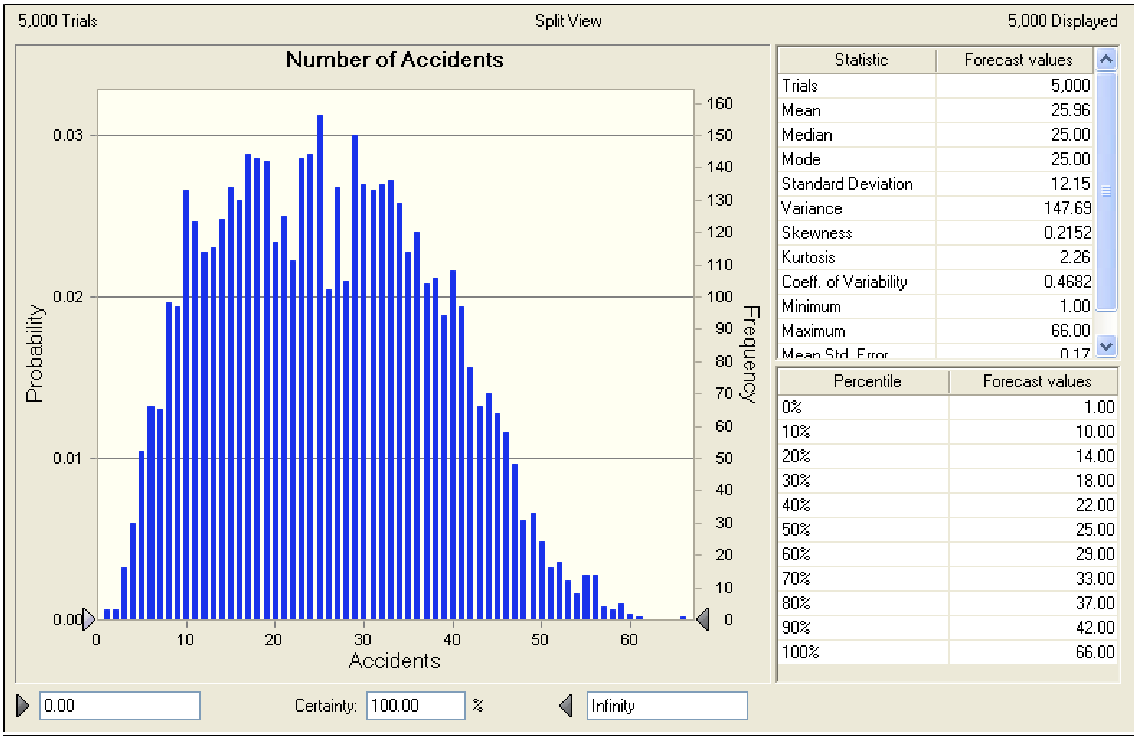
Best Estimate

The annual number of pilot fatigue related passenger airplane accidents is probably somewhere between 0.65 and 4.51, and the annual number of pilot related cargo airplane accidents is between 0.29 and 1.42. These ranges in the number of these types of accidents can also be addressed using simulation analysis.

<u>Passenger Airplane Accidents</u>

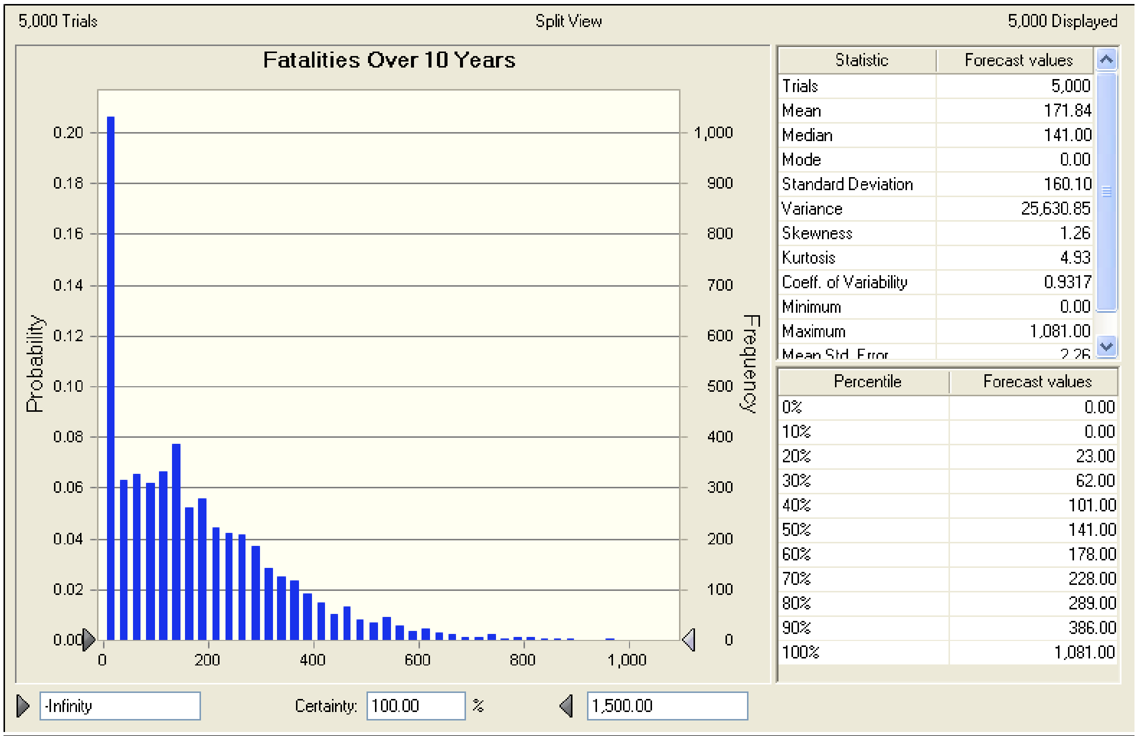
A 5,000 trial simulation analysis using a Poisson distribution with a mean ranging between 0.65 and 4.51 was run to provide a distribution of the possible outcomes of passenger airplane accidents over any future 10-year period (see figure 10). The mean is 25.96 accidents; and the standard deviation is 12.15 accidents. The range is between 1 and 66 accidents.

Figure 10 Distribution of Possible Future Passenger Airplane Accidents



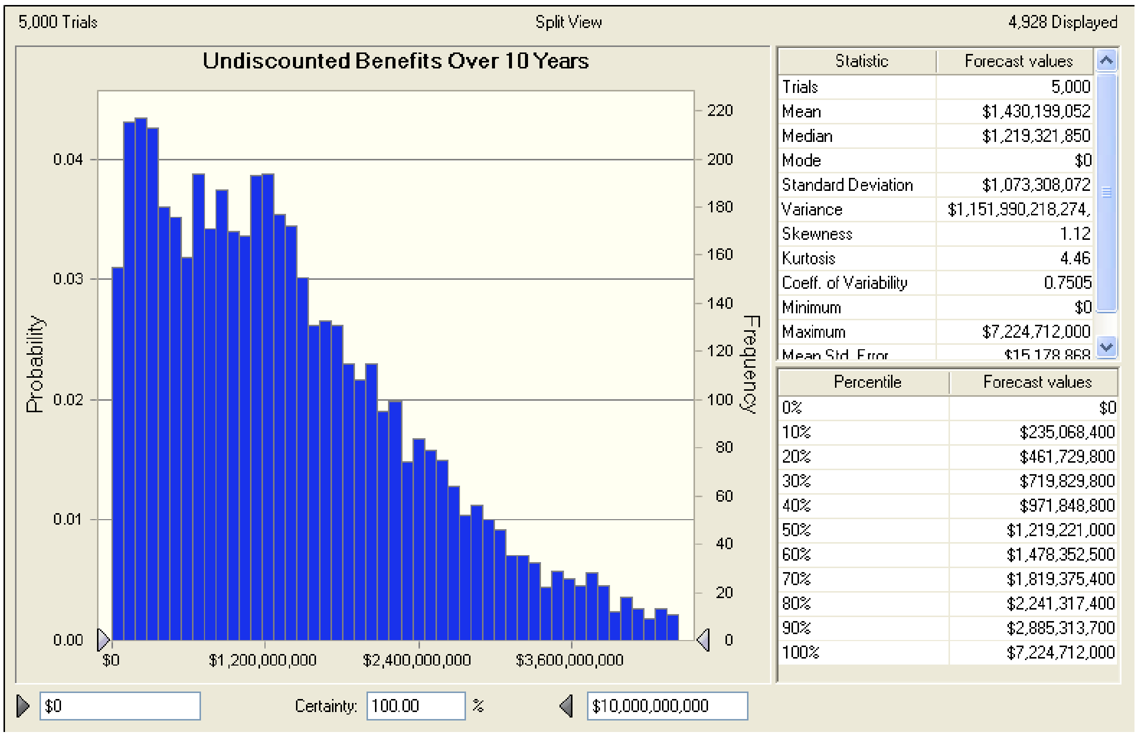
The distribution of future fatalities is shown in figure 11. There is over an 80 percent chance there will be some fatalities during any given future 10-year period. There could possibly be as many as 1,081 fatalities during a future 10-year period. The mean of the simulation distribution of possible future fatalities was 172. The simulation results suggest there is a 30 percent chance there could be 228 or more fatalities during a future 10-year period, a 20 percent chance there could be 289 or more fatalities, and a 10 percent chance there could be 386 or more fatalities.

Figure 11 Distribution of Fatalities from Possible Future Passenger Airplane Accidents



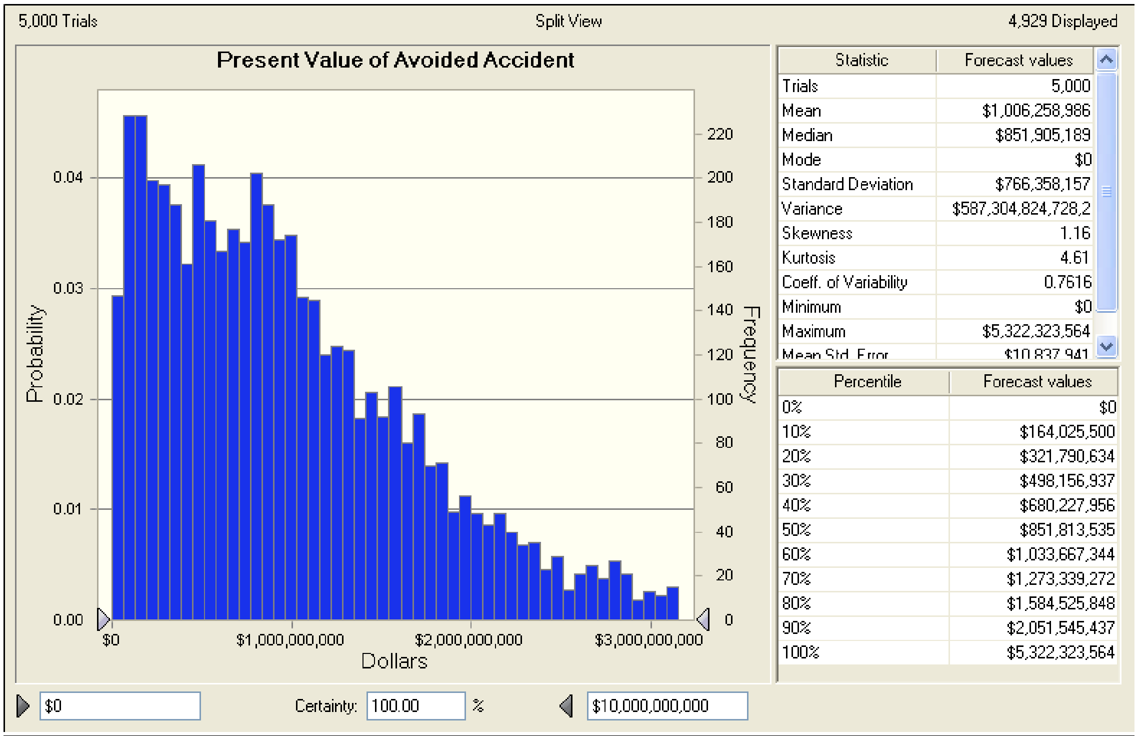
The distribution of the undiscounted costs of the possible future passenger airplane accidents has a lognormal distribution (see figure 12). The median for the costs is $1.219 billion, while the mean is $1.430 billion. The minimum cost is zero and the maximum cost is $7.225 billion. There is a 30 percent chance that costs would exceed $1.819 billion; there is a 20 percent chance that costs would exceed $2.241 billion; and a 10 percent chance that costs would exceed $2.884 billion.

Figure 12 Distribution of Benefits of Avoiding Possible Future Passenger Airplane Accidents



The distribution of the present value of the cost of the possible future accidents has a lognormal shape similar to that for undiscounted costs, but the costs projections are a little lower. The mean value is $1.006 billion; and the maximum value is $5.322 billion. There is a 30 percent chance that costs would exceed $1.273 billion; there is a 20 percent chance that costs would exceed $1.584 billion; and a 10 percent chance that costs would exceed $2.051 billion.

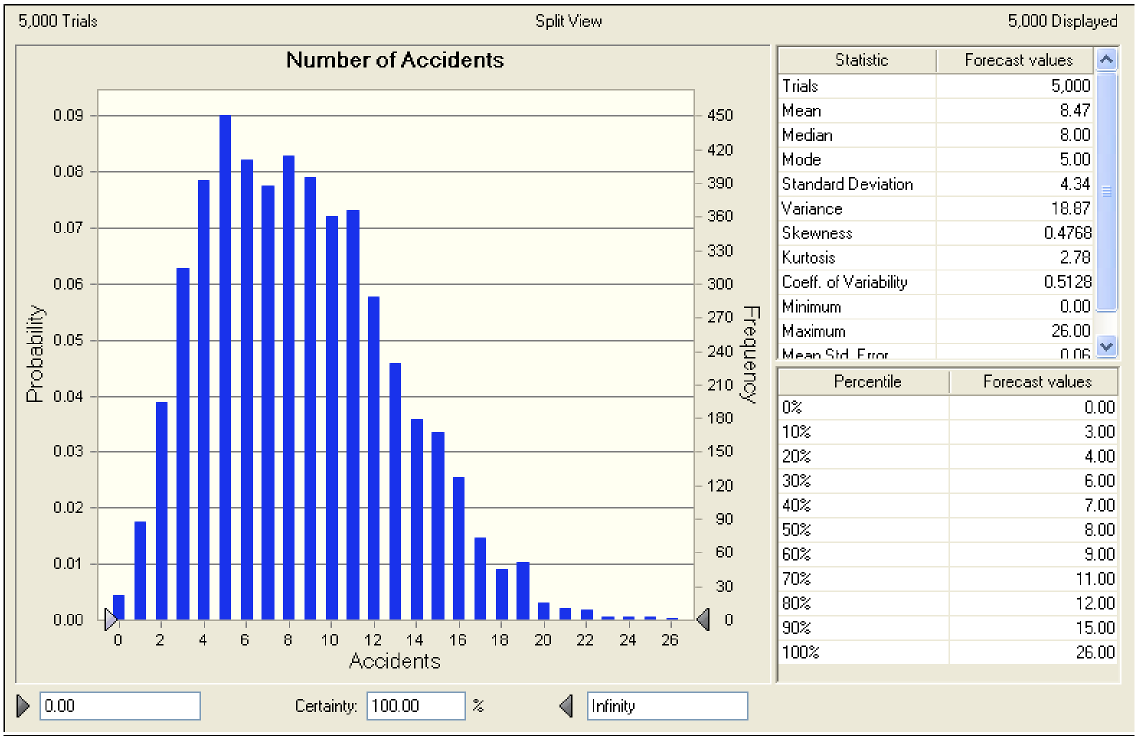
Figure 13 Distribution of the Present Value of the Costs of Possible Future Passenger Airplane Accidents



<u>Cargo Airplane Accidents</u>

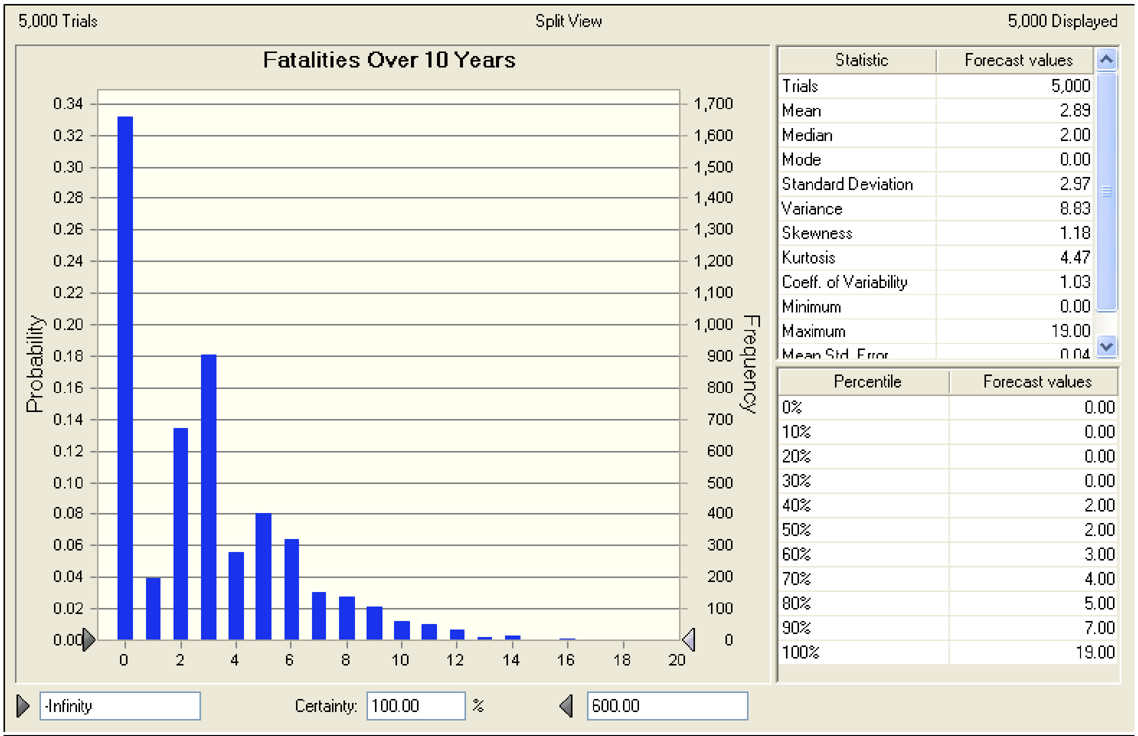
A 5,000 trial simulation analysis using a Poisson distribution with a mean ranging between 0.29 and 1.42 was run to provide a distribution of the possible outcomes of passenger airplane accidents over any future 10-year period (see figure 14). The mean is 8.47 accidents; and the standard deviation is 4.34 accidents. The range is between no accidents and 26 accidents.

Figure 14 Distribution of Possible Future Cargo Airplane Accidents



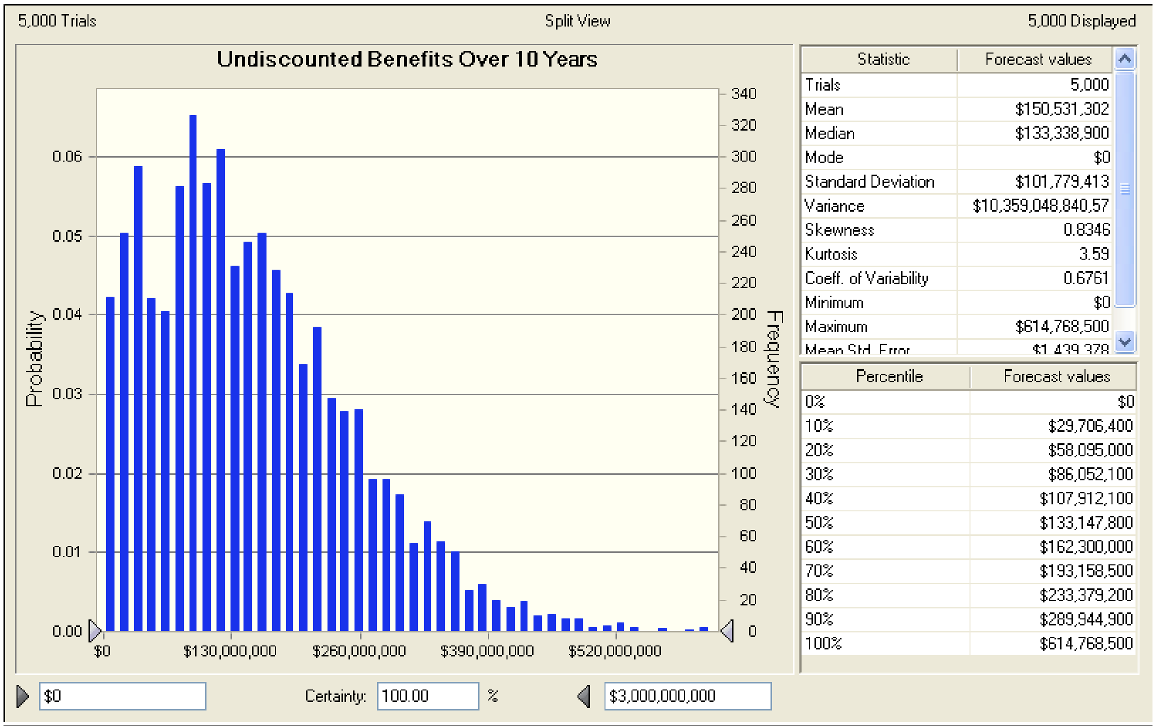
The distribution of future fatalities is shown in figure 15. There is over a 30 percent chance there will be no fatalities in each the simulation trial. However, there could possible be as many as 19 fatalities during a future 10-year period. The mean of the simulation distribution of possible future fatalities was 2.89. The simulation results suggest there is a 30 percent chance there could be 4 or more fatalities during a future 10-year period, a 20 percent chance there could be 5 or more fatalities, and a 10 percent chance there could be 7 or more fatalities.

Figure 15 Distribution of Fatalities from Possible Future Cargo Airplane Accidents



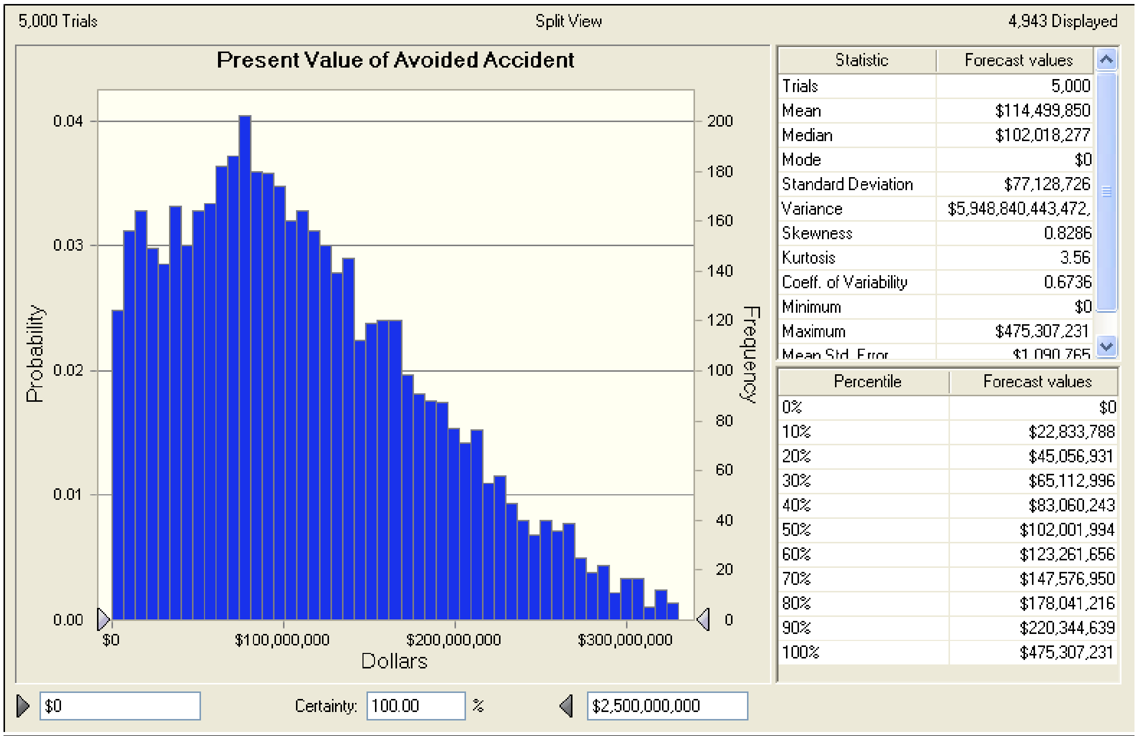
The distribution of the undiscounted costs of the possible future cargo airplane accidents is shown in figure 16. The median for the costs is \$133.3 million, while the mean is \$150.5 million. The minimum cost is zero and the maximum cost is \$614.8 million. There is a 30 percent chance that costs would exceed \$193 million; there is a 20 percent chance that costs would exceed \$233 million; and a 10 percent chance that costs would exceed \$289 million.

Figure 16 Distribution of Undiscounted Benefits of Avoiding Possible Future Cargo Accidents



The distribution of the present value of the cost of the possible future accidents has a shape similar to that for undiscounted costs, but the costs projections are a little lower (see figure 17). The mean value is $114.5 million; and the maximum value is $475.3 million. There is a 30 percent chance that costs would exceed $147 million; there is a 20 percent chance that costs would exceed $178 million; and a 10 percent chance that costs would exceed $220 million.

Figure 17 Distribution of the Present Value of the Costs of Possible Future Cargo Airplane Accidents



Summary

When a range in the number of annual accidents is allowed in the simulation analysis, the mean is 28.9 airplane accidents in a ten-year period. These accidents would result in a mean of 174.7 deaths. The estimated cost of these accidents would be a mean value of $1.581 billion ($1.121 billion, present value). These numbers represent an estimate of the likely number of future accidents, deaths, and costs from future accidents with fatigue as a factor.

Effectiveness Analysis

The above analysis establishes an estimate of the number and range of fatigue related accidents if no action is taken to address the problem. It is seldom the case that a rule is 100 percent effective at addressing an identified problem. In particular, fatigue is rarely a primary or sole cause of an accident, and therefore this rule, if adopted, is not likely to prevent all future accidents that include fatigue as a factor.

FAA reviewed all NTSB accident reports on Part 121 accidents that occurred from 1990 through 2009 to assess the likely capacity of the NPRM to have averted those accidents. The dataset also included some Part 135 accidents prior to spring 1997 that occurred on flights which would have been subject to part 121 after spring 1997 under the Commuter Rule of that time. Most reports on major accidents (hull losses or non-hull losses that resulted in multiple fatalities) provided extensive data on flight crews' duty tours and recent rest periods, which facilitated relatively strong assessments.

The FAA's Office of Accident Investigation and Prevention (AVP) rated each accident by conducting a scoring process similar to that conducted by the Commercial Aviation Safety Team (CAST), a well-documented and well understood procedure. All the accidents that have had final National Transportation Safety Board (NTSB) reports published have been scored against the CAST safety enhancements. AVP used the NTSB recommendations along with narratives, probable cause, contributing factors and other pertinent data to score the accidents.

When these accidents were not well defined in the probable cause or contributing factors statements of the NTSB reports, AVP used a Joint Implementation Monitoring Data Analysis Team (JIMDAT)-like method. The JIMDAT-type scoring system is from 0 to 5, and the score is based on the likelihood that a proposed action would have mitigated that accident. The level and percentage of effectiveness criteria follows:

5- 90% effectiveness. The proposed requirement directly addresses the NTSB causal factors and would very likely prevent the accident in the future.

4- 75% effectiveness. The proposed requirement directly addresses the majority of the NTSB causal factors and would probably prevent or is likely to reduce the risk of the respective accident, given the circumstances that prevailed.

3- 50 % effectiveness. The proposed requirement directly addresses one of several NTSB causal factors and is likely to reduce the risk of the respective accident, given the circumstances that prevailed.

2- 35% effectiveness. The proposed requirement generally addresses the NTSB causal factors and is likely reduce the risk of the respective accident, given the circumstances that prevailed.

1- 15% effectiveness. The proposed requirement is likely to have reduced the risk of the respective accident, given the circumstances that prevailed.

0- 0% effectiveness. The proposed requirement would not reduce the risk of this type of accident in the future.

AVP applied the above methodology to the details of each such pilot fatigue accident to reach a qualitative assessment of the NPRM's potential capacity to avoid each pilot fatigue accident. The qualitative assessments ranged from zero (0) to low (1), moderate (3), high (4) and very high (5). The qualitative assessments then were converted to quantitative effectiveness scores as follows: zero; 15%; 35%; 50%; 75%; and 90%. The effectiveness scores yielded about 8 accidents avoided over 20 years (see Technical Report submitted to the docket for the scoring results of the above accidents used in this analysis). According to this scoring, the proposed rule would be 40 percent effective at preventing passenger airplane accidents where pilot fatigue was a contributing factor and would be 58 percent effective at preventing cargo airplane accidents where pilot fatigue was a contributing factor.

Accordingly, the above estimate of the benefits of avoiding passenger airplane accidents where pilot fatigue was a causal factor have been reduced to 40 percent of their above stated values. The undiscounted mean benefit was reduced from $1.403 billion to $572.1 million and the maximum undiscounted benefit was reduced from $7.225 billion to $2.890 billion. The mean present value of the benefit was reduced from $1.006 billion to $402.5 million and the maximum present value benefit was reduced from $5.322 billion to $2.129 billion.

Next, the estimated benefits of avoiding cargo airplane accidents were reduced to 58 percent of their above stated values. The undiscounted mean benefit was reduced from $150.5 million to $87.3 million and the maximum undiscounted benefit was reduced from $614.8 billion to $356.6 million. The mean present value of the benefit was reduced from $105.7 million to $61.3 million and the maximum present value benefit was reduced from $446.2 million to $258.8 million.

The estimated benefit of avoiding passenger and cargo airplane accidents would be a mean value of $659.4 million ($463.8 million, present value).

Additional Benefits

The FAA has investigated other areas of potential benefit from this proposed rule. These areas are not quantified at this time, but are additional factors that should be considered when deciding whether to proceed with this rule.

The first area is in the area of minor aircraft and equipment damage on the ramp. By necessity, the focus on fatal accidents examines extremely remote events where something in the events leading to the accident did not reliably provide the necessary safety margin or back up. In part the focus on fatal accidents comes from the fact they are investigated in detail, event chains and causes are well defined, and assumptions can be made about cause and effect. However, there is a much larger universe of relatively minor accidents that may involve much larger annual dollar losses than the few fatal accidents that do occur. However, so few of these are investigated in much detail that they tend to be disregarded when looking at new safety regulations.

In the 170 Part 121 accidents from 2004-2008, there were a total of ten events that had a fatality. Overall, 90 fatalities occurred on those ten flights over the course of five years. Using a VSL of $6 million, the monetized value of loss of life is $540 million, and the average value of lost lives is about $100 million per year. This amount is only a small fraction of the overall cost of accidents on airport ramps. One estimate puts the cost of ground accidents and incidents which include injuries, fatalities and property damage at $5 billion per year worldwide. In the U.S. alone, total costs of ramp incidents and accidents exceed $3 billion per year. However, these events are not investigated in detail—i.e., there is a lack of causal information, no human factors report with work chronology, etc.

The fatigue literature suggests that the greatest benefits from fatigue reduction lie in increased productivity and in the reduction of human errors. Thus, we would expect to see a much larger number of events where pilot fatigue is a cause or factor, than is represented by fatal accidents alone. Preliminary research shows that the frequency of ground accidents during the evening (6:00 PM to midnight) and early morning (midnight to 6:00 AM) is higher than the distributions of scheduled takeoffs and landings would suggest. We observe a similar relationship when we look at Aviation Safety Reporting System (ASRS) reports citing pilot fatigue and related topics.

Of course not all the ground accidents involve pilot error, and not all instances of pilot error are cause by fatigue. However, the data on when these accidents occur suggest they are more prevalent when the potential for fatigue is greatest. In addition, the types of events such as taxiing a wing tip into another aircraft or gate, are symptomatic of poor decision making, poor spatial judgment, a focus on completing the flight quickly and other factors which may be more prevalent when fatigued. If even only a few percent of the losses from ground accidents are caused by pilot fatigue, the annual losses are large Three percent would be $90 million per year. These data suggest that the scope of accidents/incidents for valuing safety needs to be expanded to account for losses due to ground events where appropriate.

The second area is in the value of having well rested (and well-trained) pilots in the cockpit to solve minor problems before they become accidents. The aviation system is extremely complex, and aircraft are extremely complex machines. It is also extremely safe. When an accident occurs, it is generally the result of a long chain of multiple failures. The flightcrew in the cockpit is generally the last opportunity to break the chain and prevent an accident. It is well established that fatigued people are less likely to quickly and efficiently diagnose and solve problems than well-rested people. Every day, small events and mishaps are dealt with by the cockpit crew and they never become accidents, or the outcome is somewhat mitigated by the quick action of the crew. (The Flight 1549 that landed safely in the Hudson River is an example of how very quick reaction and decision making can avert catastrophes.) Some small number of incidents and accidents caused by things other than fatigue or human error maybe could have been prevented or mitigated if the crew had quickly behaved differently. While we have documented the likely size of the accident problem with fatigue as a factor, it is not possible to estimate the impact of increased problem solving capability from fewer fatigued pilots. It is, however, real and significant.

Sensitivity Analysis: Value of Statistical Life Estimates for FAA Regulatory Programs

Complex analyses for difficult public policy decisions typically employ sensitivity analyses to allow decision makers to see the impact of different values of key variables, to see how those different values impact the results of the analysis. The value of a statistical life (VSL) is an important policy measure as it is primarily used when federal agencies look to compare the costs and benefits of potential investment and regulatory policies and programs. In this regulatory impact analysis, FAA presented total benefits based on VSLs of $6 million, as suggested by 2009 guidance from DOT, and consistent with OMB Circular A-4. If $8.4 million were used for VSL, the undiscounted benefits would be $837 million and the present value of those benefits would be $589 million. A VSL value of $8.4 million is consistent with recent literature[14][15]. The FAA requests public comment on whether decision-makers should

[14] *See* Thomas J. Kniesner, W.Kip Viscusi, and James P. Ziliak, "Policy Relevant Heterogeneity in the Value of Statistical Life: New Evidence from Panel Data Quantile Regressions," Journal of Risk Analysis, Vol.40, No. 1, pp. 15-31

[15] W. Kip Viscusi, "The Heterogeneity of the Value of Statistical Life: Introduction and Overview," Journal of Risk Analysis, Vol.40, No. 1, pp. 1-13

consider using a VSL higher or lower than $6 million to evaluate commercial aviation safety proposals.

COST ANALYSIS

Cost Overview

The total estimated cost of the proposed rule is $1.25 billion ($804 million present value using a seven percent discount rate) for the ten year period from 2013 to 2022. The FAA classified costs into four main components and estimated the costs for each component.[16] We obtained data from various industry sources; the sources of the data used in cost estimation are explained in each section. We were very fortunate that several carriers ran two alternatives to the proposed rule through their crew scheduling programs. Their estimates provided some comparison data to calibrate and validate our costing approach. Without their help, we would have likely missed some cost elements. The Cost Summary Table below identifies the four main cost components. Flight operations cost makes up about 60 percent of the total cost of the rule. Each of the main cost components are explained in-depth in the following sections of this document.

Cost Summary

Cost Area	Nominal Cost (in $ millions)	Present Value Cost (in $millions)
Flight Operations	$760.3	$484.2
Scheduling Reliability	$4.9	$3.0
Fatigue Training Costs	$262.3	$167.2
Cost of Rest Facilities	$226.6	$149.1
Total Cost	$1,254.1	$803.5

[16] The FAA also calculated alternative scheduling costs, which comprise the largest cost component of the proposed rule. Discussions of these alternatives follow the main cost section.

In addition to the costs presented in the Cost Summary Table, there may be costs of a fatigue risk management system (FRMS). The FAA is not imposing an FRMS program requirement on Part 121 carriers, but is allowing them the option of developing and implementing such a program. Operators might do this for ultralong flights, which have flight time over 16 hours. Operators might develop an FRMS program as an alternative to the flight and duty period rules proposed by this rulemaking when the crew scheduling cost savings equal or exceed the costs of the FRMS program. The FAA estimates that an FRMS program would cost between $0.8 and $10.0 million for each operator over ten years. The FAA believes that about 35 operators have at least partially adopted an FRMS program at this time. The FAA estimates the total cost would be $205.7 million ($144.9 million present value), which would be more than offset by a reduction in crew scheduling costs. Accordingly, the cost is not added to the total costs imposed by this rule. The FAA calls for comment on this aspect of the proposal as it has not assigned a cost to the cumulative maximums.[17]

Flight Operations – Overview

The flight operations cost component of the proposed rule is composed of five sub-components: crew scheduling costs, cost to supplement the flight engineer on augmented operations, crew management system computer programming costs, cost savings of reduced reserves, and cost savings of the elimination of the flight time limit for

[17] Cumulative maximums are limitations on the amount of duty or flight time that flightcrew members are allowed to work over a period of time greater than a single duty period; for instance, the proposed rule sets a maximum of 65 duty hours in any seven-day period and a maximum of 200 duty hours in a 28-day period.

augmented operations. Table 5 provides a summary of the five sub-components of the flight operations cost. Each of the sub-components is explained in-depth in the following sections of the document.

Table 5: Summary of Flight Operations Costs

Cost Sub-Component	Nominal Cost (millions)	PV Cost (millions)
Crew Scheduling (Resource Cost Only)	$ 1,366.7	$ 854.2
Augmented - Suppplement FE	$ 66.7	$ 40.9
Computer Programming	$ 10.0	$ 8.1
Reduced Reserves	($ 231.7)	($ 142.1)
Augmented - Eliminate Flight Time Limit	($ 451.4)	($ 276.9)
Total Flight Operations	**$ 760.3**	**$ 484.2**

Flight Operations – Crew Scheduling

Analysis of Crew Schedule Data

Six air carriers[18] provided actual crew schedule data to the FAA to assist in the cost analysis of the Flightcrew Member Duty and Rest Requirements Rulemaking. The data consisted of one spring month in 2009 and one summer month in 2009 of actual work history for each flightcrew member employed by each carrier. The specific months varied by carrier. The data included all duty time and flight time worked by each flightcrew member, and included both lineholder and reserve pilots.

[18] Two of the carriers included data for related carriers operating under multiple business names.

The individual flightcrew member work histories were used to construct baseline summary data for each carrier. The total numbers of duty periods, duty hours, flight hours, and flight segments were summarized. The summary data were divided by the number of flightcrew members in each dataset to produce the average number of duty periods, duty hours, flight hours, and flight segments per flightcrew member per month. The baseline data was later used to estimate the number of noncompliant hours under the proposed rule.

Three types of crew scheduling limits were examined: flight duty, rest, and flight time limits. Only limits relating to individual flight duty periods were applied. Cumulative limits were not applied due to data limitations.. Flight duty limits impose a maximum number of hours that a flightcrew member may be on flight duty, based on the number of flight segments flown during the flight duty period (for unaugmented operations only), the starting time of the flight duty period, and, for augmented operations only, the rest facility onboard the aircraft and the number of crew operating the flight. Rest limits require that a flightcrew member have received a minimum number of rest hours (hours free from all duty) prior to beginning a flight duty period and vary depending on geographic location (domestic or international flights).[19] Flight limits impose a maximum number of hours that a flightcrew member may operate an aircraft during a given flight duty period and vary depending on the starting time of the flight duty period (for unaugmented operations only).

[19] In the context of proposed minimum rest limits, “domestic” refers to a flight duty period beginning in the 48 contiguous states, territories, and District of Colombia. “International” refers to a flight duty period beginning outside of the 48 contiguous states, territories, and District of Colombia.

A computer program was used to apply flight duty, rest, and flight time limits to the actual crew schedule data. First, the maximum flight duty limits were applied to each individual duty period. If the flight duty period exceeded the relevant flight duty limit, the duty period was truncated at the limit. Next, the minimum rest limits were applied to each individual duty period. If a flight duty period was not preceded by the relevant minimum number of rest hours, then the preceding flight duty period was truncated at the point where the minimum number of rest hours was sufficient for the flight duty period in question. Finally, the flight limits were applied to each individual flight duty period. If the sum of all flight time within a flight duty period exceeded the relevant flight limit, the last flight segment of the flight duty period was eliminated from the data, with the elimination of flight segments continuing backwards, if necessary, until the sum of all flight time within the flight duty period was lower than the flight limit. For all of the types of limits, if the flight duty period was truncated while a flight segment was underway, then the entire flight segment was eliminated from the data.

The application of the proposed flight duty, rest, and flight time limits resulted in modified flightcrew member work histories. These modified work histories were used to construct modified summary data for each carrier, similar to the baseline summary data. The modified number of duty periods, duty hours, flight hours, and flight segments also were summarized. The modified summary data was divided by the number of flightcrew members in each dataset to produce the average number of duty periods, duty hours, flight hours, and flight segments per flightcrew member per month.

The modified average number of flight hours per flightcrew member was compared to the baseline average number of flight hours per flightcrew member for each carrier. The difference between the two numbers represented the average number of flight hours per flightcrew member that were not compliant with the applied flight duty, rest, and flight time rules. The assumption is that these extra hours result in needing to either hire new pilots or pay existing pilots for more hours of duty. This is a very conservative initial estimate, which is later adjusted.

The FAA evaluated the proposed flight duty, rest, and flight time limits to produce an estimated crew scheduling cost for the entire air transport industry. Table 6 details the most significant differences between the proposed rule and current Part 121 rules.

Table 6: Comparison of Proposed Rule to Current Part 121

Scenario	Rest Time		Duty Time		Flight Time	
	Minimum Rest Prior to Duty - Domestic	**Minimum Rest Prior to Duty - International**	**Maximum Flight Duty Time - Unaugmented**	**Maximum Flight Duty Time - Augmented**	**Maximum Flight Time - Unaugmented**	**Maximum Flight Time - Augmented**
Current Part 121	Daily: 8-11 depending on flight time	Minimum of 8 hours to twice the number of hours flown	16	16-20 depending on crew size	8	8-16 depending on crew size
NPRM	9	9	9-13 depending on start time and number of flight segments	12-18 depending on start time, crew size, and aircraft rest facility	8-10 depending on FDP start time	None

Scenario	Rest Time		Duty Time		Flight Time	
	Minimum Rest Prior to Duty - Domestic	Minimum Rest Prior to Duty - International	Maximum Flight Duty Time - Unaugmented	Maximum Flight Duty Time - Augmented	Maximum Flight Time - Unaugmented	Maximum Flight Time - Augmented
Current Part 121	Daily: 8-11 depending on flight time	Minimum of 8 hours to twice the number of hours flown	16	16-20 depending on crew size	8	8-16 depending on crew size
NPRM	9	9	9-13 depending on start time and number of flight segments	12-18 depending on start time, crew size, and aircraft rest facility	8-10 depending on FDP start time	None

Cost Estimates Using Crew Schedule Data

All Part 121 air carriers in the U.S. air transport industry were categorized into seven groups based on the size of the aircraft type with the most block hours in 2008[20] and operating characteristics. Table 7 defines the groups based on aircraft size and operating characteristics. The number of air carriers in each group and number of flightcrew members in each group are also presented.

[20] Department of Transportation, Bureau of Transportation Statistics, Air Carrier Summary Data (Form 41 and 298C Summary Data), T2: U.S. Air Carrier Traffic and Capacity Statistics by Aircraft Type, 2008.

Table 7: Air Carrier Groups for NPRM Cost Analysis

Group		Aircraft Type with Most Block Hours	Part 121 Air Carriers	Part 121 Flightcrew Members
1	Large Cargo Carrier	Aircraft > 100 seats equivalent	26	10,125
2	Commercial Passenger Carrier	Aircraft > 100 seats	8	39,406
3	Low Cost Carrier	Aircraft > 100 seats	9	11,260
4	Regional Passenger Carrier	Aircraft 20 < seats < 100	30	20,980
5	Small Cargo Carrier	Aircraft < 100 seats equivalent	3	236
6	Small Passenger Carrier	Aircraft < 20 seats	4	281
7	Charter Passenger Carrier	Aircraft > 100 seats	12	1,230
Total			92	83,518
Source: FAA OPSS, October 2009				

Each of the six air carriers that provided crew schedule data to the FAA was assigned to one of the seven air transport industry groups. Each of the industry groups was represented in the data provided to FAA, except for the small passenger, small cargo, and charter passenger groups. The crew schedule data provided to the FAA represented 23 percent of all Part 121 flightcrew members, as shown in Table 8.

Table 8: Coverage of Industry

Total Part 121 Flightcrew Members	Flightcrew Members in Data Provided to FAA	Coverage Share
83,518	**19,529**	**23.4%**

Three industry groups were not represented in the data provided to the FAA and were assigned to a comparison group for purposes of cost estimation. The comparison group is the industry group that most closely resembles the unrepresented industry group. Table 9 presents the comparison group for each of the seven industry groups.

Table 9: Comparison Groups

Group	Comparison Group
Large Cargo	Large Cargo
Commercial Passenger	Commercial Passenger
LCC	LCC
Regional	Regional
Small Cargo	Large Cargo
Small Passenger	Regional
Charter Passenger	Large Cargo

To determine the crew scheduling costs of the proposed rule, the number of noncompliant flight hours for each air carrier in the air transport industry was first calculated. The number of noncompliant flight hours for each carrier was calculated by multiplying the number of flightcrew members employed by the carrier by the average number of noncompliant flight hours per flightcrew member for the carrier's relevant comparison group. Table 10 presents the number of noncompliant flight hours and their share relative to the baseline for the proposed rule.

Table 10: Noncompliant Flight Hours

Noncompliant Flight Hours	Share of Baseline
2,385,702	4.8%

After the total number of noncompliant flight hours was calculated for each carrier, costs were calculated based on the average hourly salary for each flightcrew member, for each carrier. The primary source of salary data was a 2006 report by AIR, Inc, an aviation industry publication. The report listed both annual salary and estimated credit hours for many carriers. This information was used to estimate the average hourly salary per flightcrew member. If salary data were unavailable for a carrier, the average hourly salary per flightcrew member for that carrier's industry group was used as a proxy. The average hourly salaries were updated to 2009 values using the Air Transport Association (ATA) Passenger Airline Cost Index. The labor component of the cost index was used to update the salaries from Q3 2006 to Q3 2009.[21] Table 11 presents the average hourly salary per flightcrew member for each industry group.

Table 11: Average Hourly Salary

Group	Average Hourly Salary
Large Cargo	$121
Commercial Passenger	$129
LCC	$107
Regional	$60
Small Cargo	$55
Small Passenger	$45
Charter Passenger	$92

The average hourly salary per flightcrew member for each carrier was multiplied by the noncompliant flight hours for each carrier, resulting in an estimated salary cost for each carrier. After estimating the additional crew scheduling salary cost, it was necessary

[21] Q3 2009 data was the most recent available at the time of publication.

to calculate the additional hotel and per-diem costs that would be incurred by carriers. During the rulemaking, one carrier had estimated its expected crew scheduling costs resulting from the flight duty, rest, and flight limits of one alternative to the proposed rule. As part of this analysis, the carrier allocated its total crew scheduling costs to salary, hotel, and per diem categories. We have used their costs proportions to estimate hotel and per diem for other scenarios.

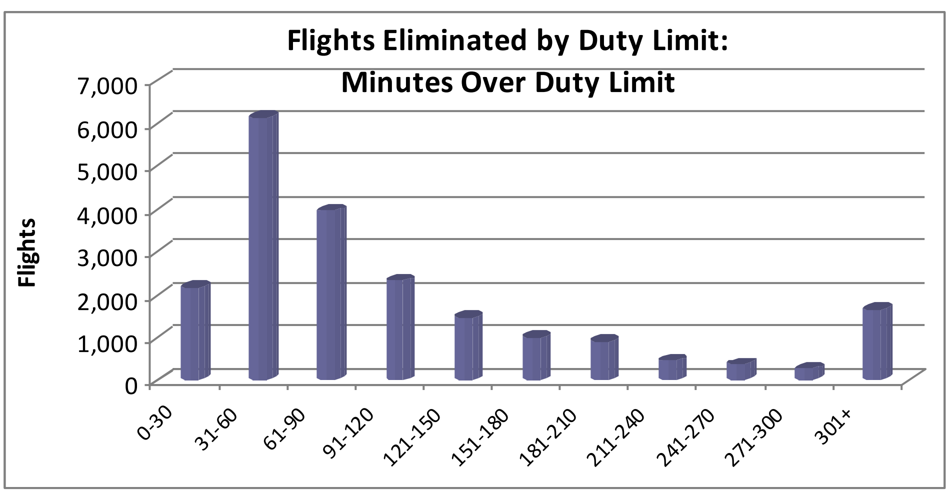
The individual carrier salary, hotel, and per-diem costs were summarized based on the seven industry groups to result in unadjusted additional annual crew scheduling costs resulting from the application of NPRM flight duty, rest, and flight time limits, as shown in Table 12.

Table 12: Unadjusted Crew Scheduling Costs

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$ 338.3	$ 276.2
2014	$ 338.3	$ 258.1
2015	$ 338.3	$ 241.2
2016	$ 338.3	$ 225.4
2017	$ 338.3	$ 210.7
2018	$ 338.3	$ 196.9
2019	$ 338.3	$ 184.0
2020	$ 338.3	$ 172.0
2021	$ 338.3	$ 160.7
2022	$ 338.3	$ 150.2
Total	**$ 3,383.4**	**$ 2,075.6**

The FAA believes that substantial opportunity for re-optimization exists because many of the flight segments that are eliminated for non-compliance with the proposed rule are only non-compliant by small amounts of time. Approximately 86 percent of the eliminated flights are due to non-compliance with duty limits, rather than flight or rest limits. The FAA examined the amount of time by which the duty period associated with each eliminated flight segment exceeded the maximum allowable duty time. Chart 1 presents these results. Nearly 40 percent of flights were eliminated due to their duty period exceeding the maximum allowable duty time by less than 60 minutes.

Chart 1: Duty Period Non-Compliance for Eliminated Flights



The FAA believes the crew scheduling costs calculated using this methodology substantially overestimate the probable actual cost impact of the proposed rule. Most airlines employ computer programs to optimize crew schedules – to minimize the number of crew hours, and hotel and per diem costs it takes to fly a given flight schedule within imposed constraints. The FAA accordingly has developed a methodology to adjust the estimate based on total non-compliant hours to a more realistic representation of costs after re-optimization. We ask for comments on the cost adjustments described in the next section and request a detailed explanation or justification for any and all comments.

Crew Scheduling Cost Adjustments

To approximate the reductions in cost that will occur when airlines optimize crew schedules following implementation of the rule, the FAA made several adjustments to the crew scheduling costs presented in Table 12. These adjustments include both short-term and long-term optimization that the FAA believes is likely to occur.

The FAA applied a short-term optimization factor of 25 percent to the unadjusted costs. This discount off of raw costs approximates the savings expected from the computer models used to build schedules; flight schedules will be rearranged into new trips that meet the new constraints of the rule. Typically, industry will experience from 10 percent to 40 percent savings from reoptimizing in this fashion. FAA selected a factor of 25 percent because it approximates the difference in costs submitted by a sample of carriers to FAA when they evaluated an alternative to the proposed rule, using their computer models, to the costs estimated by the FAA using the same cost estimation process described previously. Table 13 presents the annual costs after short-term optimization.

Table 13: Crew Scheduling Costs after Short-Term Optimization

Year	Optimization Factor	Nominal	PV
2013	25%	$ 253.8	$ 207.1
2014	25%	$ 253.8	$ 193.6
2015	25%	$ 253.8	$ 180.9
2016	25%	$ 253.8	$ 169.1
2017	25%	$ 253.8	$ 158.0
2018	25%	$ 253.8	$ 147.7
2019	25%	$ 253.8	$ 138.0
2020	25%	$ 253.8	$ 129.0
2021	25%	$ 253.8	$ 120.6
2022	25%	$ 253.8	$ 112.7
Total		**$ 2,537.5**	**$ 1,556.7**

After determining the crew scheduling costs after short-term optimization, FAA examined the salary component of the crew scheduling costs and identified the share that would be additional pay to existing crews versus salary for new hires. The initial shares are identical to those provided by one carrier that submitted a detailed cost estimate to FAA of an alternative to the proposed rule. Over time, FAA believes that the share of pay to existing crews will increase while the share of new hire salary will decrease, because carriers will continue to schedule crews ever more efficiently. Table 14 provides the annual shares of the crew scheduling cost components.

Table 14: Crew Scheduling Cost Components

Year	Existing Crews	New Hires	Hotel & Per Diem
2013	41%	48%	11%
2014	43%	46%	11%
2015	45%	44%	11%
2016	47%	42%	11%
2017	49%	40%	11%
2018	51%	38%	11%
2019	53%	36%	11%
2020	55%	34%	11%
2021	57%	32%	11%
2022	59%	30%	11%

Once the share of salary costs between the existing crews and new hires was determined, FAA identified additional long-term optimization factors, independent of the previously described short-term optimization. The long-term optimization factors reflect changes to crew bases, flight schedules, and other similar changes that will be implemented over a number of years. These also include potential adjustments to contracts between pilots and airlines that govern pay and working conditions. In conjunction with this step, FAA identified costs as either transfer costs or resource costs. The sum of these represents the financial impact on the carrier.

Transfer costs are defined as temporary cost increases resulting from short-term disruptions for the industry and its participants. These result in financial transfers between the carriers and flightcrew members. Resource costs are defined as true costs to society, due to inefficient use of resources. (The key difference between resource costs and transfers is whether the pilot ends up with free time that can be put to other productive uses. If a pilot does end up with additional free time for the same pay as before, this represents a transfer between the carrier and the pilot.) Tables 15 and 16 identify the long-term optimization factors, transfer costs, and resource costs for existing crews and new hires, respectively. Over the longer term, we expect that carriers will be able to improve scheduling efficiency of existing crew members. In the case of new pilots, there is less of an opportunity to improve scheduling efficiency.

Table 15: Long-Term Optimization of Additional Pay to Existing Crews

Year	Optimization Factor	Transfer Cost	Resource Cost
2013	60%	67%	33%
2014	40%	50%	50%
2015	20%	0%	100%
2016	20%	0%	100%
2017	20%	0%	100%
2018	20%	0%	100%
2019	20%	0%	100%
2020	20%	0%	100%
2021	20%	0%	100%
2022	20%	0%	100%

Table 16: Long-Term Optimization of Pay to New Hires

Year	Optimization Factor	Transfer Cost	Resource Cost
2013	95%	0%	100%
2014	90%	0%	100%
2015	80%	0%	100%
2016	80%	0%	100%
2017	80%	0%	100%
2018	80%	0%	100%
2019	80%	0%	100%
2020	80%	0%	100%
2021	80%	0%	100%
2022	80%	0%	100%

Table 17 presents the total crew scheduling costs, including salary to existing crews and new hires, hotel, and per-diem. The costs are categorized as either transfer or resource costs. The final reported costs of the proposed rule include only the resource costs from Table 17, as they represent the true cost of the rule to society.

Table 17: Final Crew Scheduling Costs

Year	Transfer Costs		Resource Costs	
	Nominal Cost (millions)	PV Cost (millions)	Nominal Cost (millions)	PV Cost (millions)
2013	$ 64.4	$ 52.5	$ 165.5	$ 135.1
2014	$ 33.6	$ 25.6	$ 156.0	$ 119.0
2015	$ 0.0	$ 0.0	$ 141.3	$ 100.8
2016	$ 0.0	$ 0.0	$ 138.3	$ 92.1
2017	$ 0.0	$ 0.0	$ 135.2	$ 84.2
2018	$ 0.0	$ 0.0	$ 132.2	$ 76.9
2019	$ 0.0	$ 0.0	$ 129.1	$ 70.2
2020	$ 0.0	$ 0.0	$ 126.1	$ 64.1
2021	$ 0.0	$ 0.0	$ 123.0	$ 58.5
2022	$ 0.0	$ 0.0	$ 120.0	$ 53.3
Total	**$ 97.9**	**$ 78.2**	**$ 1,366.7**	**$ 854.2**

Flight Operations – Additional Pilot to Supplement Flight Engineer

Carriers currently operating flights in excess of eight hours with a flightcrew of two pilots and one flight engineer will incur additional pilot salary costs on these flights under the proposed rule. Under current Part 121 rules, flight engineers are considered to be a crewmember for purposes of determining whether a flight can operate under augmented flight and duty rules. The proposed rule will not allow flight engineers to be considered as crewmembers when determining whether a flight can operate under augmented flight and duty rules. Therefore, carriers will need to add another pilot to the flightcrew for those flights that currently exceed eight hours and have a flightcrew of two pilots and a flight engineer.

The first step to estimating the cost impact of this aspect of the proposed rule was to examine the crew schedule data provided to the FAA and identify the flights affected by this rule change. Flights exceeding eight hours with a two pilot flightcrew were identified. Only those flights on aircraft types that utilize a flight engineer were considered. The only flights that met these criteria were operated by carriers in the large cargo group. The number of flight hours associated with these flights was then annualized. The annual number of flight hours was divided by the number of flight engineers for the relevant carriers to produce an average number of flight hours affected by the rule change per flight engineer. The result is 29.1 flight hours per flight engineer per year. The only aircraft types operated by flight engineers in the sample data that FAA received from the carriers are Boeing 727 and Boeing 747 aircraft.

The average number of flight hours affected per flight engineer was extrapolated to the entire air transport industry using the number of flight engineers listed on each air carrier's operating certificate in OPSS. The average number of flight hours affected per flight engineer was multiplied by the number of flight engineers at each carrier. The result represents the total number of flight hours that must be flown by a pilot to comply with the proposed rule. The total number of flight hours for each carrier was multiplied by the average hourly pilot salary for the carrier's industry group to obtain a total estimated cost of this aspect of the proposed rule. Table 18 summarizes the results by industry group. Industry groups that did not include a carrier with at least one flight engineer were excluded from Table 18.

Table 18: Annual Cost of Adding a Pilot to Supplement Flight Engineer on Augmented Flights

Industry Group	Flight Engineers	Flight Hours Affected	Average Pilot Hourly Salary	Additional Pilot Salary Cost (millions)
Large Cargo	1,648	49,020	$121	$5.9
Charter Passenger	92	2,715	$92	$0.3
Commercial Passenger	125	3,690	$129	$0.5
Total		**55,425**		**$6.7**
Note: Analysis was conducted on a carrier-specific basis. Aggregated results are presented here.				

The nominal annual cost of adding a pilot to supplement the flight engineer on augmented flights is $6.7 million. The nominal cost for the period of analysis is $66.7 million and the present value cost for the period of analysis is $40.9 million, as shown in Table 19.

Table 19: Cost of Adding a Pilot to Supplement Flight Engineer on Augmented Flights

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$6.7	$5.4
2014	$6.7	$5.1
2015	$6.7	$4.8
2016	$6.7	$4.4
2017	$6.7	$4.2
2018	$6.7	$3.9
2019	$6.7	$3.6
2020	$6.7	$3.4
2021	$6.7	$3.2
2022	$6.7	$3.0
Total	**$66.7**	**$40.9**

Flight Operations – Computer Programming

Carriers will incur computer programming costs as they will need to update their crew management systems and their schedule optimization systems with the constraints imposed by the proposed rule. This will be a one-time cost incurred in 2013 as carriers update their computer systems. Computer programming costs were estimated for each individual carrier, based on the number of flightcrew members listed on the carrier's operating certificate.

Carriers were assigned to one of three groups based on the number of flightcrew members. Costs were estimated based on the number of person-days required to complete the computer programming and a daily professional staff cost of $2,500. Table 20 presents the nominal and present value computer programming costs. We invite specific comment on this estimate of the expected computer programming costs for carriers.

Table 20: Computer Programming Costs

Year	Flightcrew Members	Carriers	Cost per Carrier	Nominal Cost (millions)	PV Cost (millions)
2013	>1,000	21	$250,000	$ 5.3	$ 4.3
	250-1,000	21	$100,000	$ 2.1	$ 1.7
	>250	52	$50,000	$ 2.6	$ 2.1
Total		**94**		**$ 10.0**	**$ 8.1**

Flight Operations – Cost Savings from Reduced Reserves

The proposed rule is designed to reduce the risk of fatigued flightcrew members by limiting the maximum number of hours they are permitted to be on duty, the number of hours they actually fly during duty periods, and by ensuring that they receive adequate rest periods before reporting for duty. It is expected that the proposed rule will result in better-rested flightcrew members. The proposed rule will reduce flight crew member fatigue, thus reducing the use of sick time. When a flightcrew member is scheduled for duty and calls in sick or fatigued, the airline must use a reserve flightcrew member to complete the scheduled duty. The proposed rule will reduce the use of reserve flightcrew members to cover fatigue-induced sick call-ins by flight crew members, which will reduce the flight operations cost associated with fatigue issues for carriers.

While the precise share of current sick time attributable to fatigue is unknown, it is most likely greater than zero. Similarly, while the precise amount by which the proposed rule will reduce sick time is unknown, it is also most likely greater than zero. For the purposes of this analysis, FAA assumes that sick time accounts for five percent of total industry flightcrew member pay. The proposed rule is expected to reduce the use of sick time by five percent. The nominal value of the cost savings is $231.7 million ($142.1 million present value) over the ten-year period of analysis. Table 21 presents the annual cost savings.

Table 21: Reduced Reserves Cost Savings

Year	Nominal Cost Savings (millions)	PV Cost Savings (millions)
2013	$ 23.2	$ 18.9
2014	$ 23.2	$ 17.7
2015	$ 23.2	$ 16.5
2016	$ 23.2	$ 15.4
2017	$ 23.2	$ 14.4
2018	$ 23.2	$ 13.5
2019	$ 23.2	$ 12.6
2020	$ 23.2	$ 11.8
2021	$ 23.2	$ 11.0
2022	$ 23.2	$ 10.3
Total	**$ 231.7**	**$ 142.1**

Flight Operations – Cost Savings from Augmented Operations

The proposed rule eliminates the existing maximum flight time limit for augmented operations, which creates a potential cost-saving opportunity for carriers. Carriers are required to operate some flights with four flightcrew members under existing maximum flight time limits. Some of these flights could be operated with three flightcrew members under the proposed rule, which would reduce carriers' flight operations costs.

The existing maximum flight time limit for flag and supplemental carriers is 12 hours for three flightcrew members and 16 hours for four flightcrew members. Although there are no maximum flight time limits in the proposed rule for augmented operations, flightcrew members' flight time will be limited in practice by maximum flight duty time limits. The proposed rule sets the maximum flight duty time for a flightcrew member when operating a flight with three flightcrew members at 16 hours for flights on an aircraft with a Class 1 rest facility and when the flight duty period begins between 0700-1259. This maximum flight duty time limit is lower if the aircraft has a lesser-quality rest facility and/or if the flight duty period begins at an earlier or later time.

To determine the potential cost savings resulting from the elimination of augmented maximum flight time limits, the FAA analyzed actual flightcrew member schedule data from six carriers. The data included complete duty and flight records for every flightcrew member (lineholder and reserve) for one spring month and one summer month in 2009. Due to the limited sample size, the FAA needed to make several assumptions and the resulting potential cost estimate is highly uncertain.

First, only flights conducted with four crewmembers with a flight duration of 12 to 14 hours were considered for potential cost savings. Flights of less than 12 hours were not considered because flag and supplemental carriers are allowed to operate flights of less than 12 hours with three flightcrew members under existing maximum flight time limits. Flights of more than 14 hours were not considered because the maximum flight duty time for a flightcrew member under the proposed rule is 16 hours when operating a flight augmented with one additional flightcrew member. The two hour difference is accounted for by check in preceding the flight and check out time following the flight. To the extent that actual check in/check out is greater than or less than the assumed two hours, this potential cost savings estimate may overestimate or underestimate the actual cost savings.

Second, it is assumed that flightcrew member labor agreements will permit the carriers to reduce the number of flightcrew members from four to three. To the extent that labor agreements restrict the flexibility of carriers to reduce the number of flightcrew members on these flights, this potential cost savings estimate will overestimate the actual cost savings.

Third, it is assumed that the crew scheduling needs of carriers will permit them to reduce the number of flightcrew members from four to three. To the extent that carriers desire to operate a flight with four flightcrew members rather than three flightcrew members for operational or schedule reliability purposes, this potential cost savings estimate will overestimate the actual cost savings.

Fourth, to extrapolate the potential cost savings of those carriers for which FAA had data to the entire US air transport industry, it was necessary to assume that the scheduling practices of other carriers were similar to the scheduling practices of those carriers for which FAA had data. If the scheduling practices of the remainder of the US air transport industry materially differ from the scheduling practices of those carriers for which FAA had data, this estimate of potential cost savings may over- or understate the actual cost savings.

To estimate the potential cost savings of those carriers for which FAA had data, flight segments of 12 to 14 hours operated by four flightcrew members were identified. Four carriers operated flights that met these criteria. The carriers represented the commercial passenger and large cargo industry groups. For the flights that met the criteria, the following data was collected: flight hours, flight duty period start hour, and aircraft rest facility.

A distribution of flight hours by flight duty period start hour and aircraft rest facility was calculated. The share of flight hours for which the maximum flight duty period limit applied (16 hours) was used to adjust the number of flight hours. This adjusted number of flight hours represented a realistic number of flight hours that could be reduced from four flightcrew members to three flightcrew members based on maximum flight duty period constraints. Table 22 displays the distribution of flight hours that was used to make the flight hours adjustment.

Table 22: Flights between 12 and 14 Hours Duration Operated by Four Flightcrew Members

Flight Duty Period Start	Aircraft Rest Facility	Share of Flight Hours	NPRM Maximum Flight Duty Time
0000-0559	**1**	13.3%	14
0000-0559	**2**	14.9%	13
0600-0659	**1**	0.1%	15
0600-0659	**2**	0.0%	14
0700-1259	**1**	23.5%	16
0700-1259	**2**	16.9%	15.5
1300-1659	**1**	0.6%	15
1300-1659	**2**	6.8%	14
1700-2359	**1**	17.0%	14
1700-2359	**2**	6.9%	13

Next, the number of adjusted flight hours per flightcrew member was calculated. This was accomplished by dividing the total flightcrew members by the adjusted flight hours. This figure was then annualized. Table 23 presents the annual adjusted flight hours saved per flightcrew member.

Table 23: Annual Adjusted Flight Hours Saved per Flightcrew Member

Industry Group	Hours Saved per Crewmember
Commercial Passenger	10.2
Large Cargo	0.6

The estimate of adjusted flight hours saved per flightcrew member was extrapolated to a subset of the entire US air transport industry. The subset consisted of those passenger carriers that had at least one flight segment exceeding eight hours in the year ended June 2009.[22] The subset also included all carriers in the large cargo and charter passenger industry groups.

While aggregated results are reported in this section, the cost savings estimate was conducted on a carrier-specific basis. The adjusted number of flight hours saved per flightcrew member was multiplied by the total number of flightcrew members for each carrier.[23] The total adjusted flight hours saved per flightcrew member was multiplied by the average hourly salary for that carrier to result in an estimated cost savings. Table 24 presents the results of the potential cost savings by industry group.

[22] These carriers were determined by FAA analysis of Official Airline Guide (OAG) data.
[23] Flightcrew member data from FAA OPSS.

Table 24: Cost Savings Resulting From Elimination of Maximum Flight Time Limit for Augmented Operations

Industry Group	Flight Hours Eliminated	Average Hourly Salary	Salary Cost Savings (millions)
Large Cargo	5,890	$121	$0.8
Charter Passenger	702	$92	$0.1
Commercial Passenger	321,247	$129	$44.2
Total	**327,839**		**$45.1**

The nominal annual cost savings resulting from the elimination of maximum flight time limits on augmented flights is $45.1 million. The nominal cost savings for the period of analysis is $451.4 million and the present value cost savings for the period of analysis is $276.9 million, as shown in Table 25.

Table 25: Cost Savings Resulting from Elimination of Maximum Flight Time Limit for Augmented Operations

Year	Nominal Cost (millions)	PV (millions)
2013	$45.1	$36.8
2014	$45.1	$34.4
2015	$45.1	$32.2
2016	$45.1	$30.1
2017	$45.1	$28.1
2018	$45.1	$26.3
2019	$45.1	$24.6
2020	$45.1	$22.9
2021	$45.1	$21.4
2022	$45.1	$20.0
Total	**$451.4**	**$276.9**

Flight Operations – Total Cost

The total flight operations cost is composed of the additional crew scheduling costs (flightcrew member salary, hotel, and per diem), plus the cost of supplementing a two-pilot and flight engineer flightcrew with an additional pilot for flights greater than eight hours, plus the computer programming costs, less the cost savings from reduced reserves, and less the cost savings resulting from the elimination of maximum flight time limits for augmented operations. The net nominal value of the total flight operations cost for the period of analysis is $760.3 million, with a present value of $484.2 million. Table 26 presents the annual nominal and present value total flight operations cost. Table 27 provides breakdown of the total flight operations cost by cost sub-component. The FAA asks for comments regarding the flight operations cost, accompanied by a detailed justification.

Table 26: Total Flight Operations Cost

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$ 113.8	$ 92.9
2014	$ 94.4	$ 72.0
2015	$ 79.7	$ 56.8
2016	$ 76.6	$ 51.1
2017	$ 73.6	$ 45.8
2018	$ 70.5	$ 41.1
2019	$ 67.5	$ 36.7
2020	$ 64.5	$ 32.8
2021	$ 61.4	$ 29.2
2022	$ 58.4	$ 25.9
Total	**$ 760.3**	**$ 484.2**

Table 27: Total Flight Operations Cost Summary

Cost Sub-Component	Nominal Cost (millions)	PV Cost (millions)
Crew Scheduling (Resource Cost Only)	$ 1,366.7	$ 854.2
Augmented - Suppplement FE	$ 66.7	$ 40.9
Computer Programming	$ 10.0	$ 8.1
Reduced Reserves	($ 231.7)	($ 142.1)
Augmented - Eliminate Flight Time Limit	($ 451.4)	($ 276.9)
Total Flight Operations	**$ 760.3**	**$ 484.2**

Schedule Reliability

Schedule reliability refers to the accuracy of the scheduled flight duty period compared to the actual flight duty period. Carriers will be required to report the scheduling reliability and pairing-specific reliability to the FAA every two months.[24] The FAA expects carriers to use existing software packages, but carriers will need to incorporate and write new reports, which will warn of potential compliance issues with the proposed rule. The FAA is aware of at least two smaller operators who run schedule reliability programs manually without the support of software. For operators who perform the analysis manually, there would be no software investment required.

Although the reporting requirements would exist for all carriers, the only carriers who would incur any significant cost would be the ones who do not schedule reliably, that is, those having existing unrealistic scheduled vs. actual times. These carriers would have to publish more realistic crew schedules and might have to make some scheduling adjustments. The FAA believes that most carriers are already publishing realistic schedules overall and there would be a minimal impact on these carriers to publish and adjust an existing schedule.

The FAA estimates that each carrier would take about two days to modify their scheduling software to create the required report. We assume that the carriers will use the equivalent of a GS-14, step 5 employee to do this work. With a fully loaded hourly cost of $68.86 and roughly 98 operators, the industry cost would be roughly $108,000

[24] The report format would be either .xls or .xml.

($88,000 present value) in the first year to make the necessary changes to their scheduling programs.

Each operator would take roughly one more day to prepare, troubleshoot, and submit the report every two months (six reports per year) to the FAA. In this case the FAA assumes that each operator will use the equivalent of a GS-11, step 5 employee with a burdened hourly cost of $33.21. The annual cost per operator is $1,600. For the industry (98 operators) for the ten-year period of analysis, the total cost is $1.6 million ($1.0 million present value).

The FAA believes the burden on it for imposing the reporting requirements would be 2.5 FTE's. We assume these employees will be at the GS-13, step 5 grade level (at Washington DC locality pay rates) at a burdened annual cost of $130,500. The total government cost for the period of analysis is $3.3 million ($2.0 million present value).

The total estimated cost to implement scheduling reliability reporting is $4.9 million ($3.0 million present value.) Annual costs are shown in Table 28.

Table 28: Schedule Reliability Costs[25]

Year	Operator Annual Costs		Government Cost		Implement Report		Total Costs	
	Nominal (millions)	PV (millions)	Nominal (millions)	PV (millions)	Nominal (millions)	PV (millions)	Nominal (millions)	PV (millions)
2013	$0.2	$0.1	$0.3	$0.3	$0.1	$0.1	$0.6	$0.5
2014	$0.2	$0.1	$0.3	$0.2			$0.5	$0.4
2015	$0.2	$0.1	$0.3	$0.2			$0.5	$0.3
2016	$0.2	$0.1	$0.3	$0.2			$0.5	$0.3
2017	$0.2	$0.1	$0.3	$0.2			$0.5	$0.3
2018	$0.2	$0.1	$0.3	$0.2			$0.5	$0.3
2019	$0.2	$0.1	$0.3	$0.2			$0.5	$0.3
2020	$0.2	$0.1	$0.3	$0.2			$0.5	$0.2
2021	$0.2	$0.1	$0.3	$0.2			$0.5	$0.2
2022	$0.2	$0.1	$0.3	$0.1			$0.5	$0.2
Total	**$1.6**	**$1.0**	**$3.3**	**$2.0**	**$0.1**	**$0.1**	**$4.9**	**$3.0**

Fatigue Training - Overview

The proposed rule amends existing flight, duty, and rest regulations by requiring Part 121 operators to develop fatigue training programs. The intent of the fatigue training will be to educate all employees responsible for developing air carrier schedules and safety of flight on the symptoms of fatigue, as well as the factors leading to fatigue and how to mitigate fatigue-based risk. The employees that will be required to complete fatigue training programs include flightcrew members, dispatchers, and management. The fatigue training will be incorporated into existing distance learning programs used by carriers. Table 29 provides a summary of fatigue training costs, which are explained in detail in the following sections.

[25] Totals may not add due to rounding.

Table 29: Fatigue Training Costs Overview

Employee Group	Nominal Cost (millions)	PV Cost (millions)
Flightcrew Members	$ 234.2	$ 149.3
Dispatchers and Management	$ 28.1	$ 17.9
Total Fatigue Training	**$ 262.3**	**$ 167.2**

Fatigue Training – Flightcrew Members

This section describes the approach used to estimate the fatigue training costs for flightcrew members (captains, first officers, and flight engineers). Initial and recurring fatigue training costs were calculated for all flightcrew members from 2013 to 2022. The primary cost component is salary compensation for the time that flightcrew members spend in fatigue training. There will be no hotel or per-diem costs because the training will be conducted through distance learning programs.

Flightcrew members' data were derived from the FAA Operating Specification Subsystem (OPSS), which reports the number of flightcrew members as recorded on each carrier's operating certificate. Table 30 shows the total number of captains, first officers, and flight engineers by air carrier group. The initial fatigue training cost for 2013 is based on the cost of training these flightcrew members.

Table 30: Air Carrier Groups for NPRM Cost Analysis

Group		Aircraft Type with Most Block Hours	Part 121 Air Carriers	Part 121 Flightcrew Members
1	Large Cargo Carrier	Aircraft > 100 seats equivalent	26	10,125
2	Commercial Passenger Carrier	Aircraft > 100 seats	8	39,406
3	Low Cost Carrier	Aircraft > 100 seats	9	11,260
4	Regional Passenger Carrier	Aircraft 20 < seats < 100	30	20,980
5	Small Cargo Carrier	Aircraft < 100 seats equivalent	3	236
6	Small Passenger Carrier	Aircraft < 20 seats	4	281
7	Charter Passenger Carrier	Aircraft > 100 seats	12	1,230
Total			92	83,518

Source: FAA OPSS, October 2009

Initial fatigue training is five hours. Every flightcrew member will be required to undergo initial fatigue training in 2013. In subsequent years, newly qualified flightcrew members will be required to undergo initial fatigue training, in addition to previously qualified flightcrew members that change employers. The annual retirement rate for flightcrew members is 3.3 percent. It is assumed that an equivalent number of flightcrew members will be qualified to replace those that retire. The “churn” rate (the share of flightcrew members that change employers within a given year) is one percent.

After undergoing initial fatigue training, each flightcrew member will be required to complete two hours of recurring training every year. This training will also be incorporated into existing distance learning programs.

The total number of flightcrew members for each year from 2013 to 2022 is assumed to be equivalent to the total number of flightcrew members holding certificates in October 2009, as recorded by OPSS. Table 31 shows the annual number of flightcrew members required to undergo both initial and recurring fatigue training from 2013 to 2022.

Table 31: Flightcrew Members in Fatigue Training

Year	Initial Training	Recurring Training	Total
2013	83,518	0	83,518
2014	3,591	79,927	83,518
2015	3,591	79,927	83,518
2016	3,591	79,927	83,518
2017	3,591	79,927	83,518
2018	3,591	79,927	83,518
2019	3,591	79,927	83,518
2020	3,591	79,927	83,518
2021	3,591	79,927	83,518
2022	3,591	79,927	83,518

The average hourly salaries of flightcrew members were then determined based on carrier-specific annual salary data from AIR, Inc. The salary data was then converted into an average hourly salary. The average hourly salary was calculated by dividing the average annual salary by the minimum guaranteed pay credit hours per month as defined in pilot labor agreements. The average hourly salaries were updated to 2009 values using the Air Transport Association (ATA) Passenger Cost Index. The labor component of the cost index was used to update the salaries from Q3 2006 to Q3 2009.

Flightcrew member fatigue training costs are equal to the number of flightcrew member training hours multiplied by the average hourly salary. Table 32 presents the nominal annual costs of fatigue training for flightcrew members. The total nominal cost over the ten-year period is $234.2 million. Table 33 presents the present value annual costs of fatigue training for flightcrew members. The total present value cost over the ten-year period is $149.3 million.

Table 32: Flightcrew Member Fatigue Training Nominal Annual Costs

Year	Initial Cost (millions)	Recurrent Cost (millions)	Total Cost (millions)
2013	$ 48.5	$ 0.0	$ 48.5
2014	$ 2.1	$ 18.6	$ 20.6
2015	$ 2.1	$ 18.6	$ 20.6
2016	$ 2.1	$ 18.6	$ 20.6
2017	$ 2.1	$ 18.6	$ 20.6
2018	$ 2.1	$ 18.6	$ 20.6
2019	$ 2.1	$ 18.6	$ 20.6
2020	$ 2.1	$ 18.6	$ 20.6
2021	$ 2.1	$ 18.6	$ 20.6
2022	$ 2.1	$ 18.6	$ 20.6
Total	**$ 67.2**	**$ 167.0**	**$ 234.2**

Table 33: Flightcrew Member Fatigue Training Present Value Annual Cost

Year	Initial Cost (millions)	Recurrent Cost (millions)	Total Cost (millions)
2013	$ 39.6	$ 0.0	$ 39.6
2014	$ 1.6	$ 14.2	$ 15.7
2015	$ 1.5	$ 13.2	$ 14.7
2016	$ 1.4	$ 12.4	$ 13.8
2017	$ 1.3	$ 11.6	$ 12.9
2018	$ 1.2	$ 10.8	$ 12.0
2019	$ 1.1	$ 10.1	$ 11.2
2020	$ 1.1	$ 9.4	$ 10.5
2021	$ 1.0	$ 8.8	$ 9.8
2022	$ 0.9	$ 8.2	$ 9.2
Total	**$ 50.6**	**$ 98.7**	**$ 149.3**

Fatigue Training – Dispatchers and Management

The proposed rule also requires that dispatchers and upper management having operational control over pilots be given fatigue training. The number of dispatchers in the U.S. air transport industry is equal to approximately three percent of the number of pilots. The number of management personnel is estimated to be three times the number of dispatchers. Therefore, the total number of dispatchers and management personnel required to receive fatigue training is estimated to be 12 percent of total flightcrew members. The corresponding increase in cost is assumed to be 12 percent.

The estimated total net present value cost of the proposed fatigue training requirements for dispatchers and management personnel over the ten-year period from

2013 to 2022 is $17.9 million. Table 34 lists both nominal and present value fatigue training annual costs for dispatchers and management.

Table 34: Dispatcher and Management Fatigue Training Costs

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$ 5.8	$ 4.7
2014	$ 2.5	$ 1.9
2015	$ 2.5	$ 1.8
2016	$ 2.5	$ 1.7
2017	$ 2.5	$ 1.5
2018	$ 2.5	$ 1.4
2019	$ 2.5	$ 1.3
2020	$ 2.5	$ 1.3
2021	$ 2.5	$ 1.2
2022	$ 2.5	$ 1.1
Total	**$ 28.1**	**$ 17.9**

Fatigue Training - Summary

The estimated total net present value cost of the proposed fatigue training requirements for flightcrew members, dispatchers, and management personnel over the ten-year period from 2013 to 2022 is $167.2 million. Table 35 lists both nominal and present value fatigue training annual costs.

Table 35: Total Fatigue Training Costs

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$ 54.3	$ 44.3
2014	$ 23.1	$ 17.6
2015	$ 23.1	$ 16.5
2016	$ 23.1	$ 15.4
2017	$ 23.1	$ 14.4
2018	$ 23.1	$ 13.5
2019	$ 23.1	$ 12.6
2020	$ 23.1	$ 11.7
2021	$ 23.1	$ 11.0
2022	$ 23.1	$ 10.3
Total	**$ 262.3**	**$ 167.2**

Rest Facilities – Overview

The proposed rule establishes maximum flight duty time limits for augmented operations that are dependent on the start time of the flight duty period, the number of crew assigned to the flight, and the class of rest facility installed on the aircraft. There are two types of costs associated with the rest facility cost component of the proposed rule. First, there is the cost resulting from the physical installation of the rest facilities in the aircraft fleet. Second, there is the loss of passenger revenue when the use of the rest facility removes seats from passenger revenue service. Table 36 provides an overview of the ten-year costs of the rest facility component of the proposed rule.

Table 36: Rest Facility Cost Overview

Cost Area	Nominal Cost (millions)	PV Cost (millions)
Installation	$ 49.8	$ 40.7
Lost Passenger Revenue	$ 176.8	$ 108.5
Total Rest Facilities	**$ 226.6**	**$ 149.1**

The proposed rule establishes detailed specifications for each of the three classes of rest facilities. Class 1 rest facilities are most conducive to reducing the risk of fatigue in augmented operations; accordingly, the maximum flight duty time permitted for augmented operations conducted with Class 1 rest facility-equipped aircraft is greater than the maximum flight duty time permitted for augmented operations conducted with either Class 2 or 3 rest facility-equipped aircraft. The definitions of the rest facilities are as follows:

- A Class 1 rest facility is a bunk or other surface that allows for a flat sleeping position and is located separate from both the flight deck and passenger cabin in an area that is temperature-controlled, allows the crewmember to control light, and provides isolation from noise and disturbance.
- A Class 2 rest facility is a seat in an aircraft cabin that allows for a flat or near flat sleeping position; is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation; and is reasonably free from disturbance by passengers or crewmembers.

- A Class 3 rest facility is a seat in an aircraft cabin or flight deck that reclines at least 40 degrees and provides leg and foot support.

Rest Facilities – Installation

There are three cost categories associated with the installation of rest facilities. First, there are one-time, non-recurring, design costs. These consist of system, development, engineering, analysis, and certification costs. Second, there are "kit" equipment costs for the hardware required for each installation. Third, there is the cost of the labor required for rest facility installation.

The FAA obtained detailed cost estimates from two supplemental type certificate (STC) holders. Their estimates indicate that Class 1 facilities are much higher in cost relative to Class 2 and 3 facilities, which are roughly equivalent. For the purposes of this analysis, FAA averaged the cost estimates from the two STC holders and summarized the costs into a per-installation cost. Table 37 presents the cost per installation used for this analysis.

Table 37: Cost per Rest Facility Installation

Rest Facility Class	Cost per Installation
Class 1	$259,000 - $1,500,000
Class 2	$46,000
Class 3	$31,000

In order to estimate the total cost of on board rest facilities, the FAA multiplied the unit costs by the number of aircraft that could be affected by the rule (defined as aircraft that operate long range). FAA believes that in the long term it is more cost effective for carriers to install rest facilities than to add pilots to the flightcrew. FAA believes that no Class 2 or Class 3 rest facility will need to be added or upgraded on any of the aircraft currently used in international transportation because existing business or first class seats meet the requirements as Class 2 or Class 3 rest facilities.

Rest facilities will need to be installed or upgraded on 104 aircraft used in international service. Installation will be completed by the end of 2013. Nineteen of these aircraft will have bunks installed at $1.5 million per aircraft and the remaining 85 aircraft will have the single bunk facility upgraded to a double bunk facility at $250,000 per aircraft. The total estimated cost is $49.8 million ($40.7 million present value). This cost estimate does not include any weight penalty costs. The FAA solicits public input regarding the weight penalty costs.

Rest Facilities - Loss of Passenger Revenue

There will be some passenger revenue loss associated with the use of rest facilities in augmented operations. The FAA found that it is always cheaper to use a higher level rest facility than to add a flightcrew member. As discussed in the previous section, Class 1 rest facilities will be installed in locations so that there is no impact on passenger revenue. Existing business and first class seats meet the criteria to serve as Class 2 and Class 3 rest facilities. Currently, most carriers assign flightcrew members to rest in coach seats during augmented operations. The proposed rule will result in the loss of passenger revenue because carriers will need to assign flightcrew members to rest in Class 2 or 3 rest facilities (i.e. business/first class seats) rather than cheaper coach seats. The loss of passenger revenue is thus equal to the fare difference between business/first class seats and coach seats.

FAA analyzed one year of actual flights to determine the categories and total number of aircraft and flights affected. We multiply the estimated number of affected flights by the revenue lost when Class 2 or Class 3 rest facilities are used. The weighted average additional incremental loss for a Class 2 rest facility[26] is $2,034 and the weighted average cost for a Class 3 rest facility[27] is $5,084. We multiply the estimated number of annual flights by the appropriate estimated cost of the revenue lost. The total cost would be $17.7 million.

Table 38 shows the estimated annual operations for the most cost effective solutions based upon the proposed constraints, equipment, and number of pilots. The FAA has analyzed the duty matrix and evaluated it in terms of the additional costs per pilot[28] versus the costs of additional facilities and estimates that in the long run it would always be less costly to provide rest facilities rather than to add a pilot.[29] Our analysis assumes that there are always three pilots available per flight and that carriers attempt to minimize the potential flightcrew costs. For the flights that are 15.5 hours or more, a

[26] Weighted average price difference between coach and business class
[27] Weighted average price difference between coach and estimated first class
[28] To estimate the hourly pilot cost of $625, we divide the approximate annual burdened pilot cost of $300,000 by the estimated hours flown per year of 480 (40 hours per month times 12 months per year).
[29] Once the flight time exceeds 14 hours, additional crew would be required.

Class 1 rest facility would be required, which would not result in any passenger revenue loss.

Table 38: Estimated Annual Operations for the Most Cost Effective Solutions

Duty Period Start Time	Class 2 Rest Facility			Duty Time			Total
	Annual Operations	Passenger Revenue Loss per Operation	Nominal Annual Cost	Annual Operations	Passenger Revenue Loss per Operation	Nominal Annual Cost	Nominal Annual Cost
0000-0559	157	$5,084	**$797,082**	144	$2,034	**$293,453**	**$1,090,535**
0600-0659	0	$5,084	**$0**	0	$2,034	**$0**	**$0**
0700-1259	835	$5,084	**$4,247,137**	760	$2,034	**$1,544,990**	**$5,792,127**
1300-1659	947	$5,084	**$4,814,215**	1,259	$2,034	**$2,560,179**	**$7,374,394**
1700-2359	550	$5,084	**$2,795,734**	309	$2,034	**$628,148**	**$3,423,882**
Total	**2,489**	**$5,084**	**$12,654,167**	**2,472**	**$2,034**	**$5,026,770**	**$17,680,937**

Rest Facilities – Summary

The installation and upgrade of aircraft rest facilities and the lost passenger revenue resulting from the use of the rest facilities results in a ten-year nominal cost of $226.6 million ($149.1 million present value.) Table 39 presents the annual nominal and present value costs of the rest facility component of the proposed rule.

Table 39: Rest Facilities Cost Summary

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$ 67.5	$ 55.1
2014	$ 17.7	$ 13.5
2015	$ 17.7	$ 12.6
2016	$ 17.7	$ 11.8
2017	$ 17.7	$ 11.0
2018	$ 17.7	$ 10.3
2019	$ 17.7	$ 9.6
2020	$ 17.7	$ 9.0
2021	$ 17.7	$ 8.4
2022	$ 17.7	$ 7.9
Total	**$ 226.6**	**$ 149.1**

Summary of Benefits and Costs

Following NTSB recommendations regarding pilot fatigue, labor and industry worked together to provide the basis of this rulemaking. Furthermore, Congress has directed the FAA to issue a rule addressing pilot fatigue. We have validated the need for this rule in the benefit discussion. Based on the expected effectiveness of this proposed rule at preventing fatigue accidents with an averted fatality valued at $6 million, the simulation methodology produced benefits of $659.4 million with $463.8 million in present value. The total estimated costs of the proposed rule over 10 years are $1.25 billion ($804 million at present value). There is over a 7 percent probability that undiscounted cost of avertable passenger airplane accidents would exceed $1.25 billion and over a 10 percent probability the present value of the cost of avertable passenger airplane accidents would exceed $796 million. The benefits from a near term catastrophic accident in a 150-passenger airplane with average load factor exceeds the cost of this rule. If the value of an averted fatality were increased to $12.6 million, the present value of the benefits would equal the present value of compliance costs.

In addition, the FAA has identified two additional areas of unquantified benefits: preventing minor aircraft damage on the ground, and the value of well rested pilots as accident preventors and mitigators. Due to data limitations, the FAA was unable to estimate the cumulative effect of preventing minor aircraft damage on the ground, but if the rule were to reduce damage by about $600 million over 10 years ($340 million present value) it would break even in terms of net benefits. These considerations lend weight towards moving ahead with this proposal. FAA invites comment on this issue.

Appendix A

Pilot Deviations and Accidents by Duty Hours

a. Pilot Deviations

Between 1987 and the present, there were 686 records of pilot deviations in part 121 operations that contain information on pilot duty time in the 24 hours preceding the deviation (cases where equipment failure was listed for the deviation were excluded from the data set). Table A-1 and Figure A-1 below show the frequency of pilot deviations in relation to duty time.

As part of the analysis for this rulemaking, the FAA obtained data on pilot work patterns from ten carriers covering one month of flight activity during 1999.[30] These data were used to create profiles of the work patterns of the pilot population. Data for nine carriers were provided by pilot labor unions. The FAA also obtained data on actual pilot use from one major part 121 air carrier that was added to data from the other carriers.[31]

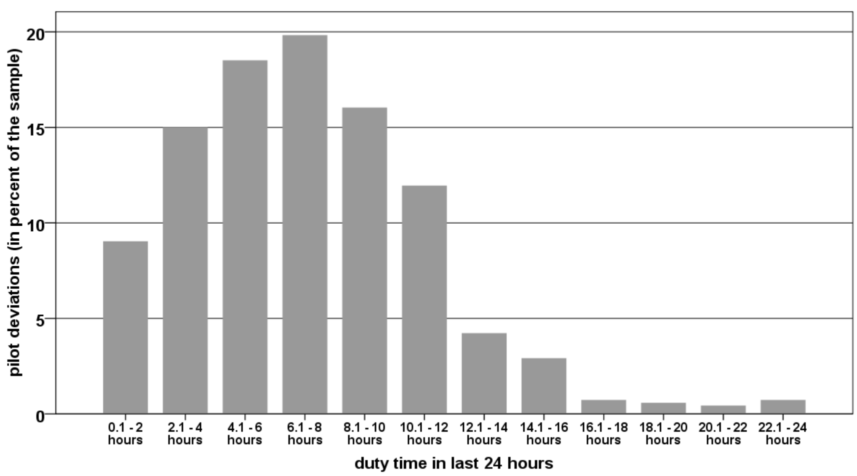
[30] *Ibid.*

[31] FAA has also received more recent data on pilot work patterns from six carriers, covering two months of actual flight activity during 2009 for each carrier. These data on flight crew exposure to risk are currently being characterized and analyzed by FAA, and these data have not yet been organized around the "for each duty hour, how many duty hours have occurred in the prior 24 hours?" parameter. For this reason, the comparisons to occurrences of pilot deviations and accidents are made to the 1999 pilot work activity data.

Table A-1. Distribution of Pilot Deviations by Duty Hours

Duty Time in the Last 24 hours	Pilot Deviations	Percent	Cumulative Percent
0 – 2 hours	62	9.0	9.0
2 – 4 hours	103	15.0	24.0
4 – 6 hours	127	18.5	42.5
6 – 8 hours	136	19.8	62.3
8 – 10 hours	110	16.0	78.3
10 – 12 hours	82	12.0	90.3
13 – 14 hours	29	4.2	94.5
15 – 16 hours	20	2.9	97.4
16 + hours	17	2.5	99.9
Total	***686***	***99.9***	

Figure A-1. Distribution of Pilot Deviations by Duty Hours



The data was converted into one record for each pilot with a scheduled (or for one carrier, an actual) line of flying for the month. Each pilot record tracked a pilot's activity for every hour in the entire month. The beginning and end of each trip segment were recorded for each pilot and put into a database. Parameters of interest were then calculated such as the length of duty periods, flight time and duty time per day or in the last 24 hours, rest time, and the numbers of takeoffs and landings. The analysis tracked these activities in local time as well as base time (defined as the time at the location where the pilot began a multi-day trip).

Although some carriers provided data for both captains and first officers, other carriers provided data for captains only. The study used data only for captains in the accident analysis to prevent weighing one carrier's responses more heavily than another in measuring exposure. The FAA found there were differences between the two sets of data in some work schedule parameters examined.

Table A-2. Distribution of Pilot Duty Time in Prior 24 Hours and Pilot Deviations

Hours	Captain's Hours	Duty Time Percentage	Pilot Deviations	Deviations Percentage
0 to 2	284,128	23%	316	9%
2 to 4	279,531	22%	427	12%
4 to 6	261,051	21%	597	17%
6 to 8	212,764	17%	686	20%
8 to 10	138,749	11%	644	19%
10 to 12	64,147	5%	476	14%
12 to 14	14,798	1%	218	6%
14 or more	1,176	<1%	106	3%
Total	1,256,344		3,470	

Figure A-2. Pilot Prior Duty Time

Exposure v Pilot Deviations

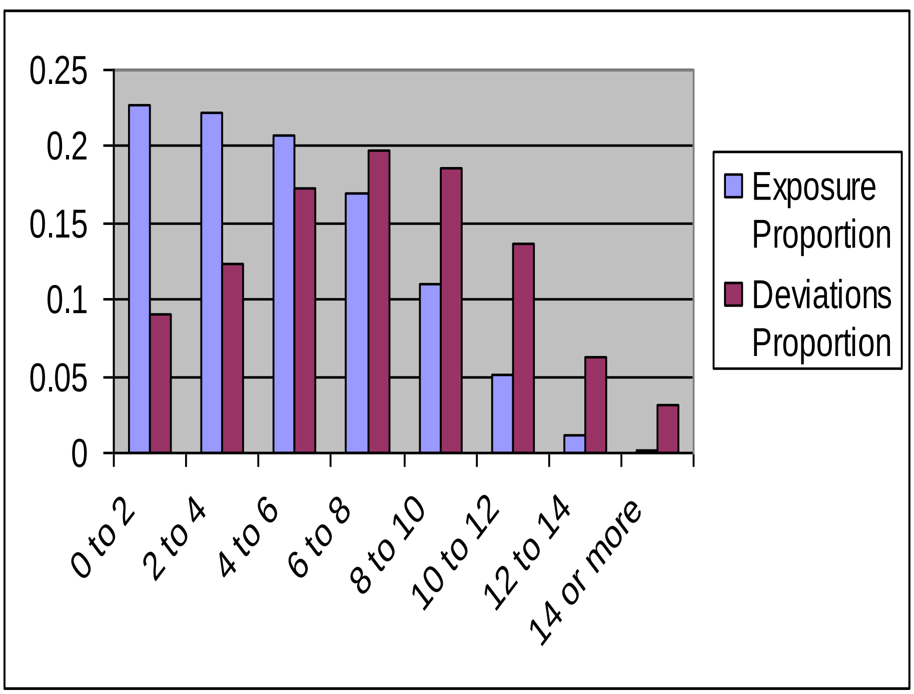
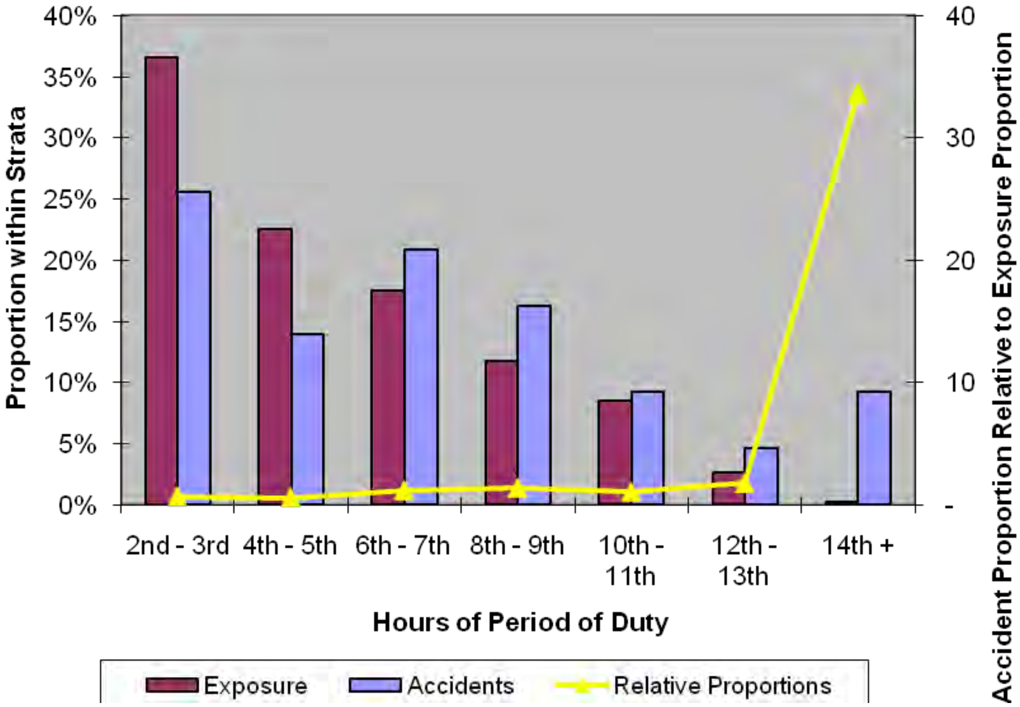
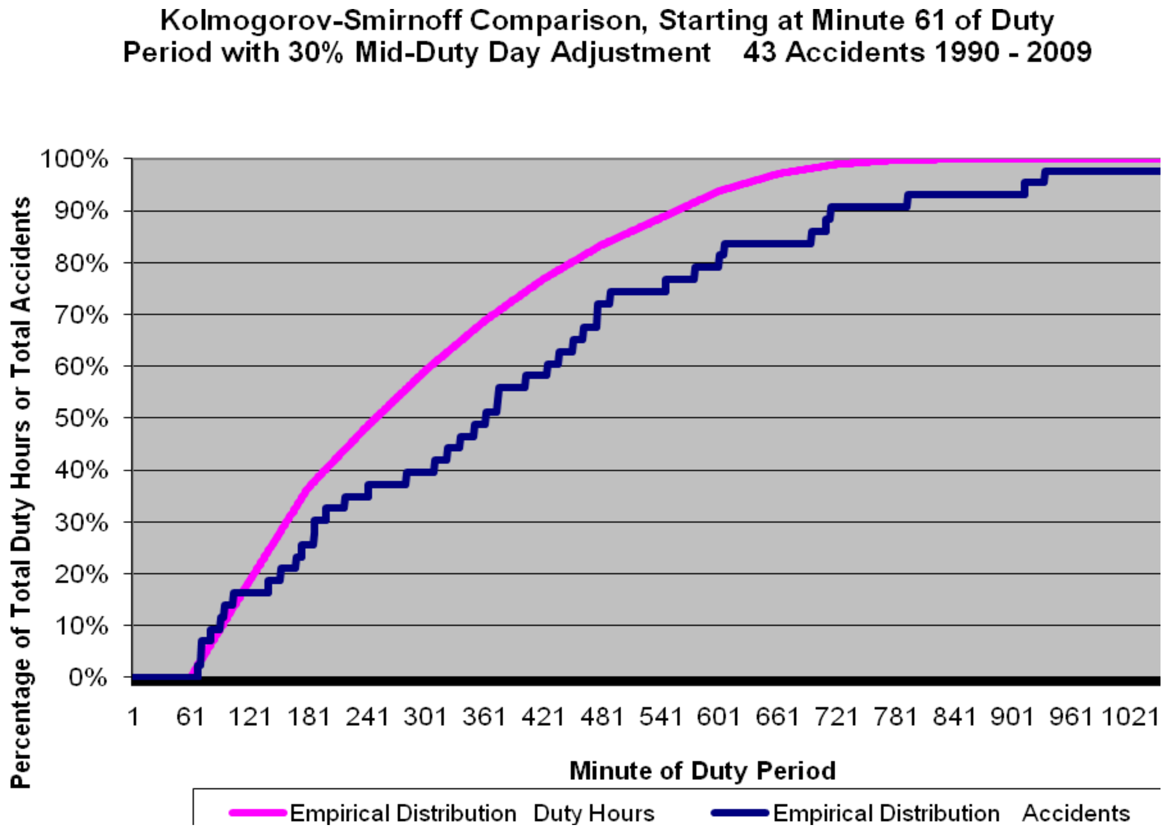


Table A-2 and Figure A-2 suggest that pilot deviations are less likely to occur when a pilot has less than 6 hours of duty time during the past 24 hours than if the pilot has more than 6 hours of duty time during the past 24 hours. Moreover, pilot deviations after 6 hours of duty time are much higher than one would expect given exposure. This finding is consistent with the above fatigue science findings.

Captains' Duty Hours and Accidents by Length of Duty Period with 1990-2009 Accident Data





Appendix B

Statistical Tests of Relationship between Length of Duty Time and Accidents

The Flight Crewmember Duty and Rest Requirements NPRM accident analysis for the United States air transportation industry is based on statistical comparison of domestic flight crew duty data from six operators, based on their flight crews' actual activity during a spring and summer month of 2009. Two statistical testing methods were used to examine the distribution of pilot duty hours and the distribution of duty hour features of accident histories. The statistical comparisons were made for the hour within a pilot duty period that a accident occurs.[32] If the

[32] To illustrate, suppose the total available pilot duty data are comprised of two pilots, one of whom serves a duty period that is seven hours in length, and the second of whom serves a duty period of nine hours in length. In this case, the data set characterizing pilot duty by hour in duty period contains two hours of duty in the first hour of the duty period, two hours of duty in the second hour of the duty period, and so forth, culminating in two hours of duty in the seventh hour of the duty period, one hour of duty in the eight hour of the duty period, and one hour of duty in the ninth hour of the duty period. If, to continue the example, one of the pilots experiences an occurrence of interest in the seventh hour of her duty period, then the data set for "occurrences of interest" would contain one instance, taking place in the seventh hour of the duty period.

likelihood of a human factors accident occurring is the same for all hours within a duty period, then the distribution of accident occurrence by the hour within a duty period should not be significantly different from the distribution of pilot duty hours by hour within the duty period, and the relative frequency of the occurrence of such accidents would be expected to resemble the relative frequency of hours within pilot duty periods. The purpose of the statistical tests is to compare these two distributions and assess their similarity to or dissimilarity from one another using accepted statistical tools.

There are 43 accidents in the data set. They include accidents involving FAR part 121 operators that resulted in significant aircraft damage, serious injury to passengers or worse outcomes, and occurred between 1990 and 2009. They are accidents for which mechanical failures were not causal and in which human factors issues involving the flight crews were pertinent. NTSB investigations and reports on some of these accidents cited "fatigue" or pilot rest and duty issues as relevant to the accident**.** The purpose of the statistical analysis is to examine the relationship if any between human factor accidents and duty patterns, the accident data set also includes human factors accidents for which no citation of "fatigue" or similar factors was made.

Duty period characteristics from the accident pilot histories are then categorized in a comparable way, with a count of all accidents in the data set that occurred in the first or second hour of the pilot's duty period, the third or fourth hour of the pilots duty period, and so forth. This initial data set for 2009 pilot work patterns and accident incidence is reported in Table B-1.

Table B-1. Pilot Duty and Accident Incidence **by Hour in Duty Period**

Hour Block	Exposure Duty Hrs	Percentage of Duty Hrs	Accidents	Percentage of Accidents
0 to 1	195,691	13.34%	0	0.00%
1 to 2	192,786	13.14%	7	16.28%
2 to 3	187,372	12.77%	4	9.30%
3 to 4	175,247	11.95%	4	9.30%
4 to 5	160,567	10.95%	2	4.65%
5 to 6	141,538	9.65%	4	9.30%
6 to 7	119,601	8.15%	5	11.63%
7 to 8	98,501	6.71%	6	13.96%
8 to 9	76,547	5.22%	1	2.33%
9 to 10	54,501	3.72%	2	4.65%
10 to 11	34,533	2.35%	1	2.33%
11 to 12	19,078	1.30%	1	2.33%
12 to 13	8,143	0.56%	1	2.33%
13 to 14	1,867	0.13%	2	4.65%
14 to 15	631	0.04%	0	0.00%
15 to 16	238	0.02%	2	4.65%
16 to 17	93	0.01%	0	0.00%
17 to 18	41	0.00%	1	2.33%
Total	1,466,975		43	

While hour by hour duty period characteristics represent a sensible approach to identifying pilot exposure to human factors accident risk, some adjustment to these data is necessary for a valid comparison, since in some cases specific duty hours (or percentages of duty hours) can be shown to be unrelated to the possibility of aviation accident or mishap. For this analysis, two specific adjustments are considered.

First, it is nearly always the case that the first hour of a pilot's duty day involves check-in and information gathering that takes place on the ground, prior to the first take off of the day. Naturally enough, every duty period has a first hour, and as can be seen in Table 1 above, the first hour makes up a significant percentage of total pilot duty hours, even though no flight activity occurs during it. For this reason, in the following statistical tests the first hour of pilot duty periods is omitted from consideration.

Second, once pilots have completed their first flight segment of the day (which lasts varying amounts of time depending on flight distance, itinerary, etc.), during any given hour of pilot duty periods, some percentage of pilots are on the ground between flight segments and involved in post-flight or pre-flight activities. Average flight segment lengths vary by airline and by airline business model, so it is not possible to develop specific modeling approaches to this issue.

In the pilot exposure data made available by airlines for this analysis, out of 1,271,284 total duty hours served (a total which excludes duty hours that are the pilot's first duty hour of the day), there are 985,566 flight hours. This suggests that about 77 per cent of duty hours actually involve accident risks stemming from flight activity, and that some adjustment to the distribution of duty hours counted over the duty period would be appropriate for accurately reflecting exposure to human factors accident risk. Since duty hours begin to fall off significantly after the eighth hour of duty, as shown in Table B-1 above, and since once the final hours of a duty period are reached it is more likely that the pilot is in flight and performing his or her final segment of the duty day, this adjustment in the exposure data is accomplished by reducing the duty hours reported between the third and eighth duty hours of the duty period by 30 percent. The effect of this adjustment to exposure risk is illustrated in Table B-2, which updates the "raw" exposure data from Table B-1.

Table B-2. "Risk Adjusted" Pilot Duty and Accident Incidence by Hour in Duty Period

Hour Block	Exposure Duty Hrs	Percentage of Duty Hrs	Accidents	Percentage of Accidents
0 to 1	***n/a***			
1 to 2	192,786	13.14%	7	16.28%

2 to 3	187,372	12.77%	4	9.30%
3 to 4	***122,673***	8.36%	4	9.30%
4 to 5	***112,673***	7.66%	2	4.65%
5 to 6	***99,077***	6.75%	4	9.30%
6 to 7	***83,721***	5.71%	5	11.63%
7 to 8	***68,951***	4.70%	6	13.96%
8 to 9	***53,583***	3.65%	1	2.33%
9 to 10	54,501	3.72%	3	6.98%
10 to 11	34,533	2.35%	1	2.33%
11 to 12	19,078	1.30%	1	2.33%
12 to 13	8,143	0.56%	1	2.33%
13 to 14	1,867	0.13%	1	2.33%
14 to 15	631	0.04%	0	0.00%
15 to 16	238	0.02%	2	4.65%
16 to 17	93	0.01%	0	0.00%
17 to 18	41	0.00%	1	2.33%
Total	1,039,684		43	

The Pearson's Chi Squared "goodness of fit" test[33] is a frequent approach to testing whether these two distributions – expressed as histograms reporting the percentage of each variable within each two hour time bucket – have a statistically significant difference. If there is no statistically significant difference between the two distributions, there is limited evidence to

[33] A description of the Chi Square goodness of fit test can be found in any introductory statistics text. A comprehensive discussion of the test, with references, can be found online at http://en.wikipedia.org/wiki/Pearson's_chi-square_test

support a claim that accident likelihood changes with changes in duty hour. An interpretation of this outcome is that the risk of accident does not vary with duty time. Thus, for the statistical test, the null hypothesis is that there is not a statistically significant difference between the two distributions.

To conduct the Chi Squared test, pilot duty hours from the exposure data set (disregarding the first hour of each pilot duty period) are divided into distinct categories of two hours in length: duty hours that occurred in the second or third hour of a duty period**,** duty hours that occurred in the fourth or fifth hour of a duty period, and so forth, with the final bucket made up of duty hours that occurred in the 14th or greater hour of a duty period.

The test statistic is taken from a Chi Squared distribution with n-1 degrees of freedom, where n is the number of histograms used in the comparison of exposure and accident data. In this case there are seven degrees of freedom for the text. Table 3 reports these test results and the critical values for the Chi Squared test at the 5% and 10% significance levels. The calculated Chi Squared test value of 131.5 exceeds these critical values, indicating that the distribution of exposure hours and the distribution of accident incidence within duty periods are not the same, although it is important to recognize that this outcome is driven largely by the comparison between exposure hours in the 14th and greater hours of pilot duty periods and the frequency of accidents occurring during those later hours of pilot duty periods.

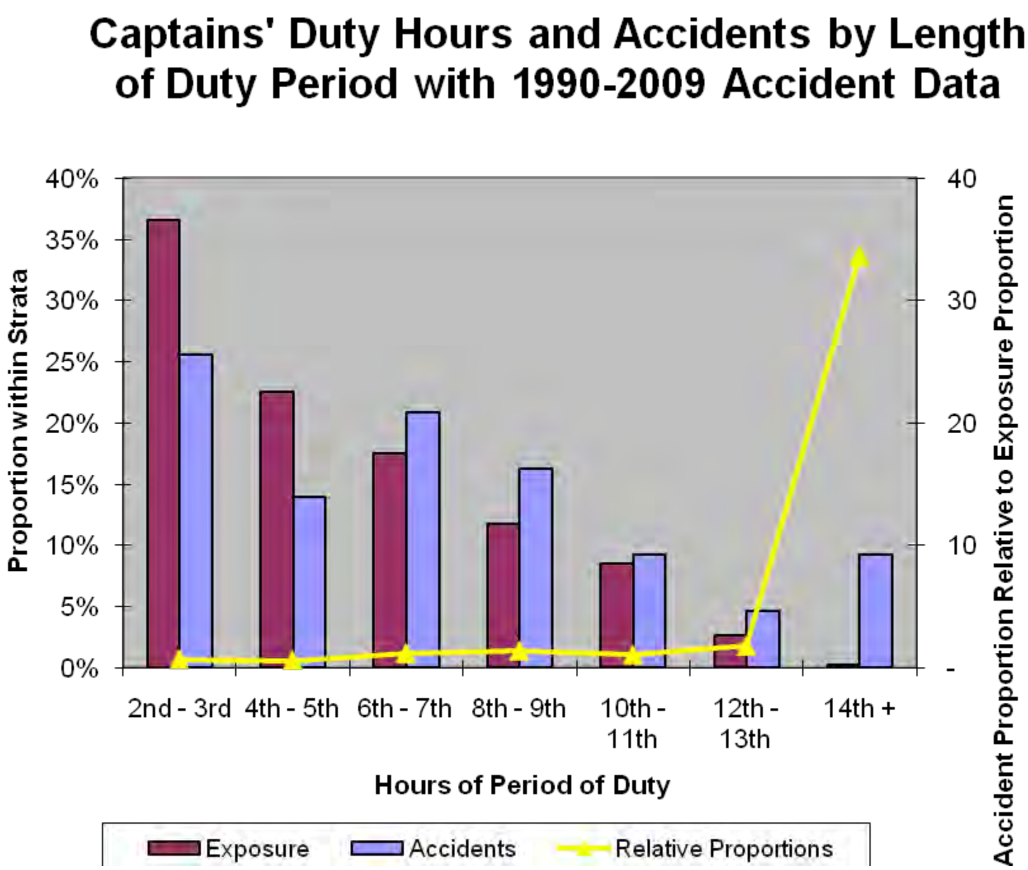
Table B-3. Chi Squared Results for Comparing Time in Duty Period Exposure and Accident Characteristics

Hour in Duty Period	Pilot's Hours	Exposure Proportion	Accidents	Accident Proportion	Relative Proportion
2nd & 3rd	380,158	0.37	11	0.26	0.70
4th & 5th	235,070	0.23	7	0.16	0.72
6th & 7th	182,797	0.18	9	0.21	1.19
8th & 9th	122,534	0.12	7	0.14	1.18
10th & 11th	89,034	0.09	4	0.09	1.09
12th & 13th	27,221	0.03	2	0.05	1.78
14th +	2,870	0.00	4	0.09	36.70
Total	***1,039,684***		***43***		

	Calculated Chi²:	***131.5***		***10% Chi²:***	***10.6***
	Degrees of Freedom:	***6***		***5% Chi²:***	***12.6***

The data underlying the Chi Squared comparison is shown graphically in Figure B-1. below.

Figure B-1. Pilot Duty Hours and Accidents by Hour in Duty Period – Accidents 1990 to 2009



A second statistical test was also used to assess the significance, if any, of differences between the distribution of pilot duty hours observed in the 2009 exposure data and the distribution of the set of human factors accidents by the time at which the accidents occurred in the pilot's duty period. This test, which is also used to examine the similarity of distributions, is the two sample Kolmogorov-Smirnov test (henceforth, K-S test), which is used to test whether two samples can be regarded as samples from a single distribution.[34]

The K-S test is performed by expressing the exposure data and accident data as two separate cumulative distribution functions, each running from 0 to 100 per cent. To make this comparison, some adjustment of the data sets being compared is made.

Because data on accident time (that is, time within a duty period) exists at the hour and minute level, the exposure data is converted from hourly to "by minute" data by dividing the percentage share of duty hours within an hour block by 60. Consider a simple example where duty periods last 1 or 2 hours, and of 100 total duty hours, 60 are in the first hour block (from 0 to 1 hours) and 40 are in the second hour block (from 1 to 2 hours). In this case, 60 percent of duty hours are within the first hour block, and 40 percent are within the second hour block. To convert this exposure profile from an hour basis to a minute basis, these percentages are divided by 60 (minutes per hour). Thus, each minute within the first hour block represents one percent of the total minutes contained by the 100 duty hours, and each minute within the second hour block represents 0.667 percent contained by the 100 total duty hours.

Table B-4 presents the "risk adjusted" distribution of duty hours that is shown in TableB-2 above along with the "percentage of duty minutes within each duty hour" calculation described above. In the 2009 exposure dataset for duty hours, about 13.1 percent of observed duty hours occur in someone's second hour within a duty period (when first flights of the day commence and exposure to risk begins, as discussed above), and if this percentage share is subdivided into minutes, each of the 60 minutes with this second duty hour represents about 0.219% of all duty minutes over the 17 hour span between the second hour and the 18$^{th.}$ The reported exposure data also includes the reduction by 30 per cent of duty hours between the third and ninth hours in duty periods, to reflect the fact that during the middle portions of the duty day, some percentage of pilots are on the ground between flights. They are actively engaged in their duties during these times, but they are not at risk of an in flight accident.

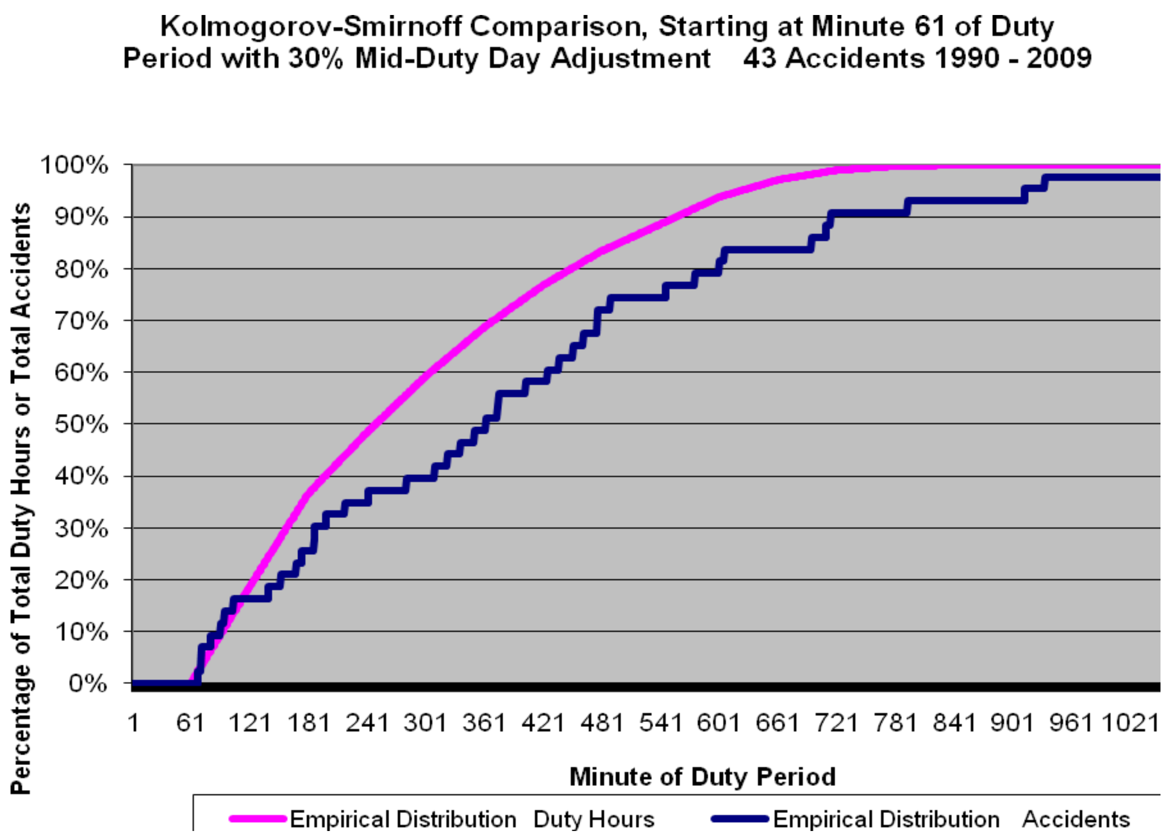
[34] A description of the Kolmogorov-Smirnov test can be found in more advanced statistics texts. A comprehensive discussion of the test, with references, can be found online at http://en.wikipedia.org/wiki/Kolmogorov-Smirnov_test

Table B-4. Percentage Distribution of Duty Hours and Minutes, Domestic Pilot "Hour in Duty Period" Exposure Set

Hour Block	Exposure Duty Hrs	Percentage of Duty Hrs	Percentage per Duty Min	Accidents	Percentage of Accidents
0 to 1	n/a				
1 to 2	192,786	13.14%	0.2190%	7	16.28%
2 to 3	187,372	12.77%	0.2129%	4	9.30%
3 to 4	122,673	8.36%	0.1394%	4	9.30%
4 to 5	112,397	7.66%	0.1277%	2	4.65%
5 to 6	99,077	6.75%	0.1126%	4	9.30%
6 to 7	83,721	5.71%	0.0951%	5	11.63%
7 to 8	68,951	4.70%	0.0783%	6	13.96%
8 to 9	53,583	3.65%	0.0609%	1	2.33%
9 to 10	54,501	3.72%	0.0619%	3	6.98%
10 to 11	34,533	2.35%	0.0392%	1	2.33%
11 to 12	19,078	1.30%	0.0217%	1	2.33%
12 to 13	8,143	0.56%	0.0093%	1	2.33%
13 to 14	1,867	0.13%	0.0021%	1	2.33%
14 to 15	631	0.04%	0.0007%	0	0.00%
15 to 16	238	0.02%	0.0003%	2	4.65%
16 to 17	93	0.01%	0.0001%	0	0.00%
17 to 18	41	0.00%	0.0000%	1	2.33%
Total	1,039,684			43	

Also shown in Table B-4 are 43 accidents, which took place between 1990 and 2009, for which adequate data exists for identifying when within a duty period the accident occurred. Thus, each accident represents 1/43, or 2.33 percent, of the total data set of accidents. These accidents occurred at duty times up to 17 and a half hours, so the comparison constructed for the K-S test procedure looks at exposure data periods up to 18 hours in length, although there are relatively very few of these extremely long duty periods in the exposure data. A graphical comparison of the cumulative duty minute distribution and the cumulative distribution of accidents by duty minute is shown in Figure B-2.

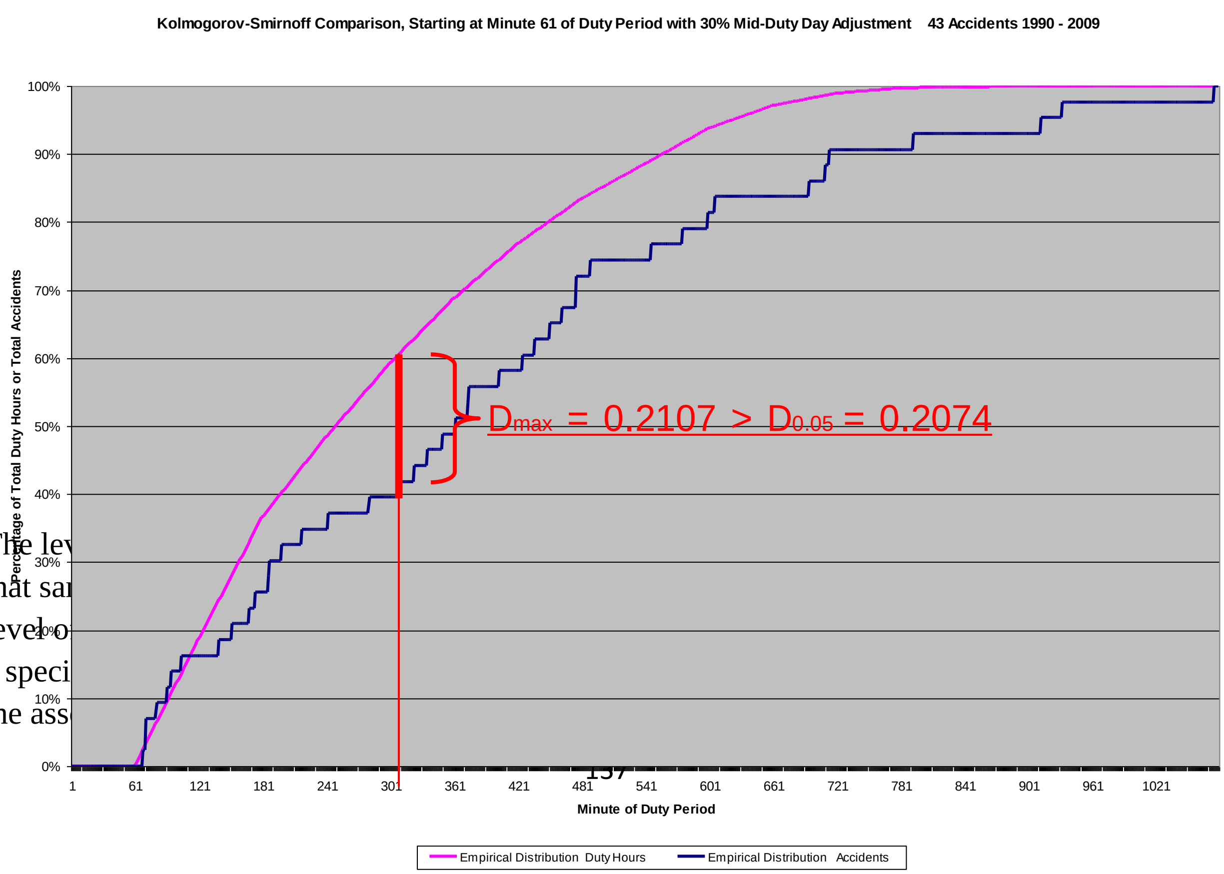
Figure B-2. Comparison of Exposure and Accident Cumulative Percentage Profiles



As shown in the figure, the two cumulative curves for exposure and accident duty times each rise to 100 percent, but do so along different paths or trajectories. The purpose of the K-S test (like that of the Chi Squared test) is to test whether the two curves can be regarded as representing samples from distinct probability distributions. In these tests, the statistical "null hypothesis" is that the two distributions of events (duty hours served as a measure of exposure to risk, and accidents by the hour within the duty period at which the accident occurred) are the same. If the statistical test (Chi Squared or K-S) results in the rejection of this null hypothesis at some level of significance, then with that level of confidence it can be asserted that exposure to risk is not summed up by relative numbers of hours within specific hours within the duty period, and that other factors, such as whether the duty hour at which an accident occurs is early or late in a duty period, also contribute to accident risk. If the two curves are distinct from one another at a statistically significant level, it could be concluded that a pilot's time within a duty period does influence the risk or likelihood of a human factors related accident occurring, and in this particular case, this risk increases with the duty time.

The testing procedure for the K-S test of significant difference between two curves involves measuring the distance between the curves at each point. The test statistic is the maximum of those distances, taken over the whole domain over which the two curves reach their terminal value of 100 percent. In the present example, the maximum value is 0.2107, which occurs at minute 309, where the cumulative percentage for the exposure data reaches 60.6 per cent and the cumulative percentage for the accident data reaches 39.5 per cent. (The point or minute at which the maximum distance between these cumulative percentage curves occurs is not relevant to the test result.) This distance is shown in Figure B-3.

Figure B-3. Test Statistic for Comparison of Exposure Duty Hour Curve and Accident Curve



The lev
that sa
level o
a speci
the ass

137

Table B-3. Critical Values for K-S Testing (Sample Size of 43)

Level of Significance	K-S Test Factor	1/root(43)	K-S Test Critical Value	Test Statistic
0.20	1.07	0.152	0.1632	
0.15	1.14	0.152	0.1738	
0.10	1.22	0.152	0.1860	
0.05	1.36	0.152	0.2074	**0.2107**
0.01	1.63	0.152	0.2486	

Comparison of these critical values with the test statistic at the 0.05 significance level of 0.2074 indicates that at that level of significance, the difference between the cumulative curve of exposure times within duty periods and the cumulative curve of times within duty periods at which accidents occurred can be regarded as statistically significant. This can be interpreted as indicating that the frequency with which accidents from the recent past happened within specific hours within a duty period is not related simply to the proportion of duty hours that pilots serve within specific hours of their duty period, and that the risk of an accident is not uniform across all hours within duty periods. That is, with this level of significance, the hour of the duty period matters for accident risk.

Appendix C

Pilot Deviations by Time of Day

One way to study pilot deviations is examine how they vary throughout the day. Deviations represent multiple types of violations, ranging from serious runway incursions interfering with landings and takeoffs to simple airspace transgressions. Given their potential severity, they are recorded system-wide because they are all assumed to represent precursors to potential accidents. Each violation record contains multiple fields addressing the aircraft, the environment and the pilot involved in the incident. These incidents number in the thousands. These records provide a needed large sample to address the fatigue issue. In particular, pilot deviations carry several data fields considered related to pilot fatigue. They are: (a) duty time in the last 24 hours before the violation, (b) flight time in the past 24 hours before the violation, (c) leg time before the violation, (d) time of day, and (e) season of the year.

Pilot deviations are actions of the pilot which violate the Code of Federal Regulations (CFR), previously called Federal Aviation Regulation (FAR). Pilot deviations also take place when the North American Aerospace Defense Command (NORAD), Air Defense Identification Zone (ADIZ) tolerance is neglected. Starting with 1987, pilot deviations have been documented by air traffic and flight standards on FAA Form 8020-17, Preliminary Pilot Deviation Report, and FAA Form 8020-18, Investigation of Pilot Deviation Report. The results are then coded into the Pilot Deviation System (PDS) database. The FAA uses the PDS database to monitor the number of events, type of events (e.g., air deviations, surface deviations, or airspace violation) and the factors related to the events. The FAA issues one report for each pilot deviation regardless of the number of aircraft involved. The information in the database reflects a mix of preliminary and final reports. Pilot deviations require 90 days to stabilize due to reporting procedures, volume, and workload.

A large sample from the database ranging from 1987 to present was secured and analyzed in multiple ways. To focus strictly on fatigue as the key issue, records with the following conditions were removed from the analysis:

(a) improbable values, blanks, “zero” in the field of interest,

(b) non- Part 121 operations, and

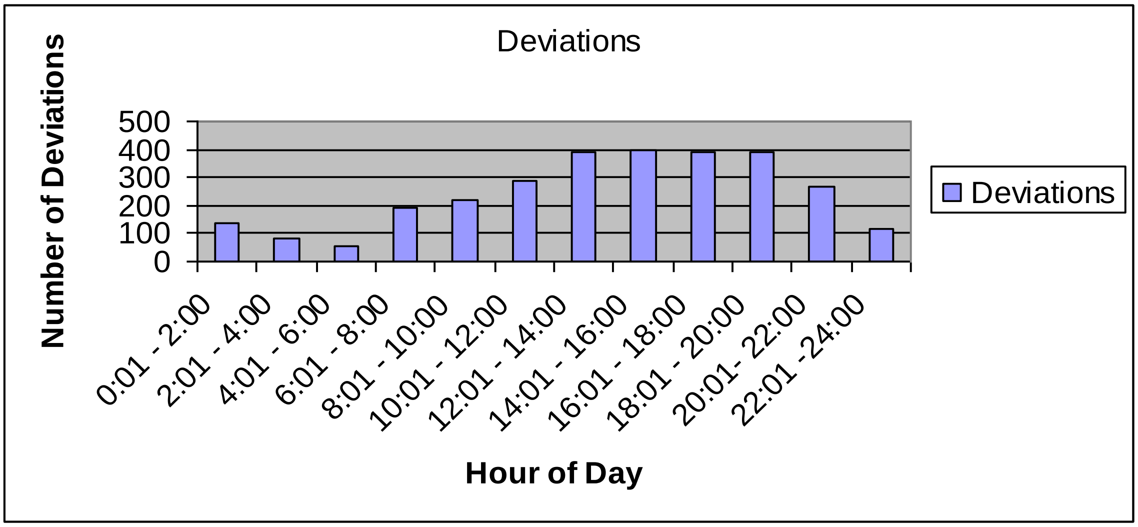
(c) deviations caused by adverse weather or equipment failure, two causes not truly being pilot-related.

As can be seen in table C-1 and figure C-1 pilot deviations are more likely to occur in the afternoon than any other time of day. Also, there are few pilot deviations between 12:00 midnight and 6:00 am.

Table C-1. Distribution of deviations by local hour of the day.

Local hour of the day when deviation occurred	Pilot deviations	Percent	Cumulative Percent
0:01 – 2:00	137	4.5	4.7
2:01 – 4:00	80	2.6	7.4
4:01 – 6:00	57	1.9	9.4
6:01 – 8:00	193	6.4	16.0
8:01 – 10:00	218	7.2	23.4
10:01 – 12:00	286	9.4	33.2
12:01 – 14:00	392	12.9	46.6
14:01 – 16:00	398	13.1	60.2
16:01 – 18:00	387	12.8	73.4
18:01 – 20:00	391	12.9	86.8
20:01 – 22:00	269	8.9	96.0
22:01 – 24:00	117	3.9	100.0
Total	***2,925***		

Figure C-1. Distribution of deviations by local hour of the day.



The distribution of pilot deviations can be compared to the distribution of aircraft activity to see if pilot deviations are more than would be expected for any portion of the day. In this analysis the count of takeoffs and landings by time of day were used as a measure of aircraft activity. The results are presented in table C-2 and figure C-2.

Table C-2 Pilot Deviations and Take Off and Landing Operations By Time of Day

Hours	Deviations	Percent	Operations	Percent
0:01 - 2:00	137	4.7	468,610	2
2:01 - 4:00	80	2.7	240,000	1
4:01 - 6:00	57	1.9	441,659	1.9
6:01 - 8:00	193	6.6	2,094,083	8.9
8:01 - 10:00	218	7.5	2,594,592	11
10:01 - 12:00	286	9.8	2,788,547	11.8
12:01 - 14:00	392	13.4	2,784,202	11.8
14:01 - 16:00	398	13.6	2,772,942	11.8
16:01 - 18:00	387	13.2	2,917,272	12.4
18:01 - 20:00	391	13.4	2,829,391	12
20:01- 22:00	269	9.2	2,265,871	9.6
22:01 -24:00	117	4	1,384,053	5.9
Total	***2,925***		***23,581,222***	

Figure C-2 Pilot Deviations and Take Off and Landing Operations By Time of Day

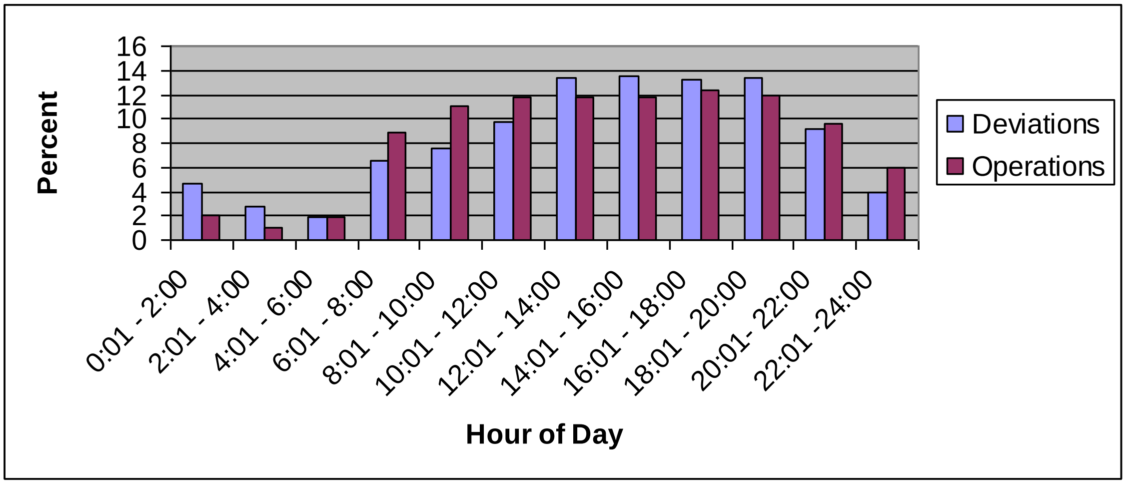


Table C-2 and Figure C-2 show that a higher percentage of deviations occur late at night (0:001 am to 4:00 am) than the percentage of takeoff and landing operations during those hours. The same can be said the afternoon and evening (12:01 pm to 10:00 pm). During the morning (4:01 am to 12:00 n) and late evening (10:01 pm to 12:00 m), the percentage of pilot deviations is lower then the percentage of operations during those times. That pilot deviations are high relative to aircraft activity between midnight and 4:00 am is not too surprising given that people least alert during that period of time when they are in their window of circadian low, but it is a bit of a surprise that deviations are relatively low between 10:00 pm and midnight when many people go to sleep. Most people are rested from a night's sleep and are most alert during the morning so deviation should be expected to be relatively low during that time. During the afternoon and evening, many people begin to become tired and less alert and deviations are expected to increase during that time.

Sometimes incidents have a more serious consequence than a deviation citation; sometimes the incident becomes an accident. The above findings for pilot deviation incidents also apply to accidents.

TAB 4

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Parts 117 and 121

[Docket No. FAA–2009–1093; Notice No. 10–11]

RIN 2120–AJ58

Flightcrew Member Duty and Rest Requirements

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The FAA is proposing to amend its existing flight, duty and rest regulations applicable to certificate holders and their flightcrew members. The proposal recognizes the growing similarities between the types of operations and the universality of factors that lead to fatigue in most individuals. Fatigue threatens aviation safety because it increases the risk of pilot error that could lead to an accident. The new requirements, if adopted, would eliminate the current distinctions between domestic, flag and supplemental operations. The proposal provides different requirements based on the time of day, whether an individual is acclimated to a new time zone, and the likelihood of being able to sleep under different circumstances.

DATES: Comments are due November 15, 2010.

FOR FURTHER INFORMATION CONTACT: For technical issues: Dale E. Roberts, Air Transportation Division (AFS–200), Flight Standards Service, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, DC 20591; telephone (202) 267–5749; *e-mail: dale.e.roberts@faa.gov.* For legal issues: Rebecca MacPherson, Office of the Chief Counsel, Regulations Division (AGC–200), 800 Independence Avenue, SW., Washington, DC 20591; telephone (202) 267–3073; *e-mail: rebecca.macpherson@faa.gov.*

SUPPLEMENTARY INFORMATION: Later in this preamble under the Additional Information section, we discuss how you can comment on this proposal and how we will handle your comments. Included in this discussion is related information about the docket, privacy, and the handling of proprietary or confidential business information. We also discuss how you can get a copy of this proposal and related rulemaking documents.

Authority for This Rulemaking

The FAA's authority to issue rules on aviation safety is found in Title 49 of the United States Code. This rulemaking is promulgated under the authority described in 49 U.S.C. 44701(a)(5), which requires the Administrator to promulgate regulations and minimum safety standards for other practices, methods, and procedures necessary for safety in air commerce and national security.

Table of Contents

I. Executive Summary

As discussed in greater detail throughout this document, this rulemaking proposes to establish one set of flight time limitations, duty period limits, and rest requirements for pilots in part 121 operations. The rulemaking aims to ensure that pilots have an opportunity to obtain sufficient rest to perform their duties, with an objective of improving aviation safety.

Current part 121 pilot duty and rest times differ by type of operation (domestic, flag, and supplemental). A general summary of current versus proposed flight time limits, duty time limits, and rest time requirements are included in the table below.

Scenario	Rest time		Duty time		Flight time	
	Minimum rest prior to duty—domestic	Minimum rest prior to duty—international	Maximum flight duty time—unaugmented	Maximum flight duty time—augmented	Maximum flight time—unaugmented	Maximum flight time—augmented
Current Part 121	Daily: 8–11 depending on flight time.	Minimum of 8 hours to twice the number of hours flown.	16	16–20 depending on crew size.	8	8–16 depending on crew size.
NPRM	9	9	9–13 depending on start time and number of flight segments.	12–18 depending on start time, crew size, and aircraft rest facility.	8–10 depending on FDP start time.	None.

A summary of the FAA estimates of the costs and benefits associated with the provisions in this rule can be found in the table below.

	Nominal costs (millions)	PV costs (millions)
Total Costs (over 10 years)	$1,254.1	$803.5
Benefits	Nominal benefits (millions)	PV benefits (millions)
$6.0 million VSL	659.40	463.80
$8.4 million VSL	837	589

The FAA began considering changing its existing flight, duty and rest regulations in June 1992, when it announced the tasking of the Aviation Rulemaking Advisory Committee (ARAC) Flightcrew Member Flight/Duty Rest Requirements working group.[1] The tasking followed the FAA's receipt of hundreds of letters about the interpretation of existing rest requirements and several petitions to amend existing regulations. While the working group could not reach consensus, it submitted a final report in June 1994 with proposals from several working group members. Following receipt of the ARAC's report, the FAA published a notice of proposed rulemaking in 1995 (1995 NPRM).[2] The FAA received over 2000 comments to the 1995 NPRM. Although some commenters, including the National Transportation Safety Board (NTSB), NASA, Air Line Pilots Association, and Allied Pilots Association, said the proposal would enhance safety, many industry associations opposed the 1995 NPRM, stating the FAA lacked safety data to justify the rulemaking, and industry compliance would impose significant costs. The FAA never finalized the 1995 rulemaking, and on November 23, 2009, the agency withdrew it because it was outdated and raised many significant issues that the agency needed to consider before proceeding with a final rule.[3]

On June 10, 2009, Federal Aviation Administration (FAA) Administrator J. Randolph Babbitt testified before the Senate Committee on Commerce, Science, and Transportation, Subcommittee on Aviation Operations, Safety, and Security on Aviation Safety regarding the FAA's role in the oversight of certificate holders. He addressed issues regarding flightcrew member[4] training and qualifications, flightcrew fatigue, and consistency of safety standards and compliance between air transportation certificate holders.[5] He also committed to assess the safety of the air transportation system and to take appropriate steps to improve it.

In June 2009, the FAA chartered the Flight and Duty Time Limitations and Rest Requirements Aviation Rulemaking Committee (ARC)[6] comprised of labor, industry, and FAA representatives to develop recommendations for an FAA rule based on current fatigue science and a thorough review of international approaches to the issue. The FAA chartered the ARC to provide a forum for the U.S. aviation community to discuss current approaches to mitigate fatigue found in international standards and make recommendations on how the United States should modify its regulations. The ARC consisted of 18 members representing airline and union associations. The members were selected based on their extensive certificate holder management, direct operational experience, or both.

Specifically, the FAA asked the ARC to consider and address the following:

- A single approach to addressing fatigue that consolidates and replaces existing regulatory requirements for parts 121 and 135.[7]
- Generally accepted principles of human physiology, performance, and alertness based on the body of fatigue science.
- Information on sources of aviation fatigue.
- Current approaches to address fatigue mitigation strategies in international standards.
- The incorporation of fatigue risk management systems (FRMS) into a rulemaking.

The ARC met over a 6-week period beginning July 7, 2009. Early on, the FAA told the ARC members it was very interested in the ARC's recommendations, but that the agency retained the authority and obligation to evaluate any proposals and independently determine how best to amend the existing regulations. The agency reiterated that participation on the ARC in no way precluded the ARC members from submitting comments critical of the NPRM when it was published. On September 9, 2009, the ARC delivered its final report to the FAA in the form of a draft NPRM.[8]

The ARC's goal was to reach as much agreement as possible on the prospective regulation. However, the members recognized early on that they would not be able to reach consensus on all issues. They were, however, generally successful in agreeing upon broad regulatory approaches and were able to reach consensus on two issues—how to address reserve[9] and the role of commuting in any proposed regulations.

The Cargo Airline Association (CAA) presented a separate proposal for FAA consideration to address the unique operations of its members.[10] According to the CAA, cargo operations are subject to different operational and competitive factors than scheduled passenger air carrier operations, including flight delays and schedule changes outside of the control of the certificate holder. The National Air Carrier Association (NACA) also submitted an alternate proposal to the ARC.[11] NACA proposed

[1] 57 FR 26685; June 15, 1992.

[2] Flightcrew Member Duty Period Limitations, Flight Time Limitations and Rest Requirements notice of proposed rulemaking (60 FR 65951; December 20, 1995).

[3] 74 FR 61067.

[4] A "flightcrew member" is defined in 14 CFR 1.1 as a pilot, flight engineer, or flight navigator assigned to duty in an aircraft during flight time.

[5] In this document, the terms "certificate holder" and "carrier" are used interchangeably. Technically, one could be a "certificate holder" under part 121 without also being an air carrier. Accordingly, the draft regulatory text only uses the term "certificate holder".

[6] *See http://www.faa.gov/about/office%5Forg/headquarters%5Foffices/avs/offices/afs/afs200/* for the ARC Charter.

[7] While tasked to consider part 135 operations, the ARC did not consider these operations, and this proposal does not address them either.

[8] A copy of the ARC recommendations can be found in the docket for this rulemaking.

[9] *See* proposed § 117.3 (Definitions) were the term "Reserve Flightcrew Member" is defined.

[10] This proposal may be found in attachment 1 to the ARC report.

[11] This proposal may be found in attachment 2 to the ARC report.

that the regulations contained in subpart S to part 121 continue to apply to certificate holders conducting unscheduled supplemental operations. In addition, it proposed to include a requirement that such operators develop and implement FRMS.

To assist the ARC with its goal of developing proposed rules to enhance flightcrew member alertness and employ fatigue mitigation strategies, the following experts in sleep, fatigue, and human performance research presented a brief overview of the existing science and studies on sleep and fatigue to the ARC:

- Dr. Gregory Belenky, M.D., Sleep and Performance Research Center, Washington State University and Dr. Steven R. Hursh, Ph.D., President, Institutes for Behavior Resources, Professor, Johns Hopkins University School of Medicine presented information on sleep, fatigue, and human performance.
- Dr. Thomas Nesthus, Ph.D., FAA Civil Aeromedical Institute (CAMI) presented an overview of the current FAA fatigue studies.
- Dr. Peter Demitry, M.D., 4d Enterprises, addressed questions from the ARC but did not make a presentation.

The ARC members considered the information presented by the scientists as well as other available scientific information and used their substantial operational experience knowledge base to develop the ARC proposals.

Following their presentations, the scientific experts encouraged the ARC to consider the entire body of scientific studies in developing any proposed limitations and requirements, rather than any one scientific study.[12]

On August 1, 2010, the President signed the Airline Safety and Federal Aviation Administration Extension Act of 2010, Public Law 111–216 (the Act). In section 212 of the Act, Congress directed the FAA to issue regulations no later than August 1, 2011 to "specify limitations on the hours of flight and duty time allowed for pilots to address problems relating to pilot fatigue."

The Act directed the FAA to consider several factors that could impact pilot alertness including time of day, number of takeoffs and landings, crossing multiple time zones, and the effects of commuting. In addition, the agency was directed to review the available research on fatigue, sleep and rest requirements recommended by the NTSB and NASA, and applicable international standards. Finally, the agency was to explore alternate procedures to facilitate alertness in the cockpit, air carrier scheduling and attendance policies (including sick leave), and medical screening and treatment options.

The FAA has developed a proposal for addressing the risk of fatigue on the safety of flight based on an evaluation of the available literature, existing regulatory requirements in both the United States and other countries, and the broad personal, professional experience of the ARC members and FAA staff, as well as the recommendations of the NTSB and NASA. Today's proposal is consistent with the statutory mandate set forth in the Act and takes a new approach whereby the distinctions between domestic, flag, and supplemental operations are eliminated. Rather, all types of operations would take into account the effects of circadian rhythms, inadequate rest opportunities and cumulative fatigue.

The FAA believes its proposal sufficiently accommodates the vast majority of operations conducted today, while reducing the risk of pilot error from fatigue leading to accidents. In some areas, the FAA proposes to relax current requirements, while in others, it strengthens them to reflect the latest scientific information. The agency proposes to provide credit for fatigue-mitigating strategies, such as sleep facilities, that some certificate holders are currently providing with no regulatory incentive. The agency has also tentatively decided that certain operations conducted under the existing rules are exposing flightcrew members to undue risk.

Today's proposal sets forth a matrix that addresses transient fatigue (i.e., the immediate, short-term fatigue that can be addressed by a recuperative rest opportunity) by establishing a 9-hour minimum rest opportunity prior to commencing duty directly associated with the operation of aircraft (flight duty period, or FDP), placing restrictions on that type of duty, and further placing restrictions on flight time (that period of time when the aircraft is actually in motion—flight time is encompassed by FDP).

The proposal provides carriers with a level of flexibility not afforded today by permitting a limited extension of FDP and a limited reduction in the minimum rest opportunity in circumstances that are neither within the carrier's control nor reasonably foreseeable. In order to assure that carriers are adequately scheduling flightcrew member's work days, so as not to overuse the extension, carriers would be required to report on both their overall schedule integrity and specific crew-pairing schedule integrity on a bi-monthly basis. Should a carrier fail to meet the required levels of integrity, it would have to adjust its schedule to make it more reliable.

The proposal addresses cumulative fatigue by placing weekly and 28-day limits on the amount of time a flightcrew member may be assigned to any type of duty, including FDP. Further 28-day and annual limits are placed on flight time. Flightcrew members would be required to be given at least 30 consecutive hours free from duty on a weekly basis, a 25 percent increase over the current requirements.

In addition, today's proposal addresses the impact of changing time zones and flying through the night by reducing the amount of flight time and FDP available for these operations. More flight time and FDP would be available for certificate holders that add additional flightcrew members and provide adequate rest facilities to allow flightcrew members an opportunity to sleep aboard the aircraft. Credit would also be available to certificate holders that provide sufficient ground-based rest facilities.

All carriers would have to develop training programs to educate all employees responsible for developing air carrier schedules and safety of flight on the symptoms of fatigue, as well as the factors leading to fatigue and how to mitigate fatigue-based risk.

For those operations that cannot be conducted under the proposed prescriptive requirements, today's proposal also allows a carrier to develop a carrier-specific fatigue risk management system (FRMS). An FAA-approved FRMS would allow a certificate holder to customize its operations based on a scientifically-validated demonstration of fatigue-mitigating approaches and their impact on a flightcrew member's ability to safely fly an airplane beyond the confines of the proposed rule. Finally, today's proposal provides a limited exception for certain emergency operations or operations conducted under contract with the United States government that cannot otherwise be conducted under the prescriptive requirements proposed here. In order to assure there is no abuse, and that the exception is necessary, the proposal includes a reporting requirement.

II. Background

A. Statement of the Problem

Fatigue is characterized by a general lack of alertness and degradation in mental and physical performance. Fatigue manifests in the aviation context

[12] A bibliography of available studies has been placed in the docket for this rulemaking.

not only when pilots fall asleep in the cockpit while cruising, but perhaps more importantly, when they are insufficiently alert during take-off and landing. Reported fatigue-related events have included procedural errors, unstable approaches, lining up with the wrong runway, and landing without clearances.

There are three types of fatigue: transient, cumulative, and circadian. Transient fatigue is acute fatigue brought on by extreme sleep restriction or extended hours awake within 1 or 2 days. Cumulative fatigue is fatigue brought on by repeated mild sleep restriction or extended hours awake across a series of days. Circadian fatigue refers to the reduced performance during nighttime hours, particularly during an individual's window of circadian low (WOCL) (typically between 2 a.m. and 6 a.m.).

Common symptoms of fatigue include:

- Measurable reduction in speed and accuracy of performance,
- Lapses of attention and vigilance,
- Delayed reactions,
- Impaired logical reasoning and decision-making, including a reduced ability to assess risk or appreciate consequences of actions,
- Reduced situational awareness, and
- Low motivation to perform optional activities.

A variety of factors contribute to whether an individual experiences fatigue as well as the severity of that fatigue. The major factors affecting fatigue include:

- *Time of day.* Fatigue is, in part, a function of circadian rhythms. All other factors being equal, fatigue is most likely, and, when present, most severe, between the hours of 2 a.m. and 6 a.m.
- *Amount of recent sleep.* If a person has had significantly less than 8 hours of sleep in the past 24 hours, he or she is more likely to be fatigued.
- *Time awake.* A person who has been continually awake more than 17 hours since his or her last major sleep period is more likely to be fatigued.
- *Cumulative sleep debt.* For the average person, cumulative sleep debt is the difference between the amount of sleep a person has received over the past several days, and the amount of sleep they would have received if they got 8 hours of sleep a night. A person with a cumulative sleep debt of more than 8 hours since his or her last full night of sleep is more likely to be fatigued.
- *Time on task.* The longer a person has continuously been doing a job without a break, the more likely he or she is to be fatigued.
- *Individual variation.* Individuals respond to fatigue factors differently and may become fatigued at different times, and to different degrees of severity, under the same circumstances.

There is often interplay between various factors that contribute to fatigue. For example, the performance of a person working night and early morning shifts is impacted by the time of day. Additionally, because of the difficulty in getting normal sleep during other than nighttime hours, such a person is more likely to have a cumulative sleep debt or to not have obtained a full night's sleep within the past 24 hours.

Scientific research and experimentation have consistently demonstrated that adequate sleep sustains performance. For most people, 8 hours of sleep in each 24 hours sustains performance indefinitely. Sleep opportunities during the WOCL are preferable, although some research indicates that the total amount of sleep is more important than the timing of the sleep. Within limits, shortened periods of nighttime sleep may be nearly as beneficial as a consolidated sleep period when augmented by additional sleep periods, such as naps before evening departures, during flights with augmented flightcrews, and during layovers. Sleep should not be fragmented with interruptions. In addition, environmental conditions, such as temperature, noise, and turbulence, impact how beneficial sleep is and how performance is restored.

When a person has accumulated a sleep debt, recovery sleep is necessary to fully restore the person's "sleep reservoir." Recovery sleep should include at least one physiological night, that is, one sleep period during nighttime hours in the time zone in which the individual is acclimated. The average person requires in excess of 9 hours of sleep a night to recover from a sleep debt.[13]

Several aviation-specific work schedule factors [14] can affect sleep and subsequent alertness. These include early start times, extended work periods, insufficient time off between work periods, insufficient recovery time off between consecutive work periods, amount of work time within a shift or duty period, number of consecutive work periods, night work through one's window of circadian low, daytime sleep periods, and day-to-night or night-to-day transitions.

The FAA believes its current regulations do not adequately address the risk of fatigue. Presently, flightcrew members are effectively allowed to work up to 16 hours a day, with all of that time spent on tasks directly related to aircraft operations. The regulatory requirement for 9 hours of rest is regularly reduced, with flightcrew members spending rest time traveling to or from hotels and being provided with little to no time to decompress. Additionally, certificate holders regularly exceed the allowable duty periods by conducting flights under part 91 instead of part 121, where the applicable flight, duty and rest requirements are housed. As the NTSB repeatedly notes, the FAA's regulations do not account for the impact of circadian rhythms on alertness, and the entire set of regulations is overly complicated, with a different set of regulations for domestic operations, flag operations, and supplemental operations.

B. NTSB Recommendations

The NTSB has long been concerned about the effects of fatigue in the aviation industry. The first aviation safety recommendations, issued in 1972, involved human fatigue, and aviation safety investigations continue to identify serious concerns about the effects of fatigue, sleep, and circadian rhythm disruption. Currently, the NTSB's list of Most Wanted Transportation Safety Improvements includes safety recommendations regarding pilot fatigue. These recommendations are based on two accident investigations and an NTSB safety study on commuter airline safety.[15]

In February 2006 the NTSB issued safety recommendations after a BAE–J3201 operated under part 121 by Corporate Airline struck trees on final approach and crashed short of the runway at Kirksville Regional Airport, Kirksville, Missouri. The captain, first officer, and 11 of the 13 passengers died. The NTSB determined the probable cause of the October 19, 2004 accident was the pilots' failure to follow established procedures and properly conduct a non-precision instrument approach at night in instrument meteorological conditions. The NTSB

[13] Recovery sleep does not require additional sleep equal to the cumulative sleep debt; that is, an 8-hour sleep debt does not require 8 additional hours of sleep.

[14] Rosekind MR. *Managing work schedules: an alertness and safety perspective.* In: Kryger MH, Roth T, Dement WC, editors. *Principles and Practice of Sleep Medicine;* 2005:682.

[15] On February 2, 2010, the NTSB released a press release summarizing the results of its investigation into the Colgan Air crash of February 12, 2009, which resulted in the death of 50 people. The NTSB did not state that fatigue was causal factor to the crash; however, it did recommend that the FAA take steps to address pilot fatigue.

concluded that fatigue likely contributed to the pilots' performance and decision-making ability. This conclusion was based on the less than optimal overnight rest time available to the pilots, the early report time for duty, the number of flight legs, and the demanding conditions encountered during the long duty day.

As a result of the accident, the NTSB issued the following safety recommendations related to flight and duty time limitations: (1) Modify and simplify the flightcrew hours-of-service regulations to consider factors such as length of duty day, starting time, workload, and other factors shown by recent research, scientific evidence, and current industry experience to affect crew alertness (recommendation No. A–06–10); and (2) require all part 121 and part 135 certificate holders to incorporate fatigue-related information similar to the information being developed by the DOT Operator Fatigue Management Program into initial and recurrent pilot training programs. The recommendation notes that this training should address the detrimental effects of fatigue and include strategies for avoiding fatigue and countering its effects (recommendation No. A–06–10).

The NTSB's list of Most Wanted Transportation Safety Improvements also includes a safety recommendation on pilot fatigue and ferry flights conducted under 14 CFR part 91. Three flightcrew members died after a Douglas DC–8–63 operated by Air Transport International was destroyed by ground impact and fire during an attempted three-engine takeoff at Kansas City International Airport in Kansas City, Missouri. The NTSB noted that the flightcrew conducted the flight as a maintenance ferry flight under part 91 after a shortened rest break following a demanding round trip flight to Europe that crossed multiple time zones. The NTSB further noted that the international flight, conducted under part 121, involved multiple legs flown at night following daytime rest periods that caused the flightcrew to experience circadian rhythm disruption. In addition, the NTSB found the captain's last rest period before the accident was repeatedly interrupted by the certificate holder.

In issuing its 1995 recommendations, the NTSB stated that the flight time limits and rest requirements under part 121 that applied to the flightcrew before the ferry flight did not apply to the ferry flight operated under part 91. As a result, the regulations permitted a substantially reduced flightcrew rest period for the nonrevenue ferry flight. As a result of the investigation, the NTSB reiterated earlier recommendations to (1) finalize the review of current flight and duty time limitations to ensure the limitations consider research findings in fatigue and sleep issues and (2) prohibit certificate holders from assigning a flightcrew to flights conducted under part 91 unless the flightcrew met the flight and duty time limits under part 121 or other applicable regulations (recommendation No. A–95–113).

In addition to recommending a comprehensive approach to fatigue with flight duty limits based on fatigue research, circadian rhythms, and sleep and rest requirements, the NTSB has also stated that FRMS may hold promise as an approach to dealing with fatigue in the aviation environment. However, the NTSB noted that it considers fatigue management plans to be a complement to, not a substitute for, regulations to address fatigue.

C. International Standards

There are a number of standards addressing flight and duty time limitations and rest requirements that have been adopted by other jurisdictions, as well as the International Civil Aviation Organization (ICAO), and these standards were reviewed by the ARC to determine if any of their philosophy or structures could be adopted by the FAA. While the ARC found many of the requirements useful, it also determined that the U.S. requirements would need to address the U.S. aviation industry and that the existing standards could not fully achieve that objective. The FAA agrees that none of the existing standards fully address the U.S. aviation environment. Nevertheless, the existing standards do serve as the basis of many of the provisions proposed today. Accordingly, specific provisions of these standards are discussed throughout the rest of this document and a copy of each standard has been placed in the docket.

1. Amendment No. 33 to the International Standards and Recommended Practices, Annex 6 to the Convention on International Civil Aviation, Part I, International Commercial Air Transport—Aeroplanes (ICAO Standards and Recommended Practices (SARP))

The ICAO SARP for Contracting States (States) provide that a certificate holder should establish flight time and duty period limitations and rest provisions that enable the certificate holder to manage the fatigue of its flightcrew members. The ICAO SARP do not provide specific numerical values for these provisions but set forth a regulatory framework for member States to use as guidelines in establishing prescriptive limitations for fatigue management. Member States are required to base their regulations on scientific principles and knowledge with the goal of ensuring that flightcrew members perform at an adequate level of alertness for safe flight operations. The ICAO SARP do not address fatigue risk management programs currently; however, these programs are currently under development.

2. United Kingdom Civil Aviation Authority Publication 371 (CAP–371)

Air Navigation Order 2000, Part VI, as amended, requires a certificate holder to have a civil aviation authority-approved scheme for regulating the flight time of aircrews. CAP–371 provides guidance on this requirement and recognizes that the prime objective of a flight limitation scheme is to ensure flightcrew members are adequately rested at the beginning of each Flight Duty Period (FDP) and are flying sufficiently free from fatigue so they can operate efficiently and safely in normal and abnormal situations. When establishing maximum FDPs and minimum rest periods, certificate holders must consider the relationship between the frequency and patterns of scheduled FDPs and rest periods, and the effects of working long hours with minimum rest.

3. Annex III, Subpart Q to the Commission of the European Communities Regulation No. 3922/91, as Amended (EU OPS subpart Q)

EU OPS subpart Q prescribes limitations on FDPs, duty periods, block (flight) time, and rest requirements. Like the previous standards discussed, EU OPS subpart Q recognizes the importance of enabling flightcrew members to be sufficiently free from fatigue so they can operate the aircraft satisfactorily in all circumstances. In establishing flight and duty limitation and rest schemes, EU OPS subpart Q requires certificate holders to consider the relationship between the frequencies and pattern of FDPs and rest periods, and the cumulative effects of long duty hours with interspersed rest. Certificate holders must take action to revise a schedule in cases where the actual operation exceeds the maximum scheduled FDP on more than 33 percent of the flights in that schedule during a specified period.

III. General Discussion of the Proposal

A. Applicability

The FAA is proposing to limit this rulemaking to part 121 certificate holders and the flightcrew members [16] who work for them. While fatigue is a universal problem that applies to all types of operations and to all safety sensitive functions, the agency has decided to take incremental steps in addressing fatigue. Thus, future rulemaking initiatives may address fatigue concerns related to flight attendants, maintenance personnel, and dispatchers.

In addition, part 135 certificate holders should pay close attention to both this NPRM and any final rule. This is because part 135 operations are very similar to those conducted under part 121, particularly part 121 supplemental operations. The FAA does not intuitively see any difference in the safety implications between the two types of operations, although it acknowledges there may be less overall risk to the flying public in part 135 operations than part 121 operations. Accordingly, the part 135 community should expect to see an NPRM addressing its operations that looks very similar to, if not exactly like, the final rule the agency anticipates issuing as part of this rulemaking initiative.

Today's proposal applies to all flights conducted by part 121 certificate holders, including flights like ferry flights that are historically conducted under part 91. While these types of flights can continue to operate under the general rules of part 91, the flight, duty, and rest requirements proposed here would also apply.

In addition, the FAA has tentatively decided against adopting different requirements based on the nature of the operation. The FAA has designed the flight, duty and rest scheme proposed today to enhance flightcrew member alertness and mitigate fatigue. The agency's existing regulatory scheme provides different rules for domestic operations, flag operations, and supplemental operations. This hodgepodge of requirements developed over time to address changing business environments and advances in technology that allowed for longer periods of flight. Thus, in domestic operations, flight time is essentially calculated based on time at the controls, while in supplemental operations, the regulations contemplate restrictions based on "time aloft" since a flightcrew member may not be at the controls for the entire flight; crew augmentation is prohibited in domestic operations; and the regulations governing flag operations, where augmentation is largely assumed, allow certificate holders to liberally increase the amount of flight time based on the presence of additional flightcrew members, regardless of whether those individuals can actually fly the airplane.

Fatigue factors, however, are universal. The sleep science, while still evolving and subject to individual inclinations, is clear in a few important respects: most people need eight hours of sleep to function effectively, most people find it more difficult to sleep during the day than during the night, resulting in greater fatigue if working at night; the longer one has been awake and the longer one spends on task, the greater the likelihood of fatigue; and fatigue leads to an increased risk of making a mistake.

The FAA recognizes there are different business models and needs that are partly responsible for the differences in the current regulations. It is sympathetic to concerns raised within the ARC by cargo carriers and carriers engaged in supplemental operations that new regulations will disproportionately impact their business models. However, the FAA also notes that the historical distinction between the types of operators has become blurred. Cargo carriers conduct the vast majority of their operations at night, but passenger carriers also offer "red eyes" on a daily basis. Some carriers operate under domestic, flag or supplemental authority, depending on the nature of the specific operation. Additionally, in some instances, the FAA has authorized a carrier to conduct supplemental operations under the flag rules.

Today's proposal is designed to recognize the growing similarities between the kinds of operations and the universality of factors that lead to fatigue in most individuals. Thus, the proposal provides different requirements based on the time of day, whether an individual is acclimated to a new time zone, and the likelihood of being able to sleep under different circumstances. If today's proposal is adopted, the FAA expects that most part 121 operators will be required to make changes to their existing operations, and some will need to make more changes than others. However, the FAA also believes that the proposal is sufficiently flexible to accommodate the vast majority of operations conducted today without imposing unreasonable costs.

B. Joint Responsibility

Fatigue mitigation is a joint responsibility of the certificate holder and the flightcrew member. Today's proposal recognizes the need to hold both certificate holders and pilots responsible for making sure flightcrew members are working a reasonable number of hours, getting sufficient sleep, and not reporting for flight duty in an unsafe condition. Many of the ways that carriers and flightcrew members will negotiate this joint responsibility will be handled in the context of labor management relations. Others will not. Today's proposal is drafted in a manner that directly imposes the regulatory obligations on both the certificate holders and the flightcrew members. It is unfair to place all the blame for fatigue on the carriers. Pilots who pick up extra hours, moonlight, report to work when sick, commute irresponsibly, or simply choose not to take advantage of the required rest periods are as culpable as carriers who push the envelop by scheduling right up to the maximum duty limits, assigning flightcrew members who have reached their flight time limits additional flight duties under part 91, and exceeding the maximum flight and duty limits by claiming reasonably foreseeable circumstances are beyond their control.

One important element of this proposal is that flightcrew members may not accept an assignment that would consist of an FDP if they are too fatigued to fly safely. Likewise a flightcrew member may not continue subsequent flight segments if he or she has become too fatigued to fly safely. Certificate holders also must assess a flightcrew member's state when he or she reports to work. If the carrier determines a flightcrew member is showing signs of fatigue, it may not allow the flightcrew member to fly. Flightcrew members should be cognizant of the appearance and behavior of fellow flightcrew members, including such signs of fatigue as slurred speech, droopy eyes, requests to repeat things, and attention to the length of time left in the duty period. If a flightcrew member (or any other employee) believes another flightcrew member may be too tired to fly, he or she would have to report his or her concern to the appropriate management person, who would then be required to determine whether the individual is sufficiently alert to fly safely.

In addition, under today's proposal, carriers would need to develop and implement an internal evaluation and audit program to monitor whether

[16] A flightcrew member is a certified pilot or flight engineer assigned to duty aboard an aircraft during a flight duty period.

flightcrew members are reporting to work fatigued. The FAA anticipates that the program would look at both the number of instances in which this happens as well as the reasons contributing to the problem. The FAA is aware of anecdotal reports of pilots flying when fatigued because they are short on sick leave, as well as instances when pilots have called in sick when the true problem was fatigue. As part of the internal audit, a carrier may need to delve into the reasons flightcrew members call in sick to make sure it is capturing accurately incidents of pilot fatigue. It could choose to create a separate fatigue category to mitigate the risk of pilots calling in sick when in fact they are fatigued.

A carrier would be required to take steps to correct any fatigue problem that it identifies. For example, if the carrier became aware that flightcrew members were commuting during their WOCL, the carrier could require that all flightcrew members spend the night prior to starting a series of FDPs within the local commuting area. The carrier could also implement other measures to address problems associated not only with commuting, but any behavior that could lead to flightcrew members reporting for FDPs unfit for duty.

Several ARC members urged that these requirements be encapsulated in a non-punitive fatigue policy. While the FAA certainly supports such policies, it also recognizes that requiring carriers to develop and implement non-punitive fatigue policies is challenging from a regulatory perspective. Carriers are entitled to investigate the causes for an employee's fatigue. If a carrier determines that the flightcrew member was responsible for becoming fatigued, it has every right to take steps to address that behavior. To the extent the fatigue may be a function of the carrier not following the regulatory requirements, the FAA certainly would investigate and possibly initiate enforcement action. In addition, self-reporting could be encapsulated in a carrier's voluntary disclosure program under the FAA's Aviation Safety Action Program (ASAP), which has certain non-punitive provisions built into the program.

C. Fatigue Training

The FAA believes fatigue-based training requirements are critical to informing flightcrew members how their personal behavior can unwittingly lead to fatigue, and how to mitigate the risk of fatigue in an industry that does not follow a traditional 9-to-5 work day. Fatigue training is not currently required under any regulatory regime. In the presentation to the ARC by the sleep specialists, all specialists noted that people regularly underestimate their level of fatigue, often to dangerous levels. The ARC generally agreed that fatigue training was a good idea, and several members noted that such training should extend to all "stakeholders", *e.g.,* employees of the certificate holder responsible both for scheduling and for safety of flight, rather than just flightcrew members.

The FAA agrees that flightcrew members do not bear sole responsibility for making sure they are adequately rested and that they are not the only employees of the carrier who need to be trained on the impact of fatigue on the safety of flight. The agency is proposing to require fatigue training for each person involved with scheduling aircraft and crews, all crewmembers and management personnel. The FAA is proposing to require 5 hours of initial training for all newly-hired, covered employees prior to starting work in that capacity and 2 hours of annual, recurrent training. This training would be approved through the agency's Operations Specifications (OpSpec) process.

The training curriculum would address general fatigue and fatigue countermeasures along with the following subject areas:

- FAA regulatory requirements for flight, duty and rest, and NTSB recommendations on fatigue management;
- The basics of fatigue, including sleep fundamentals and circadian rhythms;
- The causes of fatigue, including medical conditions that may lead to fatigue;
- The effect of fatigue on performance;
- Fatigue countermeasures, prevention and mitigation;
- The influence of lifestyle, including nutrition, exercise, and family life, on fatigue;
- Familiarity with sleep disorders and their possible treatments;
- The impact of commuting on fatigue;
- Flightcrew member responsibility for ensuring adequate rest and fitness for duty; and
- The effect of operating through and within multiple time zones.

In addition, the FAA recognizes that the study of fatigue and fatigue mitigation is on-going. Changes may need to be made to training programs even after approval by the FAA. Accordingly, whenever the Administrator finds that revisions are necessary for the continued adequacy of an approved fatigue education and training program, the certificate holder must, after notification, make any changes in the program that are deemed necessary by the Administrator. The FAA anticipates that such changes would be implemented through the agency's OpSpecs as provided for in 14 CFR 119.51, providing carriers with an opportunity to provide input and appeal rights.

D. Flight Duty Period

There are numerous studies that generally address fatigue, as well as models [17] that have been developed. The models predict fatigue-based performance degradation based on data input such as when a flight begins, how long it lasts, whether there is a rest opportunity, and the local time of day at departure and landing. Only one of these models has been validated in the aviation context,[18] although there is general validation in the railroad and motor carrier industries. The available validations are not directly applicable to aviation because of the impact of relatively rapid movement within multiple time zones.

While there is ample science indicating that performance degrades during windows of circadian low and that regular sleep is necessary to sustain performance, there is no evidence that flying multiple segments is more fatiguing than flying one or two segments per duty period. However, multiple segments require more time on task because there are more take-offs and landings, which are both the most task-intensive and the most safety-critical stages of flight. Also, pilots appear to generally agree that flying several legs during a single duty period could be more fatiguing.

One approach to addressing fatigue is to link the length of duty directly related to flight to the time of day and the number of legs that are scheduled to be flown. This approach recognizes the additional fatigue introduced by night-time flying and by flying several legs, with multiple take-offs and landings. As discussed earlier, the current regulatory system in the United States provides variability based on whether a given

[17] Bio-mathematical modeling of fatigue and performance can assist in providing objective metrics, which are conspicuously lacking in fatigue science. The rationale for modeling is that conditions that lead to fatigue are well known. A model simulates specific conditions and determines if fatigue could be present. Models can estimate degradations in performance and provide an estimate of schedule-induced fatigue risk that considers many dynamically changing and interacting fatigue factors.

[18] The SAFE model, developed by Mick Spencer of the United Kingdom, has been validated in the aviation context.

operation is flown under domestic, flag or supplemental rules; but within each category of operation there is little to no variability in permissible flight time based on the particular operation.

Other jurisdictions have largely eliminated the concept of a uniform flight time in favor of a variable FDP that encompasses flight time but also includes other duties directly related to flight. An FDP is duty consisting of training required by the certificate holder's approved flight training curriculum and qualification segment to be conducted in a simulator, flight training device and aircraft training,[19] as well as pre-flight deadheads [20] without an intervening rest, and all duties from the time the flightcrew member is required to report for duty to fly until the last movement of the aircraft. An FDP begins when a crewmember is required to report for duty that includes a flight, series of flights, or positioning flights (including part 91 ferry flights) and ends when the aircraft is parked after the last flight and there is no plan for further aircraft movement by the same crewmember.

Under the UK's CAP–371 an FDP is limited to no more than 13 hours under a minimum crew pairing, but may be increased through augmentation or split duty rest, and is reduced based on flying in the WOCL or flying multiple legs. The minimum FDP is 9 hours, unless flying multiple night-time operations, when FDP is reduced to 8 hours. A pilot in command may extend the FDP up to 3 hours due to unforeseen circumstances. Any duty immediately preceding flight check-in is also considered FDP, as is simulator training conducted during the same duty period if prior to flying, regardless of whether there is a break.

Under EU–OPS subpart Q, the maximum FDP is 13 hours, reduced at 30-minute increments per segment after the second segment down to a 2-hour reduction. One-hour extensions are permitted, except when an FDP has more than six segments, when no extension is permitted. There is a more complicated formula that applies when encroaching on the WOCL. There are no more than two extensions during any 7-day period. Schedule robustness is addressed by requiring that actual operations not exceed FDP more than 33 percent of the time (i.e., actual flights are within the FDP limits at least 67 percent of a scheduling season). A 2-hour extension is permitted at the discretion of the entire crew for unforeseen circumstances.

The pending EASA proposal on flight duty and rest would adopt the same FDP concept as CAP–371 and EU–OPS subpart Q. Like those standards, the maximum FDP is 13 hours unless a mitigation strategy such as augmentation is adopted, and the FDP is reduced based on time of day and number of legs flown. Unlike the CAP–371, and similar to EU–OPS subpart Q, the EASA proposal contemplates that schedules that do not regularly meet the maximum-allowable FDP will be changed. The CAP–371 merely requires a pilot in command to report when the FDP is exceeded.

The ARC members generally agreed with the approach adopted in CAP–371 and by EASA, although they could not agree on how conservative maximum FDPs should be. Tables A(1) and A(2) depict the two ranges of FDP discussed by the ARC, with Table A(1) generally representing the labor position, and A(2) generally representing the carriers' position. Both tables reduce the amount of FDP during the nighttime hours to address flying during one's WOCL, and both reduce the amount of FDP once a flightcrew member has flown more than four legs. Flightcrew members would enter the table based on the time at their home base (i.e., the city where they regularly fly from) unless they have acclimated to a different time zone, at which point they would enter the table based on local time. In addition, the FDP would be reduced by 30 minutes for unacclimated flightcrew members. Extensions no greater than 2 hours (possibly as many as 3 hours internationally or for augmented flights) beyond a scheduled FDP would be allowed for circumstances beyond a carrier's control. The decision to extend would rest on both the carrier and the pilot in command, although specific coordination might not be required in every instance. In addition, there would be limits on the number of times a crew pairing could be extended in any 168-hour period, with discussion of whether that limit should be once or twice, but general agreement that it should not be allowed on consecutive days. A flightcrew member could not continue an FDP beyond the extension except under emergency circumstances.

TABLE A(1)—FLIGHT DUTY PERIOD: UN-AUGMENTED OPERATIONS

Time of start (Home base or acclimated)	Maximum flight duty period (hours) for lineholders based on number of flight segments						
	1	2	3	4	5	6	7+
0000–0359	9	9	9	9	9	9	9
0400–0459	10	10	9	9	9	9	9
0500–0559	11	11	11	11	10	9.5	9
0600–0659	12	12	12	12	11.5	11	10.5
0700–1259	13	13	13	13	12.5	12	11
1300–1659	12	12	12	12	11.5	11	10.5
1700–2159	11	11	10	10	9.5	9	9
2200–2259	10.5	10.5	9.5	9.5	9	9	9
2300–2359	9.5	9.5	9	9	9	9	9

[19] Training conducted in accordance with the certificate holder's approved ground training program would be considered duty outside of an FDP.

[20] *Deadhead transportation* means transportation of a crewmember as a passenger, by air or surface transportation, as required by a certificate holder, excluding transportation to or from a suitable accommodation.

TABLE A(2)—FLIGHT DUTY PERIOD: UN-AUGMENTED OPERATIONS

Time of start (Home base)	Maximum flight duty period (hours) for lineholders based on number of flight segments						
	1	2	3	4	5	6	7+
0000–0159	9	9	9	9	9	9	9
0200–0459	10	10	10	10	9	9	9
0500–0659	12	12	12	12	11.5	11	10.5
0700–1259	13	13	13	13	12.5	12	11.5
1300–1659	12	12	12	12	11.5	11	10.5
1700–2159	11	11	11	11	9	9	9
2200–2259	10.5	10.5	10.5	10.5	9	9	9
2300–2359	9.5	9.5	9.5	9.5	9	9	9

In order to assure that the extensions are not abused and that carriers are creating schedules contemplating circumstances that may be beyond their control, but that are reasonably foreseeable (*e.g.,* seasonal weather trends, planned runway construction, chronically-delayed airports or markets), a carrier would provide the FAA with scheduled FDPs for all its crew pairings and the actual FDPs, including any extensions, on a regular basis. Some argued this cycle should be as little as once a month, while others argued a quarterly reporting cycle was sufficient. Should the carriers' actual FDPs fail to meet the scheduled FDP too many times during the reporting cycle, they would be required to change the scheduled FDPs to more realistic levels. The ARC agreed that 95 percent of a carrier's schedules would need to fall within the maximum FDP depicted in Table A(1) or A(2). In order to identify specific crew pairings that were problematic, each crew pairing would need to fall within the limits in the tables for a lesser percentage of the time, somewhere between 70 percent and 85 percent.

The FAA has decided to propose the more conservative FDPs depicted in Table A(1), with a 2-hour extension for unforeseeable circumstances beyond the carrier's control permitted once in a 168-hour period.[21] Since the entire flightcrew is impacted by the extension, only one flightcrew member needs to have utilized the extension in the previous 168 hours for it to no longer be available.

If the extension is less than 30 minutes, the FAA anticipates permitting multiple extensions during the 168-hour period. The FAA has tentatively determined that short incursions into the permissible extension are unlikely to be fatiguing given the other requirements of today's proposal and that limiting a flightcrew member to a single weekly extension that could be as small as five or ten minutes is unreasonable. However, the extensions are intended to address unforeseeable circumstances beyond the carrier's control. Such circumstances should be of sufficiently short duration that the carrier could not reasonably make schedule adjustments. Thus, while the FAA contemplates that adverse weather could fit within the criteria because it is beyond the control of the certificate holder, it would not always be considered unforeseeable. Carriers should anticipate thunderstorms in many parts of the United States during the summer months. Likewise, heavy snow in the northern parts of the country should be anticipated during the winter, and the jet stream follows basic seasonal patterns. By the same token, carriers are not responsible for air traffic delays; however, if they are operating out of chronically delayed airports, air traffic delays are clearly foreseeable. To the extent even small extensions are regularly occurring, the schedule reliability requirements discussed by the ARC should require schedule adjustments, even when encroachments beyond the times in the FDP table are very small.

The FAA recognizes that adopting the numbers in Table A(1) is a conservative approach. The FAA has decided to propose the more conservative numbers because it has little experience with this type of regulatory regime. However, the numbers contemplated under both tables are very similar, and the FAA is open to arguments that a more expansive FDP is merited. The agency also recognizes that upon completion of an FDP, a flightcrew member could be assigned other duties as long as he or she is provided with a required rest opportunity prior to commencing his or her next FDP. The underlying premise of today's proposal is to ensure flightcrew members are adequately rested during the time they are responsible for the operation of aircraft. To the extent other duties are not directly related to the safe operation of flight, the FAA believes there is no need to reduce the current implied daily duty limit of 16 hours in un-augmented operations, as long as those duties do not introduce the potential for fatigue during flight.

The reduction in maximum FDP during nighttime hours is broadly supported by existing sleep science. Although not addressed by sleep studies, the FAA has also tentatively decided to reduce the amount of available FDP depending on the number of legs flown (flight segments) because of a general agreement among the ARC members and FAA staff previously employed as pilots by commercial air carriers that multiple take-offs and landings are more fatiguing. Much of the available science is based on laboratory studies, with exceptionally limited validation in the aviation context; accordingly, the FAA has tentatively decided to rely on the experience of these individuals rather than assuming no adverse impact on safety. The FAA is not proposing to make any adjustments for the first four flight segments based on this same experience. The linear reduction contemplated in the EASA regulations (which is used for multiple purposes) appears to have more to do with regulatory simplicity than with any actual experience or science.

As recommended by the ARC, a flightcrew member would enter the FDP table based on home base time, unless acclimated to a different time zone. Thus, if a flightcrew member ordinarily flies out of Chicago, the flightcrew member would enter an FDP as though he or she were in Chicago, regardless of where he or she is physically located.[22]

[21] A 3-hour extension would be allowed for augmented operations.

[22] Some carriers have moved to virtual home bases, or have no home base. This is most common among supplemental operators. In those instances, the proposal contemplates that the carrier would name a home base somewhere within the continental United States, and that home base would be considered the flightcrew member's home base.

A 10 a.m. crew pairing out of Heathrow would be treated as if it commenced at 4 a.m., because of the 6-hour time difference between Chicago and London. If the operation requires the flightcrew member to cross more than four time zones, he or she would be considered unacclimated, and there would be a 30-minute reduction in the maximum FDP.

The FAA has also decided to propose the reporting requirements discussed by the ARC to assure realistic scheduling. The agency has tentatively decided that reports be filed with the FAA every two months. The ARC discussed a range of one to three months. The FAA believes a monthly reporting requirement could be excessively burdensome to both the certificate holders and the FAA. By the same token, if the reporting interval is too long, carriers may avoid addressing common delay scenarios, simply waiting them out.

Under today's proposal, carriers must first demonstrate that 100 percent of the scheduled crew pairings fall within the limits in the FDP table. Actual system-wide FDPs should not exceed the maximum levels in the FDP table more than five percent of the time. Each crew pairing would need to fall within the FDP table 80 percent of the time. The agency believes a 20 percent variation for a specific crew pairing provides carriers with sufficient flexibility to address multiple yet small excursions beyond the FDP table, while still forcing the carriers to recognize when a particular crew pairing is problematic. Because no flightcrew member may exceed the limits in the FDP table beyond 30 minutes more than once in any 168-hour period, the FAA does not believe a 20 percent variation will result in any immediate adverse safety situation.

Should any of the three proposed reporting requirements be exceeded, a carrier would be required to readjust the problematic crew pairings to more realistic schedules. These adjustments, which could be seasonal in nature, would be on-going and would apply to subsequent years. To the extent a carrier could immediately implement measures to improve schedule fidelity, it should do so. However, the ability of carriers to immediately address the scheduling issue is difficult to evaluate without understanding the impact of published schedules on resolving the problem. The FAA has notionally proposed that changes be made within 60 days, but it is interested in better understanding the impact of such a requirement on carriers' schedules.

Below, and throughout this document, we invite commenters to address specific questions, along with any other matters they consider relevant. We are particularly interested in receiving recommendations that would provide the same or better protection against the problems of fatigue at lower cost. We may incorporate any such recommendation in a Final Rule in this proceeding.

With that in mind, the FAA seeks comment on the following:

(1) Please comment on adopting maximum FDPs. Should the maximum FDP vary based on time of day? Should it vary based on the number of scheduled flight segments? Should the proposed limits be modified up or down, and to what degree? Please provide supporting data.

(2) Please comment on permitting flightcrew members and carriers to operate beyond a scheduled FDP. Is the proposed 2-hour extension appropriate? Is the restriction on a single occurrence beyond 30 minutes in a 168-hour period appropriate? Should a flightcrew member be restricted to a single occurrence regardless of the length of the extension? Please provide supporting data.

(3) Please comment on the proposed schedule reliability reporting requirements. Should carriers be required to report on crew pairings that exceed the scheduled FDP, but not the maximum FDP listed in the FDP table?

(4) Should carriers be required to report on more parameters, such as cumulative duty hours or daily flight time? If so, why?

(5) What should be the interval between reporting requirements?

(6) How long after discovering a problematic crew pairing should the carrier be afforded to correct the scheduling problem?

E. Acclimating to a New Time Zone

Unlike other forms of transportation, where an individual moves gradually through multiple time zones over the course of the day, the nature of aviation allows an individual to traverse several time zones over a relatively short period of time. This phenomenon exposes flightcrew members to a greater sense of disorientation or jet lag than employees in other forms of transportation. For trips with short turn around times, a flightcrew member likely would not acclimate, and would simply enter the FDP table based on his or her home base time. However, flightcrew members remaining in a new theater for longer periods of time may need to acclimate to the new theater.

During the question and answer session with ARC members, the sleep specialists explained how an individual acclimates to time zones when flying long range operations. They stated that having sleep opportunities during a physiological night is the most important fatigue mitigation strategy for global travel. They also noted that an individual attempting to acclimate to a new time zone will adjust his or her clock approximately 1 hour per day for each hour of time zone difference. The ARC members noted that based on their collective personal experience, one could acclimate much more quickly if one managed his or her sleep opportunity appropriately. The sleep specialists also noted that even if an individual consciously decided not to acclimate to a new time zone, given enough time, the individual would begin to acclimate anyway because of the differences in exposure to daylight.

The ARC discussed various approaches to determine whether a flightcrew member is acclimated before accepting an assignment for an FDP. The ARC originally defined the un-acclimated condition as flying across five or more time zones.[23] Moving beyond these constraints would qualify as moving into a new theater of operations. The ARC members agreed that the continental United States should constitute a single theater so that a flightcrew member would always be acclimated when flying domestically. The ARC concluded that to reset from an un-acclimated condition to an acclimated condition a flightcrew member would require either three consecutive physiological night's rest,[24] during which period the flightcrew member could fly, or a 30 to 36 hour layover rest period. Some ARC members noted that a flightcrew member could be on duty during the period encompassing 3 local nights, but not during local nighttime hours.

As noted previously, sleep science has not been validated in the aviation context. The members of the ARC universally rejected the premise that it would take between six and 9 days to acclimate to a European time zone. The FAA is inclined to agree with the ARC members' experience, especially given the limited scientific information specific to aviation. The FAA also recognizes that assuring that length of time to acclimate to a new theater is impractical in the aviation context.

[23] In some areas of the world, time zones change in one half hour increments rather than one hour increments. Accordingly, one would have to experience a time change of at least four hours as well as five time zones.

[24] *Physiological night's rest* means the rest occurs between the hours of 0100 and 0700 local time. This definition assures an opportunity to sleep during the WOCL.

The FAA proposes to permit a carrier to adjust where the flightcrew member enters the FDP as an acclimated crew member if the individual has been in a new theater of operations for 72 hours or has been given at least 36 consecutive hours free from duty. Remaining in the same theater for 72 hours allows for three physiological night's rest. A 36 consecutive hour break in duty does not allow for the same amount of rest, but allows the individual to structure the available rest opportunity in a manner that best suits his or her personal sleep patterns. The FAA is not proposing to stipulate that an unacclimated flightcrew member will only become acclimated when continuing to fly within a new theater as long as that flightcrew member does not fly at night. This strikes the agency as an unnecessary constraint.

While the continental United States is considered a single theater, operations from one part of the United States could trigger the need to acclimate sooner than operations from another part of the United States. Thus, a flight from New York to Hawaii could trigger a need to acclimate in Hawaii, while a flight from Los Angeles to Hawaii would not.

The ARC discussed the amount of rest needed for flightcrew members returning to their home base after becoming acclimated in another theater. The ARC members noted that the flightcrew member is not truly acclimated to the new theater but also is no longer acclimated to his or her home base. Ultimately, the ARC members agreed that a flightcrew member must always find at least 30 to 36 continuous hours free of duty in any 168 consecutive hours and that once a flightcrew member is given this rest, the flightcrew member is considered acclimated to local time. Based on this discussion, the FAA has decided against imposing any unique restrictions on a flightcrew member simply because he or she has returned to his or her home base. Acclimation to a home base is treated the same as any other acclimation to a new theater.

However, the FAA is proposing to require a greater rest opportunity when a flightcrew member has been away from his or her home base for more than 168 hours. In this instance, the FAA proposes to require a rest period that includes 3 physiological nights, rather than 36 hours free from duty or permitting the flightcrew member to fly during that approximately 72-hour period. This decision is based on the ARC members' consideration of the amount of rest being dependent on how long the flightcrew member was away from home base. The ARC reviewed the current regulation, which requires a flightcrew member who exceeds 12 flight hours to receive twice the amount of rest upon return to home base.

The ARC members also discussed the impact of multiple consecutive round-trip flights where flightcrew members would fly consecutive flights to an international destination, lay over for a day, and then return to the home base (e.g., Houston, Texas, to Paris, France, and return to Houston).[25] These types of pairings are common, with a flightcrew member potentially flying three roundtrips in a week. The concern was that these types of flights will typically have layovers from 20 to 28 hours. The length of the layovers is primarily based on scheduling concerns.

The length of the layover does not initially appear problematic, particularly in light of the current regulations which only require one 24-hour break in duty in a 7-day period. However, when the flights are particularly long, a layover of approximately 24 hours becomes a problem because the flightcrew member is constantly flipping his or her internal clock. When one runs the scenario through the SAFTE/FAST model with a three-person augmented crew, the flightcrew member reaches high fatigue limits during the second round-trip flight and is dangerously fatigued during the third round-trip flight. However, when the flights are not particularly long flights, flightcrew members appear to have no problem flying three roundtrip flights, even with the 24-hour layovers.

The ARC developed a draft regulatory proposal to address operations so long that they almost trigger a fourth flightcrew member. Under that proposal, if the flight assignment is for a three pilot flight crew and the layover is between 20 and 28 consecutive hours and the two FDPs, separated by the layover rest, are greater than 22 to 24 hours, then the flight crew requires two physiological night's rest or one physiological night's rest with an 8-hour restriction on the next FDP.

Upon reflection, the FAA has decided that the ARC proposal is unduly complicated and only addresses a small number of potential operations. The agency has decided against proposing it. However, as part of the required training program proposed today, carriers should be educated on the risks associated with flipping a flightcrew member's internal clock, particularly when conducting operations that are on the cusp of requiring an additional flightcrew member.

The FAA requests comments on the following:

(7) Is a 3-day adjustment to a new theater of operations sufficient for an individual to acclimate to the new theater?

(8) Is a 36-hour break from duty sufficient for an individual to acclimate to a new theater?

(9) Should flightcrew members be given a longer rest period when returning to home base than would otherwise be provided based on moving to a new theater?

(10) Should the FAA have different requirements for flightcrew members who have been away from their home base for more than 168 hours? If so, why?

(11) Should the FAA require additional rest opportunities for multiple pairings between two time zones that have approximately 24-hour layovers at each destination? What if the scheduled FDPs are well within the maxima in the applicable FDP table or augmentation table?

F. Daily Flight Time Restrictions

Initial ARC discussion of FDPs assumed that, as is the case in CAP–371 and the EASA regulations, there would be no daily limit on flight time. Instead flight time would effectively be limited to approximately 2 hours less than the FDP because FDP assumes a flightcrew member will report for duty an hour and a half before flying and will spend approximately 30 minutes after completing all flying for the day completing paperwork. In that context, the maximum amount of time flying during the middle of the day could increase from the current 8 hours to as much as 11 hours, almost a 50 percent increase. The ARC noted that the FAA may decide that daily limits on flight time are still needed and proposed a variable flight time based on the hour of the day. Tables B(1) and B(2) represent potentially acceptable flight time limitations within FDPs. Table B(1) generally represents the position of the carriers, while Table B(2) generally represents the position of labor.[26]

[25] These pairings do not always involve a return to a home base, but could be a return to another city within the time zone for or adjacent to the flightcrew member's home base. They can also occur when the flightcrew member has adjusted to a new theater and an airport within that theater effectively becomes the home base.

[26] Some carriers argued that no limit should be placed on flight time and some labor representatives argued that the maximum limit should be variable, but should never exceed eight hours.

TABLE B(1)—MAXIMUM FLIGHT TIME LIMITS

Time of start (home base)	Maximum flight time (hours)
0000–0159	7
0200–0459	8
0500–0659	10
0700–1259	11
1300–1659	10
1700–2159	9
2200–2259	8.5
2300–2359	7.5

TABLE B(2)—MAXIMUM FLIGHT TIME LIMITS

Time of start (home base)	Maximum flight time (hours)
0000–0459	7
0500–0659	8
0700–1259	9
1300–1959	8
2000–2359	7

In addition, the CAA presented an alternate regulatory approach, whereby flight time limits for all-cargo operations would be more expansive and would differ dependent on whether the particular operation was a domestic operation or an international operation. The numbers proposed by the CAA are presented in Tables B(3) and B(4).

TABLE B(3)—MAXIMUM FLIGHT TIME LIMITS, DOMESTIC ALL-CARGO

Time of start (home base)	Maximum flight time (hours) 1–4 sectors	Maximum flight time (hours) 5+ sectors
0000–0459	8	7
0500–1459	11	9
1500–1659	10	8
1700–2359	8	7

TABLE B(4)—MAXIMUM FLIGHT TIME LIMITS, INTERNATIONAL ALL-CARGO

	Maximum flight time (2 pilot)	Maximum flight time (2 pilot, 1 engineer)
Flight time includes WOCL	8	12
Flight time does not include WOCL	10	12

The FAA has decided to propose a variation of the more conservative maximum daily flight time limits for unaugmented operations in Table B(2). The agency proposes to extend the number of hours reflected in Table B(2) by one hour. This approach melds the different approaches in Tables B(1) and B(2), allowing for slightly higher flight time limits during early morning and daytime hours than are currently allowed, but not permitting extensions that, at some hours, come close to a 50 percent increase over the current limits. Because current unaugmented operations are limited to 8 hours, the FAA's ability to evaluate the impact of significantly longer flight time limits on aviation safety is limited. Accordingly, the FAA believes it is appropriate to propose overall limits that are more conservative than those depicted in Tables B(1), B(3) and B(4).

The FAA recognizes that it has allowed up to 12 hours of flight time in circumstances that it has considered augmented operations, even though the third flightcrew member is not able to fly the plane. This has occurred in supplemental and flag operations when the flightcrew consists of two pilots and a flight engineer, and was more common when the fleet of aircraft requiring flight engineers was larger. Accordingly, this data set is much smaller than the set based on the 8-hour domestic limitation. Nevertheless, based on the safety history of these operations, it may be possible to demonstrate that longer flight time limits will not adversely affect safety, particularly during daytime hours when the flightcrew had an opportunity to sleep through their WOCL the previous night.

The FAA also recognizes that daily flight time limits will have the greatest impact on crew pairings that consist of a single leg. This is because when flying multiple segments, more of the FDP will be spent on layovers. Thus, for a single segment pairing, almost all of the FDP will consist of flight time, while for a pairing with three or four legs, much of the FDP will not consist of flight time. As a carrier adds legs, the FDP becomes more of a constraint than the flight time limit.

The FAA has decided against proposing special rules for all-cargo operations because there are no physiological differences between pilots who fly cargo planes and pilots who fly passenger planes. As noted before, the FAA believes the distinctions between domestic and international operations are largely irrelevant. To the extent they are truly distinct (generally due to the length of the trip), those differences are better addressed through augmentation rather than simply by extending the allowable flight time. Augmentation is discussed in greater detail in the next section.

The FAA seeks comment on the following:

(12) If the FAA adopts variable FDP limits, is there a continued need for daily flight time limits?

(13) If the FAA retains daily flight time limits, should they be higher or lower than proposed? Please provide data supporting the answer.

(14) Should modifications be made to the proposed flight time limits to recognize the relationship between realistic flight time limits and the number of flight segments in an FDP?

G. Mitigation Strategies

1. Augmentation

Even with the variable FDP and flight time, there will continue to be a need to augment crews for longer flights. Ideally, augmentation should follow the same approach as FDP, *i.e.,* circadian rhythms, acclimation to time changes, and multiple flight segments should be considered in determining how much augmentation is required. Further consideration should be given to the quality of the available rest facility.

Essentially, the current regulations require augmentation beyond 8 hours of scheduled flight time. Under the FAA's flag and supplemental rules, augmentation permits the following increases in flight time above the 8-hour limitation contemplated under the agency's domestic rules: [27]

- If there are three flightcrew members (one of whom may be an engineer), maximum flight time is extended to 12 hours. There is no requirement for a rest facility.
- If there are four pilots (or three pilots and two flight engineers), maximum flight time is extended to 16

[27] Because the domestic rules do not allow for any extension of flight time, augmentation is not used domestically.

hours. There must be an FAA-approved rest facility on board the aircraft (generally a bunk).

- There are no hard constraints on flight time that exceeds 16 hours. Instead, the FAA has addressed the carriers' fatigue mitigation practices on a case-by-case basis.

The FAA believes that its current approach to augmentation fails to consider several pertinent factors. It fails to adequately consider the qualifications of all of the flightcrew members, giving credit for individuals who are not qualified to operate the controls; it fails to consider the varying quality of sleep facilities below a 12-hour flight time limit; it fails to recognize that, provided an opportunity for sleep is provided, some domestic operations could benefit from augmentation; and, as is the case generally with the agency's flight and duty regulations, it fails to consider the impact of circadian rhythms.

The FAA proposes to amend the existing regulations by varying the levels of augmentation credit depending on the quality of the rest facility, except that no credit would be given for rest in coach seats. The level of extensions would also vary based on when the flight takes place to account for circadian rhythms and whether the flight crew is acclimated. Domestic augmentation would be permitted if a sufficient rest opportunity is provided. Finally, all flightcrew members would have to be type-rated as a second-in-command (SIC) or pilot-in-command (PIC) and throughout the flight at least one crewmember on the flightdeck would have to be type-rated as a PIC. The FAA would also continue to permit extensions in flight time based on the number of flightcrew members, with greater credit given for four-man flightcrews than for three-man crews.

The FAA believes this approach will provide carriers with a significant amount of flexibility. Should the carrier decide not to invest in superior rest facilities, it could opt to provide a lesser quality rest facility and add additional, qualified flightcrew members to extend the augmentation period.

The FAA's proposal is largely based on the general recommendation of the ARC. In reaching its conclusions, the ARC members reviewed the scientific material regarding augmentation that was presented during its meetings. Following are key points made by the sleep specialists during their presentations.

- In-flight naps with augmented flightcrews are dramatically helpful in mitigating sleep debt.
- When extending the FDP with an augmented flightcrew, augmented flightcrew members are presented with an opportunity for in-flight sleep, however the flightcrew members must take advantage of this sleep opportunity because augmentation is of no value if the entire flightcrew is awake.
- The value of augmented flightcrew operations depends on the available sleep facility, with a quiet, flat bunk being the most desirable.
- In-flight sleep has restorative value, and the flatter one is able to lie, the more beneficial the sleep.[28]
- To divide in-flight duty and rest among the flightcrew appropriately, route guides for positioning of sleep should be developed for augmented flightcrews (i.e., not all crewmembers need to be provided for equal sleep opportunities; rather pilots responsible for more complicated duties such as take-offs and landings may need more of a sleep opportunity, and may need that opportunity at a more ideal time in the flight).

In establishing the maximum scheduled FDP limitations for an augmented flightcrew, the ARC discussed the relative merits and safety of operations conducted with augmented flightcrews receiving in-flight rest, as compared to conventionally scheduled operations. The ARC noted that the type of rest facility needs to be addressed in the proposed rule and in advisory material.

The most comprehensive evaluation of available sleep facilities was conducted by the Dutch government in 2007 to provide science-based advice on the maximum permissible extension of the FDP related to the quality of the available onboard rest facility and the augmentation of the flightcrew with one or two pilots. Extension of Flying Duty Period by In-flight Relief (July 29, 2007) (TNO Report). The TNO report benchmarked existing research in arriving at its recommended values. The TNO report evaluated the quality of existing sleep facilities to determine how much sleep a flightcrew member could reasonably expect to get. The evaluation ranged from coach seats (a class IV rest facility) to bunks that were isolated from the rest of the crew and passengers (a class I rest facility). Based on the quality of the facility, the TNO Report assigned different values that would allow for an extension of the FDP. Based on its research, TNO decided against giving any credit for class IV rest facilities.

The ARC noted that both the TNO Report and CAP–371, to varying degrees, assign value to in-flight rest opportunities that depend on the quality of the rest facility available on the aircraft. The ARC determined that there are approximately 20 different combinations of facilities among various certificate holders. The ARC members developed a rating system dependent on the ability to lie in a horizontal, flat position; control the amount of light and noise; and rest in a temperature-controlled environment; as well as the flightcrew member's time off task. Depending on the amount of points assigned to these areas, the amount of credit for receiving rest in a type of seat could be calculated. The ARC members suggested a Type I, II, and III scheme, resulting in the following classes of sleep facilities:

- *Class 1 rest facility:* A bunk or other surface that allows for a flat sleeping position, is separated from both the flight deck and passenger cabin to provide isolation from noise and disturbance and provides controls for light and temperature.
- *Class 2 rest facility:* A seat in an aircraft cabin that allows for a flat or near flat sleeping position (around 80 degrees from the seat's vertical centerline),[29] is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation, and is reasonably free from disturbance by passengers and/or flightcrew members.
- *Class 3 rest facility:* A seat in an aircraft cabin or flight deck that reclines at least 40 degrees, provides leg and foot support, and is not located in the coach or economy section of a passenger aircraft.

Accordingly, the ARC revised the sleep credit for the class rest facility to more closely align the percentages with the TNO Report recommendations as follows:

- Class 1: 75 percent.
- Class 2: 56 percent.
- Class 3: 25 percent.
- No credit for coach seats.[30]

The ARC determined that augmentation should be required when either the maximum scheduled FDP or flight time hour limit depicted in Tables A and B of this document is insufficient for the planned operation. The ARC considered that longer flights crossing multiple time zones or overnight flights could be better indicators of the need to augment than flight times. For example,

[28] Sitting up increases blood flow to the brain and causes emission of norephrenephrine, which is stimulative instead of relaxing.

[29] This constraint would likely keep the rest facility out of the coach or economy section of the aircraft.

[30] CAA would give partial credit for coach seats.

an 8-hour, 45-minute flight during the day could be safely operated by an un-augmented flightcrew, but a 7-hour, 30-minute overnight flight should perhaps be augmented. One ARC member proposed that any planned pairing with greater than 6.5 block hours where the FDP infringes on the normal sleep cycle require augmentation.

The ARC developed Table C, which combines the limits from the first (single flight segment) column of the proposed FDP table (Table A) with principles from the TNO Report.

TABLE C—FLIGHT DUTY PERIOD: ACCLIMATED AUGMENTED FLIGHTCREW

Time of start (home base)	Maximum flight duty period (hours and minutes) based on rest facility and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 pilots	4 pilots	3 pilots	4 pilots	3 pilots	4 pilots
0000–0559	13:50	16:05	12:55	14:20	11:45	12:15
0600–0659	15:10	17:40	14:10	15:40	12:55	13:25
0700–1259	16:30	19:20	15:25	17:05	14	14:30
1300–1659	15:10	17:40	14:10	15:40	12:50	13:20
1700–2359	13:50	16:05	12:55	14:20	11:45	12:15

The ARC discussed placing an absolute cap of 16 or 18 hours (for a three- or four-man flightcrew, respectively) on the FDP, even though the TNO Report scheme results in a higher FDP. The ARC determined that higher FDPs could be achieved only by use of an FRMS. Under such a constraint, only augmented operations commencing between the hours of 7 a.m. and 1 p.m. would be constrained beyond Table C, and then only when the highest quality rest facility is provided. The ARC stated that its prescriptive approach could apply to most operations, but certificate holders engaged in ultra-long range operations could use an FRMS to develop an alternate means of fatigue mitigation tailored to their specific operations. The ARC members noted that some types of operations, such as air cargo operations, which operate under different demands and circumstances, might approach augmentation and fatigue differently than other types of operations.

The maximum scheduled FDP limitations for augmented flightcrew member operations with an unacclimated flightcrew are set forth in Table D.

TABLE D—FLIGHT DUTY PERIOD: UNACCLIMATED AUGMENTED FLIGHTCREW

Time of start (home base)	Maximum flight duty period (hours and minutes) based on rest facility and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 pilot	4 pilot	3 pilot	4 pilot	3 pilot	4 pilot
0000–0559	13:15	15:20	12:20	13:35	11:15	11:45
0600–0659	14:30	17	13:35	15	12:15	12:50
0700–1259	15:50	18:30	14:50	16:25	13:30	14
1300–1659	14:30	17	13:35	15	12:20	12:45
1700–2359	13:15	15:20	12:20	13:35	11:15	11:40

The ARC calculated the maximum scheduled FDPs in Table D for augmented flightcrew members who are not acclimated based on the same methodology provided for acclimated flightcrew members in Table C above. However, for unacclimated flightcrew members there is a roughly 30-minute reduction in the planned maximum FDP for augmentation calculation. The absolute cap of 16 and 18 hours would correspondingly be reduced to 15.5 and 17.5 hours, respectively.

The FAA has decided to propose the augmentation levels proposed by the ARC in Table C, except that the numbers have been rounded up or down to the closest half hour for regulatory efficiency. As suggested by the ARC, acclimated operations are capped at 16 hours if only a three-man crew is available and 18 hours if a four-man crew is available. In addition, the FAA is not proposing to implement Table D into the regulatory text because it is essentially a thirty minute reduction from Table C. Rather, the regulatory text specifies that the numbers in Table C are reduced by 30 minutes if a crew is not acclimated. This approach is consistent with the one proposed for un-augmented operations.

The ARC noted that augmentation should be used strictly for long flights and not to extend the FDP for multiple short flight segments. The ARC discussed whether more than two flight segments should be permitted in augmented flight operations and, if so, should an FRMS be required to do so. Some members of the ARC cautioned that augmentation should not be permitted to facilitate unnecessary additional flight segments or eliminate crew swaps. These individuals argued that augmentation was initially permitted to address those flights that could not reasonably be conducted within the existing rules at that time because the distances involved prevented long layovers or crew swaps. This issue was particularly relevant to the discussion of whether augmentation should be used for domestic operations. The primary concern related to multi-segment augmented flights was the available sleep opportunity for flightcrew members. Everyone acknowledged that flightcrew members are not going to sleep during take-off and landing. Accordingly, flight segments need to be sufficiently long to permit the flightcrew members to actually sleep. The ARC agreed that a flightcrew member assigned to a multi-segment trip needs a specific amount of available time to rest to fly the multiple segments.

The FAA agrees that short flight segments will not permit a flightcrew member to sleep. Thus, too many flight segments, even within an extended FDP, would not allow a meaningful sleep opportunity for the flightcrew. The FAA is proposing that a certificate holder not schedule an augmented crew pairing with more than three segments (including FDPs that include required technical stops such as stopping for fuel or to clear customs). In addition, two consecutive hours must be available for in-flight rest for the flightcrew member manipulating the controls during landing; a 90-minute consecutive period must be available for in-flight rest for each flightcrew member; and the last flight segment must provide a two consecutive hour rest period. The proposed requirement for the 2-hour rest opportunity on the last flight segment is designed to address a common recognition among the ARC members that, even on a flight with only two segments, the last segment is often of such duration that there is no realistic rest opportunity, even though this is when the crew is likely to be the most fatigued.

The ARC discussed the qualifications of the relief flightcrew member used in augmented operations. Some ARC members emphasized that there must be one type-rated flightcrew member on the flight deck at all times. One ARC member noted that current regulations require only one type-rated flightcrew member on the aircraft. Another ARC member stated that under no circumstances should a flight engineer serve as a relief flightcrew member. The ARC proposed that at least one flightcrew member type-rated in the aircraft be on the flight deck at all times. The ARC largely deferred to the FAA in deciding whether to allow augmentation based on the presence of a flight engineer.

As mentioned earlier in this section, the FAA does not believe a flight engineer may serve as a relief flightcrew member unless he or she is qualified as a PIC or SIC and type rated. The purpose of a relief flightcrew member is to have someone available to help fly the airplane when another flightcrew member is at rest. In order for him or her to do this, the relief flightcrew member must know how to actually operate the aircraft.

The FAA seeks comment on the following:

(15) Should augmentation be allowed for FDPs that consist of more than three flight segments? Does it matter if each segment provides an opportunity for some rest?

(16) Should flight time be limited to 16 hours maximum within an FDP, regardless of the number of flightcrew members aboard the aircraft, unless a carrier has an approved FRMS?

(17) Should some level of credit be given for in-flight rest in a coach seat? If so, what level of credit should be allowed? Please provide supporting data.

(18) Is there any reason to prohibit augmentation on domestic flights assuming the flight meets the required in-flight rest periods proposed today?

(19) Are the proposed required rest periods appropriate?

(20) Should credit be allowed if a flightcrew member is not type-rated and qualified as a PIC or SIC?

2. Split Duty Rest

The concept of allowing mitigation for split duty sleep is similar to that for augmentation, in that a crewmember can regenerate to some extent because of the ability to sleep for a period of time during his or her FDP. In fact, the quality of the sleep facility may be significantly better than the quality of a sleep facility aboard an aircraft. However, the initial theory behind augmentation was that it was impossible to simply place a fresh crew aboard the aircraft. While that may be true in some instances where split duty rest is contemplated, it is not universally true. In any case, current regulations provide no incentive for a carrier to provide its flightcrew members with a rest opportunity outside of the mandatory rest requirements. Nevertheless, some carriers have spent considerable amounts of money developing rest facilities for their employees, and others provide hotel rooms, even though not required by the FAA. Carriers have taken these steps recognizing that, even though not required, providing the rest facilities increases the level of safety.

The ARC discussed the concept of split sleep with the sleep specialists to assess the value of the type of rest obtained on a split duty trip. The scientists noted that split sleep is an area of intensive work. All other factors being equal, if the total amount of actual sleep is the same, split sleep is theoretically as valuable as continuous sleep.[31] However, the presenters noted that the value of sleep is impacted by where it falls in the circadian cycle. They stated that split sleep with 4 hours sleep during a circadian night is better than 8 hours of continuous sleep during the day. However, the larger portion of split sleep ideally would fall during the WOCL, and they reiterated that split sleep with a component at night is better than consolidated sleep during the day. This is because the ability to sleep effectively is diminished during daytime hours because it is very difficult to get continuous sleep during this time. They also stressed that actual sleep is important, and noted that a 4-hour sleep opportunity may only net 2 hours of actual sleep.[32]

The ARC discussed extending the FDP based on the opportunity for sleep during the duty period and the mitigations needed to extend the FDP. These mitigations would apply to split duty trip pairings (including continuous duty overnights, also known as CDOs), in which a flightcrew member has a downtime of several hours between flights within the same FDP.

Some members of the ARC rejected the concept of a regulatory credit for split duty sleep, while others noted that it is fully consistent with the concept of extending FDPs based on augmentation. The ARC considered allowing a certificate holder to extend the FDP up to 50 to 75 percent of time that a flightcrew member spent resting in a suitable accommodation up to a maximum FDP of 12 to 13 hours as long as certain conditions were met. First, the sleep facility should be a single occupancy, temperature-controlled facility with sound mitigations that provide a flightcrew member with the undisturbed ability to sleep in a bed and to control light. Second, the flightcrew member must be given an actual, not simply scheduled, sleep opportunity in the suitable accommodation. Some ARC members also suggested that there should be a requirement that the sleep facility be approved by the FAA, there be an employee feedback process to assure the facilities were adequate, and that the opportunity for rest coincide with the flightcrew member's circadian rhythms.

The FAA is proposing to permit credit for split duty sleep consistent with the proposal presented by those members of the ARC supporting credit. A reasonable sleep opportunity must actually be provided (as opposed to simply scheduled), and the sleep facility must be adequate to reasonably allow sleep. A carrier could extend an FDP by 50 percent of the actual available sleep opportunity if it provides at least 4

[31] However, they also noted that there is an overhead involved in getting to sleep, and that split sleep multiplies that overhead. Therefore, split sleep with 4 hours at night and 4 hours during the day would, over time, result in a cumulative sleep debt.

[32] The presenters stated that it is less clear if a split sleep involving a 2-hour sleep segment and a 6-hour sleep segment is equivalent to eight hours of continuous sleep.

hours sleep opportunity. However, the FDP could not be extended beyond 12 hours.[33] The sleep opportunity is calculated from the time the flightcrew member actually reaches the sleep facility, rather than when it is scheduled. This is because a scheduled sleep opportunity may be reduced considerably if there are delays or an unanticipated need for further aircraft movement. As with all other instances when transportation to or from a rest facility is involved, the period of time engaged in transportation does not count as duty, but it also does not count as rest.

The rest facility must be adequate to reasonably permit the flightcrew member with an opportunity to rest. To that end, it must be quiet, temperature-controlled, and light-controlled. The FAA considered whether to require that it also be a single occupancy facility. The agency has tentatively decided against such a requirement because it understands that there are currently facilities where there may be more than one bed per room, and it believes this is fundamentally a labor-management issue. Flightcrew members regularly spend the night near their home base in houses or apartments where there may be multiple beds in a single room. If this dormitory-type housing is sufficient for full rest periods, it should, from a regulatory perspective, be sufficient for a split rest facility.

The FAA seeks input on the following:

(21) Please comment on whether a single occupancy rest facility provides a better opportunity for sleep or a better quality of rest than a multiple occupancy facility such as a multi-bed crew sleeping facility or multi-bed living quarters. Please provide supporting data.

H. Consecutive Nighttime Flight Duty Periods

There was a discussion among ARC members on whether there should be a limitation on the number of consecutive nights that a pilot could fly, based, in part, on a presentation to the ARC that performance falls off under the SAFTE/FAST model after the third night. Currently the FAA places no restrictions on the number of allowable consecutive nighttime operations, as long as the crewmember receives 24 consecutive hours free from duty in a 7-day period. CAP–371 provides a scheme whereby flight duty periods are reduced based on the number of previous consecutive nights flown. The FAA is unaware of the basis for this scheme, and it is not readily apparent from a reading of the requirement.

Modeling indicates that consecutive nights of nighttime work will lead to a decrease in productivity over a relatively short period of time (approximately 3 days). The modeling notes a steady deterioration in performance because it is very difficult for most people to sleep effectively during the day.[34] The members of the ARC who had flown nighttime operations generally agreed that the first night of multiple nighttime operations was the most difficult because they were unaccustomed to being awake all night.

During the ARC discussion, the cargo contingent of the part 121 community asserted that if one changes the assumption in the SAFTE/FAST model and assumes that one can train oneself to sleep effectively during the day, it may be possible to work more consecutive nights without a significant degradation in performance. This may be particularly true if an individual is provided an opportunity to sleep during the night while packages are being sorted from one plane to the next. The cargo carriers asserted that higher levels of sleep pressure brought on by the longer period of wakefulness on day one of the pairing act to offset the general inability to sleep effectively during the day, particularly when people have been trained to understand the need to take advantage of the sleep pressure to improve their ability to sleep during the day. The FAA has asked Dr. Hursh, who developed the SAFTE/FAST model,[35] to input these assertions into the model. Dr. Hursh determined that, given a sufficient sleep opportunity at night, a person can sustain his or her performance at acceptable levels for five consecutive nights. However, the smaller the nighttime sleep opportunity, the lower level of performance, particularly by night five. In addition, training on how to maximize sleep opportunities is critical because an individual needs to get enough sleep during the day to make up for the nighttime sleep deficit. A copy of Dr. Hursh's analysis has been placed in the docket for this rulemaking.

The FAA has decided to take a comprehensive approach towards consecutive nighttime operations that it believes addresses the concerns by both contingents within the ARC. The agency proposes to permit consecutive nighttime flying, constrained only by 30-hour consecutive rest required for any 168-hour period, as long as there is an opportunity to rest in a suitable facility during the flight duty period. As proposed, this sleep opportunity would have to comport with the proposed split duty requirements for extending a flight duty period. Should no such opportunity be provided, a carrier could not assign a flightcrew member to more than three consecutive nightime FDPs. While this approach is more restrictive than currently permitted, it permits cargo carriers who provide adequate rest facilities to continue their current operations. It also assures that flightcrew members are given an opportunity for limited nighttime rest.

The FAA has concerns that simply limiting nighttime operations to three consecutive nights could result in a significant increase in the number of first night operations, since presumably carriers will not change the nature of their operations, but simply will schedule more multiple-night crew pairings to accommodate the existing operations. Thus, a flightcrew member who is currently assigned two 5-night pairings in a 2-week period could potentially be assigned three 3-night pairings in the same 2-week period, increasing the risk associated with the first night of operations by 50 percent during that timeframe. Certainly long-standing industry practice has been to fly more than three consecutive nights. The FAA is concerned that taking an approach that may appear safer in modeling could lead to adverse safety impacts in the real world.

The ARC contingent advocating restrictions on consecutive night flight duty periods suggested a fourth night was acceptable as long as a 14-hour rest was provided between nights three and four. The FAA notes that a 14-hour rest opportunity would limit a flightcrew member to a maximum 10-hour duty

[33] As a practical matter, the 12-hour limitation on FDP makes split duty sleep desirable only for nighttime operations or operations that begin late at night and restart very early in the morning. The FAA believes it is unlikely a carrier would rely on split duty sleep opportunities in the middle of the day because there would be no additional credit.

[34] A copy of the technical report evaluating the model has been placed in the docket. See also, Rosekind, M.R., Gander, P.H., Graeber, R.C., Connell, L.J., Gregory, K.B., Miller, D.L., & Barnes, R.M. (1998). Crew factors in flight operations: The initial ASA-Ames field studies on fatigue. Aviation, Space, and Environmental Medicine, 69 (2), B1–B60. Thomas, M.J.W., Petrilli, R.M., Roach, G.D. (2007). The Impacts of Australian Transcontinental "Back of Clock" operations on sleep and performance in commercial aviation flight crew (B2005/0121). Adelaide/Whyalla, Australia: University of South Australia, Centre for Applied Behavioural Science. Gander, P.H., Gregory, K.B., Connell, L.J., Miller, D.L., Graeber, R.C., & Rosekind, M.R. (1996). Crew factors in flight operations: VII. Psychophysiological responses to overnight cargo operations (NASA/TMm1996–110380). Moffett Field, CA: NASA Ames Research Center.

[35] This model is widely used, with approximately 14 major carriers and sixteen governmental agencies world-wide having used the model to evaluate fatigue in aviation and other industrial settings.

period, excluding the time required for local commuting.[36] The FAA is not sure that this approach would provide a meaningful FDP for the fourth night.

The FAA requests input on the following:

(22) Should there be any restriction on consecutive nighttime operations? If not, why?

(23) If the nighttime sleep opportunity is less than that contemplated under the split duty provisions of this notice, should a carrier be allowed to assign crew pairing sets in excess of three consecutive nights? Why or why not?

(24) If the nighttime sleep opportunity meets the split duty provisions of this notice, should the carrier be allowed to extend the flight duty period as well as the number of consecutive nighttime flight duty periods? Why or why not?

(25) Should a fourth night of consecutive nighttime duty be permitted if the flightcrew member is provided a 14-hour rest period between nights three and four?

I. Reserve Duty

While the term "Reserve" has been used for years in the air carrier industry, the term is not addressed at all in part 121. The agency has issued 11 legal interpretations on the subject of reserve, which range from examples of whether a crewmember is on duty and, if applicable, whether the required rest associated with that duty period is impeded by being in a reserve status.

The ARC discussed various definitions of reserve and initially proposed that reserve means that a pilot that does not have a regular flying schedule and is available for flight when contacted by the company. That pilot has no telephone or reporting responsibility to the company. The ARC refined the definition of "reserve" to read "a flightcrew member that is required by a certificate holder to be available to receive an assignment for duty." In addition, the ARC established the following types of reserve duty: Long-call, short-call, and airport/standby. The ARC noted that the policies that apply to reserve flightcrew members vary significantly between certificate holders, but also found that there are some relatively consistent conditions.

CAP–371 places restrictions on "Standby Duty", which is generally the equivalent of short-call reserve discussed below. When standby duty is undertaken at home, or in a suitable accommodation provided by the operator, during the period 2200 to 0800 hours local time and a crew member is given 2 hours or less notice of a report time, the allowable FDP starts at the report time for the designated reporting place. EASA recognizes "standby duty", but does not place any regulatory restrictions on this type of duty.

Reserve duty is inherently based on unpredictable events, such as covering trips for flightcrew members who become ill, have difficulty traveling to the airport for an assignment because of weather or other reasons, or are stranded due to severe weather creating flightcrew member shortages throughout a certificate holder's system. The very nature of reserve duty makes injecting predictability into a reserve flightcrew member's schedule a challenge.

The ARC set a goal to make reserve duty as predictable as possible, and to manage fatigue as much as possible. The proposal on how to address reserve limits was one of two areas of consensus by the ARC. The ARC concept includes defining limits associated with flight duty period, duty period and rest limitations.

One of the most fatiguing elements of reserve duty is the lack of predictability. Unlike a flightcrew member who has a set schedule (a line-holder), a flightcrew member on reserve may spend several hours on-call and then, once called, be expected to report to the airport ready to commence his or her duty day. The lack of predictability means the reserve crewmember cannot schedule naps or otherwise control his or her sleep opportunities to assure the reserve crewmember is adequately rested when he or she reports to work.

The ARC asked the sleep specialists what impact this lack of predictability has on a reserve flightcrew member compared to a line-holding flightcrew member. The presenters responded that depending on when a reserve flightcrew member is called and how much notice is given, he or she may not have the same opportunity to nap that a line-holder would have, because the line-holder would know about the trip and could plan his or her rest accordingly. A reserve flightcrew member also might not nap, even if he or she thought a call was unlikely, because this uncertainty may disrupt his or her sleep schedule. The ARC asked the scientists how a reserve flightcrew member could best prepare for a potential assignment, without knowing when he or she may be called. They recommended a normal night's sleep through the WOCL and a late afternoon nap in the minor WOCL. The ARC also asked the presenters if there was a maximum duty time that should be set for reserve duty. The scientific presenters noted that the ability to successfully manage time-on-duty is dependent on rest. If 8 hours sleep in the WOCL is available, then 16 hours of duty is theoretically possible.

Short-Call and Airport/Hotel Standby Reserve

Airport/standby reserve[37] is known by several terms among various certificate holders, but ultimately involves a flightcrew member on call at an accommodation or other facility at or near an airport. The flightcrew member is not at home and is not resting. The purpose of such reserve duty is to have an available flightcrew member close to the operation in case of a schedule irregularity. Flightcrew members on these assignments can receive notice to report to work in as little as 1 hour before departure time, requiring them to be in a constant state of readiness. Because of the unique nature of these assignments, and the fact that the flightcrew member is not resting, an airport/standby reserve assignment is considered to be an FDP, regardless of whether a flying assignment is ultimately received by the flightcrew member.

Short-Call Reserve

A short-call reserve flightcrew member typically receives an assignment on relatively short notice, meaning he or she would not be provided an adequate time for a legal rest period before reporting for duty. Report times are typically within two to 3 hours from notification. Short-call reserve differs from airport/standby reserve in that the flightcrew member is likely to be at home and available for contact by the certificate holder, rather than at the airport or a hotel actively awaiting an assignment. Although the flightcrew member may be at home, the opportunity for sleep before reporting for duty cannot be guaranteed. Therefore, the ARC deemed a limit on the amount of time spent on short-call reserve duty as necessary.

The ARC noted that a number of variables may impact the maximum FDP for a short call reserve.[38] These variables include:

• *Timing of on-call period within a circadian day.* Where an on-call period starts in relation to standard circadian rhythms can affect alertness and state of

[36] Although today's proposal does not contemplate a 24-hour day, the FAA assumes that consecutive nighttime operations would generally be scheduled at approximately the same time each day.

[37] The word "airport" was added to standby to differentiate between the ICAO term "standby," which is the equivalent of "reserve" in U.S. terminology.

[38] These same variables apply to airport/standby reserve but are addressed there by the maximum FDPs in the FDP table.

rest. Generally, short call availability periods may be classified as very early morning, daytime, or night. The ARC considered that daytime reserve flightcrew members can be presumed to be well-rested and alert at the start of their reserve period because they can get a regular night's sleep. For the other classifications, circadian factors may make flightcrew members less alert and rested than those on daytime reserve. One ARC member suggested that flightcrew members called to report during overnight hours should have a reduced maximum FDP.

• *Length of on-call period.* Not all carriers have the same reserve policies. Some certificate holders have relatively short on-call periods, lasting only a few hours, while other certificate holders may require flightcrew members to be on call for 12 hours or more.

• *Timing of call and report time in relation to on-call period and length of duty day.* One ARC member noted that during an on-call period, the time the flightcrew member is called and the time the flightcrew member is expected to report may affect the flightcrew member's alertness and rested state (*e.g.,* called at 5 a.m. to report at 3 p.m. vs. called at 10 a.m. to report at noon).

• *Recent on-call history.* The ARC noted that reserve flightcrew members with on-call schedules often change schedules from day to night, or vice-versa, within a short period of time. Such changes, especially if given with short notice, can result in reserve flightcrew members failing to obtain proper rest before their on-call periods.

Long-Call Reserve

Long call reserve [39] pilots are given relatively substantial advance notice of when they are to fly. This notice may be from 9 hours to over 24 hours. A long-call reserve flightcrew member typically receives an assignment for duty well in advance and will have a sleep opportunity before reporting for duty, and may have enough notice of the assignment to plan his or her rest accordingly. The ARC recognized, however, that depending on the timing of notice and the report time in relation to circadian rhythms, reserve flightcrew members may not be able to obtain a full 8 hours of sleep, despite the opportunity to do so. The lack of predictability of when the flightcrew member will be required to report for duty makes it difficult for the reserve flightcrew member to plan ahead in his or her sleep rest cycles.

The ARC considered two reserve systems developed by working groups consisting of ARC members representing industry and labor groups.

One working group proposed a WOCL Aware Reserve System to the ARC. Some key points of the system are as follows:

• Any reserve flightcrew member called between 2200 and 0600 will receive a minimum of 10 hours of rest before reporting for duty.

• Any reserve flightcrew member called to fly into the WOCL would have to be contacted within the first 6 hours of his or her reserve duty.

• If normal sleep time is not interrupted and a reserve flightcrew member is not being called to fly into the WOCL, he or she would have the same FDP limit as a line-holder because they received similar rest.

• Airport/standby reserve is to be treated like a trip assignment and is considered as an FDP. No part of airport/standby reserve may be considered rest, even if the flightcrew member is at a hotel.

The proposal for a Predictable Reserve System with Circadian Stability (Predictable System) is based on three prongs: Science, circadian stability, and adequate rest. The proposal incorporates provisions from CAP 371, and provides some recommendations from a reserve rest ARC that convened in 1999. The second proposal contained the following elements:

Reserve Limits

• Created several definitions applicable to reserve including "reserve availability period" (RAP), "reserve duty period" (RDP), "short call reserve", and "long call reserve."

• Maximum RDP is 16 hours.

• Maximum reserve availability period (RAP) for short call reserve is 14 hours.

• Carrier receives half credit for not calling a reserve crew member on phone availability between 0000 and 0600; maximum 3 hours.

Shifting RAP

• Later—12 hour maximum in any 168 consecutive hours.

• Earlier—3 hour maximum into the WOCL; 5 hour maximum otherwise.

• Not allowed on consecutive days.

Concerns were expressed regarding individuals on phone availability being called during the window of circadian low. However, it was noted that based on scientific modeling, for a reserve called during the window of circadian low, a 4-hour lookback (the period in which the carrier must contact the reserve from the start of the RAP to use the entire available FDP) actually would be better than the 6-hour lookback originally proposed under the WOCL Aware proposal.

A scenario was also posed of a pilot with a RAP starting during the window of circadian low, but not called until after the window of circadian low had passed. It was proposed that some credit be given for the sleep obtained before being called. After brief discussion, the ARC decided to move forward with a maximum FDP limit of 16 hours after the start of the RAP.

After considering the above proposals and other discussions, the ARC proposed the following requirements for reserve duty:

• "Scheduled" is defined as times assigned by a certificate holder when a flightcrew member is required to report for duty. "Assigned" is defined as scheduling by a certificate holder when a flightcrew member is required to report to duty.[40]

• Airport/standby reserve counts as part of the flightcrew member's FDP.

• RAP and RDP only apply to short call reserve.

• The maximum RDP for un-augmented operations is the flightcrew member's possible FDP under the FDP table plus 4 hours, or 16 hours, whichever is less.

• The maximum RDP for an augmented flight crew is the flightcrew member's possible FDP under the augmented FDP table plus 4 hours.

• A carrier receives half credit for not calling a reserve crew member on phone availability between midnight and 6 a.m. up to a maximum of 3 hours (*e.g.,* if the crew member is on reserve starting at 1 a.m., but isn't called until 3 a.m., the RAP is extended by 1.5 hours).

• A short-call reserve duty period in which the crewmember is not called to report to work may not exceed 14 hours.

• Conversion from long-call to short-call reserve assignment must be preceded by a legal rest period.

• A long-call reserve flightcrew member must receive a legal rest prior to reporting for duty and at least 12 hours notice of an assignment of a trip pairing that will extend into the window of circadian low.

[39] The ARC defined a long-call reserve as "a reserve flightcrew member whose obligation to report for an FDP following notification contains a legal rest period before report time."

[40] The ARC notes that "assigned" and "scheduled" are one in the same; therefore, when a certificate holder assigns a reserve flightcrew member a trip, that certificate holder has given that flightcrew member a schedule. This prevents a certificate holder from assigning a trip to a flightcrew member and stating that the term assigned does not fall under the definition of scheduled. It also prevents certificate holders from only assigning trips and not scheduling any trips.

• A reserve flightcrew member's RAP may be shifted under the following conditions:

—A shift to a later RAP may not exceed 12 hours.

—A shift to an earlier RAP may not exceed 5 hours, or if the shift will move the availability into the flightcrew member's window of circadian low, it may not exceed 3 hours.

—A shift to an earlier RAP may not occur on consecutive days.

—The total amount of shift in RAPs for a flightcrew member may not exceed 12 hours (regardless of direction) in any 168 consecutive hour period.

Tables E(1) and E(2) are visual depictions of the maximum RAP discussed above based on the two FDP tables contemplated by the ARC.

TABLE E(1)—FLIGHT DUTY PERIOD RESERVE: TWO FLIGHTCREW MEMBERS, OPTION 1

Time of start (home base)	Maximum flight duty period reserve (hours) based on number of flight segments						
	1	2	3	4	5	6	7+
0000–0359	13	13	13	13	13	13	13
0400–0459	14	14	13	13	13	13	13
0500–0559	15	15	15	15	14	13.5	13
0600–0659	16	16	16	16	15	15	14.5
0700–1259	16	16	16	16	16	16	15
1300–1659	16	16	16	16	15.5	15	14.5
1700–2159	15	15	14	14	13.5	13	13
2200–2259	14.5	14.5	13.5	13.5	13	13	13
2300–2359	13.5	13.5	13	13	13	13	13

TABLE E(2)—FLIGHT DUTY PERIOD RESERVE: TWO FLIGHTCREW MEMBERS, OPTION 2

Time of start (home base)	Maximum flight duty period reserve (hours) based on number of flight segments						
	1	2	3	4	5	6	7+
0000–0159	13	13	13	13	13	13	13
0200–0459	14	14	14	14	13	13	13
0500–0659	16	16	16	16	15.5	15	14.5
0700–1259	16	16	16	16	16	16	15.5
1300–1659	16	16	16	16	15.5	15	14.5
1700–2159	15	15	15	15	13	13	13
2200–2259	14.5	14.5	14.5	14.5	13	13	13
2300–2359	13.5	13.5	13.5	13.5	13	13	13

Because this was one of only two ARC consensus areas, the FAA has decided to propose the ARC recommendation with only a few changes.

First, the agency has decided against adding Table E to the regulatory text. The agency believes the regulatory text is sufficiently clear. Also, the table does not include the credit that could be given for not calling during the reserve crew member's window of circadian low and could be misleading. Carriers (and the pilot associations) are of course free to draft whatever tables they think are helpful to understand the regulatory requirements.

Second, the ARC did not consider time within the RAP to be duty. However, the FAA believes that it may be appropriate to designate time spent in a short-call reserve status as duty.[41] While in a short-call reserve status, the crewmember can expect that he or she will not receive an opportunity to rest prior to commencing a flight duty period. The crewmember also is required to limit his or her actions sufficiently so that he or she can report to his or her duty station within a fairly short timeframe. Accordingly, the FAA believes this time needs to be accounted for within the cumulative duty limits discussed later in this document.

While the FAA is proposing the ARC recommendation on reserve, it also notes some concern with the level of its complexity. The agency is particularly concerned that the partial credit given for not calling during the window of circadian low will be difficult to implement. It may make more sense to simply assign a credit for not calling during the window of circadian low. The agency also has some concern that the RDP for augmented operations could extend to 22 hours. While there would be some opportunity to rest on board the aircraft, this proposal would permit some reduction in the overall rest opportunity.

The FAA seeks comment on the following:

(26) Please comment on whether a 16 maximum hour FDP for long call reserve is appropriate when the maximum FDP for a lineholding flightcrew member is 13 hours.

(27) Please comment on whether the proposed maximum extended FDP of 22 hours for an augmented flightcrew member is appropriate. If not, please provide an alternative maximum FDP.

(28) Please comment on whether a certificate holder should receive credit for not calling a flightcrew member during the WOCL while on reserve.

(29) Should minimum required rest while on reserve status be greater than the amount of rest required for a lineholding flightcrew member? If so, please provide supporting data, if not, please provide rationale.

(30) Please comment on the level of complexity on the proposed reserve system.

[41] This issue was not discussed by the ARC and there appears to be a general agreement in the aviation community that reserve is neither rest nor duty. The FAA agrees this approach is appropriate for long-call reserve and acknowledges that calling short-call reserve "duty" could have adverse implications if there were a daily duty limit. However, the FAA also believes that some portions of industry have developed reserve policies that increase the likelihood of fatigue because the reserve crewmember can spend long periods of time on reserve with no anticipation of a rest opportunity prior to reporting to work.

J. Cumulative Duty Periods

The FAA's current regulations do not impose a cumulative restriction on duty, although as a practical matter, a flightcrew member engaged in domestic operations is effectively limited to a 16-hour duty day and all flightcrew members are entitled to 24 consecutive hours free from duty during a 7-day period. Rather, the FAA has historically placed limitations on the number of flight hours a flightcrew member may be assigned on a daily, weekly, monthly, and annual basis. Depending on whether one is operating under domestic, flag or supplemental rules, flight time is limited to 30–32 hours a week, 100–120 hours a month, 300–350 hours a quarter, and 1,000 hours a year.

CAP–371 and EU–OPS subpart Q impose more restrictions on cumulative duty, with weekly limits ranging from 55 to 60 hours, biweekly limits of 95 hours (CAP–371 only), and slightly less than monthly limits of 190 hours (calculated against 28 days rather than an actual month). The ICAO SARP recommend that member states restrict duty hours within any seven consecutive days or a week and 28 consecutive days or a calendar month.

Scientific studies suggest that long periods of time on duty infringe upon an individual's opportunity to sleep, thus causing a "sleep debt" which is also known as cumulative fatigue.[42] Some conclusions are based on experiments in sleep labs, and there is limited data either supporting or refuting that the amount of cumulative duty has a direct effect on cumulative fatigue.

Despite the lack of validated data, the FAA believes it is appropriate to take a conservative approach and is proposing to impose cumulative limitations on duty, flight duty periods, and flight time. Not only are cumulative limits consistent with current regulations here and abroad, but they offer protections against practices common in the aviation industry, where pilots commonly work more than an 8-hour day, often at varying times in a single week. The FAA proposes to set maximum duty limitations, flight duty periods, and flight time (block) periods based on specific time intervals. Fewer hours on duty can be equated to more opportunity for rest, which can mitigate the amount of cumulative fatigue experienced by a flightcrew member. The proposed limits decline over extended periods of time, *i.e.,* the 28-day limits are less than four times the weekly limits. This approach would allow flightcrew members to work long hours over a relatively short period of time, but prevent long duty periods over extensive lengths of time.

The ARC defined duty as "any task that crewmembers are required by the certificate holder to perform including, but not limited to: Flight duty, administrative work, ground training, ancillary training, positioning, and airport standby." The FAA believes this definition appropriately details the type of work commonly required of crewmembers except that, as discussed earlier, it believes that time spent on short-call reserve should apply to the cumulative duty limits proposed today.

Under today's proposal, duty time would be limited to 65 hours in any consecutive 168-hour period (7 days) and 200 hours in any consecutive 672-hour period (28 days). The FAA is proposing consecutive hourly limits that equate to 7 and 28 days because the current requirements assume that a day starts just after midnight, which is an arbitrary constraint that does not work well for carriers. As a result, carriers have been allowed to define when their "day" begins. This approach is unwieldy. As a practical matter, the FAA expects that carriers and flightcrew members will base their "week" on the time the flightcrew member reported for duty after completing his or her extended rest period.

The weekly limit could be extended by up to 10 hours to 75 hours during a rolling 168 hours and the 28-day limit could be extended to 215 hours if the duty period includes deadhead segments in a rest seat outside the flight deck meeting or exceeding the provisions of class 2 rest facility.[43]

Allowing an additional 10 hours duty time for non-FDP deadhead flights when adequate sleeping accommodations are provided seems to be a reasonable accommodation to that sector of the industry that relies on deadheading to position pilots to areas outside of the U.S. Since the extension is limited to no more than 10 additional hours, there should be sufficient fatigue mitigation.

Since short-call reserve periods are tentatively considered to be duty, the FAA also believes it is appropriate to allow carriers to increase the maximum cumulative duty periods to account for the time spent on short-call reserve, while still recognizing that time spent on reserve is less strenuous than time actively spent on duty.

The FAA also notes that it may be appropriate to provide the same accommodation to management personnel. The rationale for allowing longer duty periods based on deadhead segments centered on the fact that deadheading in a "rest seat" provided mitigation in the form of an opportunity to rest; office work would not allow for such mitigation, but limiting the duty period to 65 hours a week for management could have an adverse safety impact (e.g., force flying shorter, unaugmented flights) since the management workload likely will not be reduced.

The extension of the maximum duty limit would only be extended by the amount of time spent engaged in the type of duty allowing for an extension. Thus, if a flightcrew member spent 5 hours on short-call reserve, the maximum weekly duty period would only be extended by 5 hours, to a total of 70.

The proposed cumulative limitation on flight duty periods is largely consistent with the approach already adopted by the British and EASA. Specifically, the ARC recommended that flight duty period be limited to 60 hours in any consecutive 168 hours (7 days) and 190 hours in any 672 consecutive hours (28 days). The ARC decided there was no need to implement a biweekly requirement, as exists in CAP–371, instead endorsing the approach adopted by EASA. The FAA agrees that a weekly and monthly approach sufficiently mitigates the effects of cumulative fatigue and is proposing the limits suggested by the ARC. The FDP is a sub-set of duty, and the maximum FDP limits are subsumed within the maximum duty limits. To the extent any duty other than that encompassed in the definition of a FDP cannot be completed within the time dedicated to non-FDP duty (typically 5 hours a week or 10 hours in a 4-week period), the amount of FDP is correspondingly reduced. Thus, during a 168-hour period, if a flightcrew member spent 30 hours in ground

[42] Krueger, G.P. (1989). Sustained work, fatigue, sleep loss and performance: a review of the issues. Work & Stress. 3, (2), 129–141. Galy, E., Melan, C., & Cariou, M. (2008). Investigation of task performance variations according to task requirements and alertness across the 24-h day in shift workers. Ergonomics, 51 (9), 1338–1351. Rosekind, M.R., Gander, P.H., Gregory, K.B., Smith, R.M., Miller, D.L., Oyung, R., Webbon, L.L., & Johnson, J.M. (1996). Managing fatigue in operational settings 1: Physiological considerations and countermeasures. Behavioral Medicine, 21, 157–165. Graeber, R.C. (1986). Crew factors in flight operations: IV. Sleep and wakefulness in international aircrews (NASA/TMm1986–88231). Moffett Field, CA: NASA Ames Research Center. Gander, P.H., Graeber, R.C., Connell, L.J., & Gregory, K.B. (1991). Crew factors in flight operations: VIII. Factors influencing sleep timing and subjective sleep quality in commercial long-haul flight crews (NASA/TMm1991–103852). Moffett Field, CA: NASA Ames Research Center.

[43] Except that no curtain need be provided if the crewmember is being deadheaded commercially, since this would be beyond the certificate holder's control.

training, the available amount of FDP for that period would only be 35 hours.

"Flight time" retains the meaning in 14 CFR 1.1. While the ARC largely agreed on a 100 hour limitation in any 672 consecutive hours (28 days), it was unable to agree on a maximum annual limit. Some argued that the constraints on cumulative duty and flight duty periods obviated the need for any limit. This argument was particularly strong with regard to annual limits on flight time. However simple calculations of the proposed weekly and 28-day limits revealed that absent an annual limit, a flightcrew member could potentially accrue as many as 2,000 flight hours in a 12-month period. Based on this assessment, those arguing against any limit conceded that some annual limit may be appropriate, but that in any case the current limit of 1,000 hours per year could be relaxed to 1,200 hours. Others argued that the current annual limit is too high and urged the FAA to consider a 900 hour limit. The FAA has tentatively decided to retain the current annual flight time limitation of 1,000 hours in any 365 consecutive days because the ARC members were unable to agree and the current limit is within the limits presented by the ARC.

(31) The FAA seeks input on the appropriate cumulative limits to place on duty, flight duty periods and flight time. Is there a need for all the proposed limits? Should there be more limits (e.g., biweekly, or quarterly limits)?

(32) The FAA also asks for comments on measuring limits on an hourly rather than daily or monthly basis. Does this approach make sense for some time periods but not for others?

K. Rest Requirements

1. Pre-Flight Duty Period Rest

Adequate rest is the most critical component of fatigue mitigation. As such, it is critical that the FAA implement unambiguous rest requirements that address both the potential for fatigue on a daily basis and the risk posed by cumulative fatigue. Currently, 14 CFR part 121, subparts Q, R and S address rest limits within a 24-hour period. However, certificate holders conducting operations with airplanes having a passenger seat configuration of 30 seats or fewer and a payload capacity of 7,500 pounds or less, may comply with the less stringent requirements of 14 CFR sections 135.261 through 135.273. Perhaps the largest problem with the existing regulations is that there is no mechanism to assure that rest is provided prior to flight, and there is no guarantee that the 9-hour rest requirement results in 8 hours of actual sleep opportunity.

In addition, the existing requirements do not adequately apprise the regulated community on what constitutes being free from duty. The FAA has issued 55 legal interpretations regarding rest that apply to pilots, flight attendants and dispatchers, many of which relate to whether a crew member is at rest when required to answer phone calls or pagers or otherwise be in contact with the carrier.

CAP–371 defines rest as a period of time before starting a flight duty period which is designed to give crew members adequate opportunity to rest before a flight. The minimum rest period must be as long as the preceding duty period, or 12 hours, whichever is greater. After being called out from reserve, the length of minimum rest is determined by the length of reserve duty, time spent on positioning, and any completed FDP.

EASA defines a rest period as a continuous and defined period of time, subsequent to and/or prior to duty, during which a crew member is free of all duties. Certificate holders are required to ensure that rest periods provide sufficient time for flightcrew members to overcome the effects of the previous duties and be well rested for the next FDP. In addition, a certificate holder must ensure that the effects on a flight crew passing through different time zones are compensated for with additional rest. As is the case with CAP–371, the EU OPS subpart Q requires that minimum rest for an FDP beginning at home base must be at least as long as the preceding duty period or 12 hours, whichever is greater. If the FDP begins away from home base, the rest must be as long as the preceding duty period or 10 hours, whichever is greater. Within this rest period, a certificate holder must provide at least 8 hours of opportunity for sleep. EU OPS subpart Q also requires certificate holders to increase the minimum rest periodically to a weekly rest period. The pilot-in-command also may reduce rest in the event of unforeseen circumstances.

As discussed earlier, the study of sleep science is somewhat settled on the following points: The most effective fatigue mitigation is sleep; an average individual needs to have an 8-hour sleep opportunity to be restored; 8 hours of sleep requires more than 8 hours of sleep opportunity; and daytime sleep is less restorative than nighttime sleep.[44] For most people, 8 hours of sleep in each 24 hours sustains performance indefinitely.[45] There is a continuous decrease in performance as sleep is lost. Examples of this reduction in performance include complacency, a loss of concentration, cognitive and communicative skills, and a decreased ability to perform calculations. All of these skills are critical for aviation safety.[46]

The scientific presenters stated that during long pairings with significant time zone shifts, a minimum of 24 hours off would be necessary for flightcrew members to find an adequate sleep opportunity, and sufficient time free from duty.[47] A minimum of two nights of sleep might be necessary to acclimate to a different time zone.[48]

The scientific presenters noted that an individual's circadian clock is sensitive to rapid time zone changes. They added that long trips present significant issues requiring mitigation strategies.[49] Twenty-four or 48 hours of rest may not be adequately restorative during a trip pairing where a flightcrew member is working 20 days separated by 24-hour layovers. In some cases, shorter rest periods, such as 18 hours or less, may

[44] Akerstedt, T., & Gillberg, M. (1981). The circadian variation of experimentally displaced sleep. Sleep, 4 (2), 159–1659. Akerstedt, T., & Gillberg, M. (1990). Subjective and objective sleepiness in the active individual. International journal of neuroscience, 52 (1–2), 29–37. Gander, P.H., De Nguyen, B.E., Rosekind, M.R., & Connell, L.J. (1993). Age, circadian rhythms, and sleep loss in flight crews. Aviation, Space, and Environmental Medicine, 64 (3), 189–195.

[45] Rosekind, M.R., Gander, P.H., Gregory, K.B., Smith, R.M., Miller, D.L., Oyung, R., Webbon, L.L., & Johnson, J.M. (1996). Managing fatigue in operational settings 1: Physiological considerations and countermeasures. Behavioral Medicine, 21, 157–165.

[46] Caldwell, J.A., Mallis, M.M., Caldwell, J.L., Paul, M.A., Miller, J.C., & Neri, D.F. (2009). Fatigue countermeasures in aviation. Aviation, Space, and Environmental Medicine, 69 (1), 29–59.

[47] Gander, P.H., Myhre, G., Graeber, R.C., Anderson, H.T., and Lauber, J.K. (1985). Crew factors in flight operations: I. Effects of 9-hour time-zone changes on fatigue and the circadian rhythms of sleep/wake and core temperature (NASA/TMm 1985–88197). Moffett Field, CA. NASA Ames Research Center.

[48] Lamond, N., Petrilli, R.M., Dawson, D., and Roach, G.D. (2006). Do short international layovers allow sufficient opportunity for pilots to recover? Chronobiology International, 23(6), 1285–1294. Lamond, N., Petrilli, R.M., Dawson, D., and Roach, G.D. (2005). The impact of layover length on the fatigue and recovery of long-haul flight crew. Adelaide/Whyalla, Australia: University of South Australia, centre for Sleep Research.

[49] *See also,* Gander, P.H., Graeber, R.C., Connell, L.J., and Gregory, K.B. (1991). Crew factors in flight operations: VIII. Factors influencing sleep timing and subjective sleep quality in commercial long-haul flight crews (NASA/TMm 1991–103852). Moffett Field, CA: NASA Ames Research Center. Rosekind, M.R., Gander, P.H., Gregory, K.B., Smith, R.M., Miller, D.L., Oyung, R., Webbon, L.L. and Johnson, J.M. (1996). Managing fatigue in operational settings 2: An Integrated Approach. Behavioral medicine, 21, 166–170.

be more restorative because of circadian issues.

In defining a rest period, the ARC included the condition that a flightcrew member be free from all contact during a rest period. The proposed definition means that the certificate holder cannot contact a flightcrew member nor can the flightcrew member be required to contact the certificate holder during a rest period.

The ARC members agreed on a general approach towards rest without agreeing on the number of hours one needed to be free from duty to assure an 8-hour sleep opportunity. On the lower end, they developed a domestic rest requirement of 10 hours by working out in each direction from an 8-hour sleep opportunity, with 30 minutes on each end for transportation, and 30 minutes on each end for physiological needs such as eating, exercising and showering. Others on the ARC noted that a longer rest period was required to assure an 8-hour sleep opportunity.

For international operations, some members of the ARC suggested this rest requirement should increase to 12 hours. They noted that flightcrew members may require a longer rest period at international layovers because of issues with time zone changes and possible difficulties obtaining sleep because the flightcrew member is non-acclimated. There were also concerns raised with a potential for increased stress associated with communicating with air traffic control in countries where English is not the native language. Some ARC members acknowledged that the minimum period captures the same elements as the 10-hour requirement discussed above but includes an additional 2 hours to transit customs and immigration or travel a long distance to hotel accommodations in foreign destinations.

The ARC discussed permitting the minimum rest time to be reduced to a lower level due to unforeseen circumstances. On the one hand, this would allow the carrier to recover a schedule; on the other hand, the need for reduced rest may be based on factors, such as poor weather or mechanical problems with the aircraft, which are potentially more fatiguing than normal operations. Ultimately, the ARC members proposed to allow certificate holders to reduce a minimum rest period from 10 to 9 or 12 to 11 hours for operational flexibility in unforeseen circumstances, but to limit the number of times rest could be reduced to once in a 168-hour period. In addition, the decision to reduce minimum rest would be a joint decision between the pilot in command and the certificate holder.

The FAA is proposing flightcrew members be provided with a minimum of 9 hours rest prior to commencing a flight duty period. The agency has tentatively decided against proposing different requirements for domestic and international operations. Time associated with clearing customs and immigration or traveling longer distances to a hotel has been addressed by refining the time at which the rest requirement begins and ends, as discussed below. While the FAA agrees that changes in time zones and the need to acclimate require additional safeguards, the agency believes that it has already accommodated that additional risk in other provisions to the proposed rule. As to concerns raised with air traffic controllers who do not speak English as their primary language, the FAA is unconvinced that providing an additional 2 hour sleep opportunity after the flight has ended would have any impact on the stress associated with communicating with air traffic control after entering foreign air space. Based on the available sleep studies, it does not appear that a longer rest period immediately prior to commencing a flight in non-U.S. airspace would be necessary since presumably the flightcrew member has received the requisite amount of sleep to report to duty refreshed and well-rested.

As suggested by the ARC, the rest opportunity could be reduced by 1 hour once in any 168-hour period, but only if agreed to by the pilot in command. Under no circumstances may the opportunity to rest be reduced by more than 1 hour because such reductions would seriously encroach upon the 8-hour sleep opportunity. Should the time period between the beginning of the rest period and the time the flightcrew must report for transportation to the airport be less than 8 hours, the carrier would need to delay the next day's flight or make other crewing arrangements.

This proposal does not exactly mirror the ARC recommendation, because the FAA is proposing that transportation time to or from a duty station not be included in the minimum rest periods; nor would it be considered duty. Rather, the rest period would begin once the flightcrew members reach the hotel. The FAA's proposal does not change the intent of the ARC to generally assure an 8-hour sleep opportunity. However, the FAA believes that time in transit is not rest. In addition, the agency is concerned that allowing this time to be included in the rest period could result in a reduction in actual rest opportunity below 8 hours. The ARC members recognized this possibility and considered an approach whereby any time exceeding 30 minutes would not be considered in the rest period. Ultimately, the impact is the same; it is simply clearer from a regulatory perspective to acknowledge that time in transit is not rest. The FAA has decided against treating this time as duty because it recognizes that the permissible amount of cumulative duty is only nominally higher than the permissible amount of FDP and that the location of a rest facility is a lifestyle issue that is typically negotiated between the carriers and their unions.

The FAA seeks comment on the following:

(33) If transportation is not considered part of the mandatory rest period, is there a need for a longer rest period for international flights?

2. Cumulative Rest Requirements

Much as there should be cumulative limits on the amount of work a flightcrew member can be expected to perform in a week, there also needs to be an opportunity for rest that exceeds the amount of rest required on a daily basis. The scientific presenters to the ARC stated that cumulative fatigue is fatigue brought on by repeated mild sleep restriction or extended hours awake. They noted that the repeated infringement of duty time on the opportunity to sleep results in accumulated sleep debt and that the operative factor in recovery from cumulative fatigue is sleep. When a person has accumulated a sleep debt, recovery sleep is necessary. Recovery sleep requires an opportunity to obtain sufficient sleep to fully restore the person's "sleep reservoir." Recovery sleep should include at least one physiological night, that is, one sleep period during nighttime hours in the time zone in which the individual is acclimated.

The ARC discussed what would constitute rest sufficient to act as a restorative rest reset for the 168 consecutive hour rolling window. The ARC noted that current regulations require 24 hours free of duty in any 7 consecutive days dependent on the type of operation. The ARC considered whether reset rest should (1) incorporate a minimum of two physiological nights' rest, which would be variable based on when the FDPs began and ended, or (2) be a fixed number of hours ranging from 30 to 48 hours. The ARC proposed that a 30 to 36 hour rest during any 168 consecutive hours constitutes a restorative rest period. Those arguing for a 36 hour rest period noted that the 30 hour period would only rarely afford one the opportunity for two physiological nights rest. Those supporting 30 hours noted that this time frame would allow for one physiological night's rest and at least one additional sleep opportunity, albeit less than a full 8 hours.

The FAA is proposing to impose a 30 hour continuous rest requirement for each rolling 168-hour period. This approach does not guarantee two consecutive physiological nights rest in a 7-day period. Rather, it provides for a single physiological night rest and a rest opportunity immediately preceding or following that night. Although this is less rest than suggested by some members of the ARC, it still represents a 25 percent increase over current requirements. In addition, the FAA believes the cumulative limits on duty and FDP during the same 7-day period should adequately mitigate the effects of cumulative fatigue.

L. Fatigue Risk Management Systems

A Fatigue Risk Management System (FRMS) is a carrier-specific method of evaluating how to best mitigate fatigue based on active monitoring and evaluation by the carrier and flightcrew members. This cooperative approach has the potential to provide a cooperative and flexible means of monitoring and mitigating fatigue during operations when the prescriptive approach is not optimal. An FRMS requires a carrier to develop numerous processes and structures within an operation. These measures lead to an effective management and mitigation of fatigue on the part of both the carrier and its employees that might affect the operation.

An FRMS requires that a baseline of fatigue effects be identified for the affected population, scientific modeling of respective work schedules, education and management of the process for all stakeholders, and effective evaluation and validation of the instituted policies. As a continuously improving system, the knowledge gained in developing and validating fatigue data should result in regular improvements in how the certificate holder and its employees manage and mitigate fatigue.

No country has adopted FRMS as a regulatory alternative. However, ICAO is actively considering requiring member states to implement some alternative means of compliance with existing rules, and EASA has proposed requiring FRMS as an integral part of an operator's management system. Permitting FRMS as a regulatory alternative to today's proposal is widely supported by industry, with several organizations requesting that the FAA adopt FRMS as a means of addressing fatigue. Theoretically, a carrier could apply its FRMS to all of its operations. Realistically, it would likely only be used when the carrier cannot meet the more prescriptive rules because of the nature of the specific operations.

The FAA has decided to include an FRMS option in today's proposal. A certificate holder may utilize this option when it has developed an FAA-approved equivalent level of safety for monitoring and mitigating fatigue specific to those operations.[50] The proposed regulatory text provides broad performance requirements that a certificate holder would need to demonstrate it met prior to the FAA granting approval. These requirements include an additional FRMS-specific training element above and beyond the general requirement proposed today. The extent of the additional training would be determined as part of the overall approval process.

While FRMS is not fully matured, the general concepts are well understood and have been developed in other contexts. For example, the approach used to obtain ultra-long range OpSpecs is essentially an FRMS, except that it does not contemplate flightcrew members providing feedback to the certificate holder or a system of accountability. The FAA's Advanced Qualification Program, which has been in place since 1990, also incorporates many aspects of an FRMS. In addition, ICAO is currently working on developing FRMS standards. The FAA is actively engaged in the development of these standards, as are at least two members of the ARC. Accordingly, the FAA believes that FRMS will be sufficiently robust to be implemented for operations that cannot otherwise be accommodated under the rule by the time the rule takes effect.

Generally, a certificate holder would need to demonstrate that its FRMS has an education and awareness training program; a fatigue reporting system; a system for monitoring flightcrew fatigue; a performance evaluation; and possibly an incident reporting process. The FAA issued advisory circular (AC) 120–103 entitled Fatigue Risk Management Systems for Aviation Safety[51] on August 3, 2010 outlining the types of data and processes a certificate holder would need to develop to receive FRMS approval from the agency. I

As is the case with the proposed training requirements, whenever the Administrator finds that revisions are necessary for the continued adequacy of an FRMS, the certificate holder would have to make any changes in the program deemed necessary by the Administrator after being notified that such changes are needed. This would likely be done through the OpSpec process.

The FAA requests comment on:

(34) Whether some elements of an FRMS, such as an incident reporting system, would be better addressed through a voluntary disclosure program than through a regulatory mandate?

M. Commuting

The impact of commuting to a duty station has been linked to increased fatigue, most recently in the crash in Buffalo, New York. Commuting is common in the airline industry, in part because of lifestyle choices available to pilots by virtue of their being able to fly at no cost to their duty station, but also because of economic reasons associated with protecting seniority on particular aircraft, frequent changes in the flightcrew member's home base, and low pay and regular furloughs by some carriers that may require a pilot to live someplace with a relatively low cost of living. While commuting to a duty station can be handled responsibly (particularly assuming one has the means), it is also subject to abuse.

The only current impediment to irresponsible commuting in the FAA's regulations is the general requirement in part 91 that pilots report to work fit for duty. CAP–371 provides that if journey time from home to normal home base is more than 1.5 hours, crew members should consider making arrangements for temporary accommodation nearer to base. This provision is not mandatory.

The ARC unanimously recommended that pilots be reminded of their existing obligations under part 91 to report to work fit for duty, but that the FAA impose no new requirements. The FAA has tentatively rejected this approach.

Commuting is fundamentally a fitness for duty issue. If a flightcrew member commutes irresponsibly, it is possible that he or she may become fatigued. A responsible commuter plans his or her commute to minimize its impact on his or her ability to get meaningful rest shortly before flying, thus fulfilling the proposed requirement that he or she reports for an FDP rested and prepared to perform his or her assigned duty.

The FAA considered proposing a requirement similar to the one in CAP–

[50] The FAA anticipates that all FRMS proposals would be evaluated and approved at headquarters by individuals within AFS–200 dedicated to overseeing FRMS.

[51] You may view the AC at *http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/319218.*

371 mandating that pilots arrive at the pilot's domicile airport in time to receive the pre-flight rest period in that area prior to commencing flight. At first blush, this approach has appeal, in that it would require a flightcrew member to have an opportunity for rest immediately prior to commencing an FDP. However, because commuting constitutes an activity conducted by a pilot on his or her own time, it is difficult to regulate. In addition, a strict commuting regulation, such as one that requires a pilot to report to a duty station area well in advance of the scheduled flight, would not necessarily result in more responsible commuting. A pilot could choose to commute during times that interfere with his or her WOCL (for example, taking a red eye for an afternoon flight), leaving him or her less rested for flight. This approach could also discourage responsible commuting. For example, today a flightcrew member can catch a mid-morning flight to his or her duty station and then commence his or her flying shortly after arrival a couple of hours later. The flightcrew member would have received a full night of sleep, and would be in a much better position to work than the individual who had taken an overnight or very early morning flight. While the irresponsible commuter would be available to fly by mid-afternoon, the mid-morning commuter would not be available to fly until late evening, just as he or she is beginning to tire.

The FAA does believe that it is unreasonable to assume that an individual is resting while commuting. Accordingly, time spent commuting, either locally or long-distance, is not considered rest, and a certificate holder will need to consider the commuting times required by individual flightcrew members to ensure they can reach their home base while still receiving the required opportunity for rest. This approach is consistent with that taken for transportation to and from a sleep facility other than home discussed earlier in this document.

The FAA also believes it is inappropriate to simply rely on the existing requirements in part 91 to report to work fit for duty. The FAA believes a primary reason that pilots may engage in irresponsible commuting practices is a lack of education on what activities are fatiguing and how to mitigate developing fatigue. The FAA has developed a draft fitness for duty AC that elaborates on the pilot's responsibility to be physically fit for flight prior to accepting any flight assignment, which includes the pilot being properly rested. Additionally, the AC outlines the certificate holder's responsibility to ensure each flightcrew member is properly rested before assigning that flightcrew member to any flight. That document has been placed in the docket for this rulemaking. Additionally, the proposed training program discussed earlier contains an element on the impact of commuting on fatigue.

N. Exception for Emergency and Government Sponsored Operations

The ARC discussed various types of supplemental operations that may not be adequately addressed by the proposed requirements.[52] These operations range from moving armed troops for the U.S. military and conducting humanitarian relief, repatriation, Civil Reserve Air Fleet (CRAF), Air Mobility Command (AMC), and State Department missions. Many of these types of supplemental operations fly into hostile areas, while others are conducted into politically sensitive, remote areas without rest facilities. The ARC recognized the uniqueness of these operations and noted that today some AMC and emergency operations are conducted under a deviation authority contained in 14 CFR 119.55 and 119. 57.

Currently, all flights operated by an air carrier under contract with a U.S. Government agency must comply with part 121 or part 135, including flight and duty time regulations. These operations include, but are not limited to:

- AMC contracts and other Department of Defense (DOD) contracts;
- State Department contracts;
- Department of Homeland Security contracts, including FEMA, humanitarian flights and Immigration and Customs Enforcement deportations; and
- Department of Justice contract flights.

Activation of the CRAF would allow military use of civil aircraft. CRAF is activated by presidential order in a time of war.[53] Under CRAF, air carriers are required to operate their aircraft at the direction of DOD. However, the activation of CRAF does not obviate the air carrier's responsibility to operate under part 121, including the flight and duty time regulations.

14 CFR 119.55 allows the FAA Administrator to authorize an air carrier who has a contract with AMC a deviation to any part of part 119, 121, or 135 for the operation under that contract. AMC reviews an air carrier's request for a deviation and either supports it or does not support it before AMC forwards the request to the FAA for a final decision.

14 CFR 119.57 allows the FAA Administrator to authorize deviations during an emergency under certain conditions. The FAA has used this authority in the past. For instance, an OpSpec was used during Hurricane Katrina to allow humanitarian flights into and out of New Orleans. This authority is issued on a case by case basis during an emergency situation as determined by the Administrator.

Neither of these current regulatory options fully address the needs of carriers who occasionally need to exceed the allowable FDP (with extensions) or who are operating under contract to a U.S. government agency other than AMC. These operations are distinguishable from tourism operations or operations where cargo shows up late to the aircraft for loading.

The FAA recognizes that all carriers could encounter circumstances that would require a flightcrew member to exceed the limits in the FDP, including extensions. The most likely scenario probably would be a diversion into an area where, for whatever reason, it would not be safe for the crew or passengers to stay. In addition, the FAA recognizes that there is a public policy interest in permitting the United States government to contract out certain operations to air carriers. If these operations were conducted on military aircraft, the pilots would generally be subject to a 16-hour duty day, almost all of which could be flight time.

Currently, if a military pilot flies a similar operation into a hostile area and must fly an aircraft out of theater due to a military exigency, and doing so would cause that pilot to exceed the military-mandated flight and duty time limits, that pilot can call his or her or her central command for permission to do so. A similar system, with FAA involvement, seems to make sense. In the event that there is no time to call back to the air carrier, the captain's emergency authority would allow the captain to move the airplane to safety, with a report to the FAA. Likewise, the pilot in command is always authorized to address emergency situations.

The concern of the FAA is not that circumstances may arise that require

[52] The FAA notes that cost is not the critical factor since a regulatory impact on crew costs would more than likely be passed on the Department of Defense via the uniform rate process, resulting in no increase in cost to the carrier. While crew costs are typically based on historical costs, the FAA has been informed that the uniform rate process is sufficiently flexible to allow projected costs when the cost increase is the result of a regulatory action.

[53] CRAF is currently not activated.

pilots to take emergency action, but rather that air carriers should know that delays in certain operations for the U.S. government are possible and plan accordingly. Air carriers should mitigate the chances of such an event, for instance by staging crews at other airports or installing rest facilities on the aircraft to allow augmentation, in order to ensure that flight crews will not exceed FDP limits. Fundamentally, a carrier needs to have performed adequate planning for the mission, including having the appropriate onboard rest facilities or number of flightcrew members for the length of the duty day, and the emergency should not be self-induced. If a certificate holder chooses not to equip an aircraft with adequate rest facilities, then the certificate holder should not be able to claim an inability to comply with requirements because of the lack of those facilities.

The FAA proposes to allow air carriers operating commercial flights and who are not under contract with a U.S. government agency to ask for a "one time deviation" to the FDP limits under part 121 for a one time event in exceptional circumstances. Each event of this type would be reported to the FAA. The number of "one time deviations" would be tracked by the FAA, as would the rationale for needing the deviation. If the Administrator determines that the carrier is relying excessively on this deviation authority, the air carrier would have to change its operations or develop an FRMS in order to mitigate the chances of such events happening in the future. There would be extra rest requirements after such an event.

For operations under contract with a U.S. government agency that cannot be conducted consistent with the general rules because of unique circumstances (such as when operating into an SFAR area, or when there is a declared military exigency that necessitates operations outside the scope of what the regulation contemplates), a different approach is proposed. Such operations could be conducted under an exception to the FDP and flight time limits, but not to the cumulative restrictions on FDP, flight time and duty. In addition, additional rest would be required and the carrier would have to demonstrate why the operations could not have been adjusted to prevent exceeding the daily limits. This could be done with a bi-monthly reporting requirement.

By tracking these events, the FAA can determine if the air carrier is properly planning its operations and mitigating the chances of its flight crews exceeding the FDP limits. The proposed regulation contemplates that the air carrier will develop an FRMS if it cannot restructure its operations so that only very few of those operations continue to need the exception. Sections 119.55 and 119.57 would remain unchanged and used as they are today.

(35) Are there other types of operations that should be excepted from the general requirements of the proposal? If so, what are they, and why do they need to be accommodated absent an FRMS?

IV. Regulatory Notices and Analyses

Regulatory Impact Analysis, Regulatory Flexibility Determination, and Unfunded Mandates Assessment

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Pub. L. 96–354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Pub. L. 96–39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, the Trade Agreements Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation with base year of 1995). This portion of the preamble summarizes the FAA's analysis of the economic impacts of this proposed rule. The FAA suggests readers seeking greater detail read the full regulatory impact analysis, a copy of which the agency has placed in the docket for this rulemaking.

In conducting these analyses, the FAA has determined that this proposed rule: (1) Has benefits that justify its costs, (2) is an economically "significant regulatory action" as defined in section 3(f) of Executive Order 12866, (3) is "significant" as defined in DOT's Regulatory Policies and Procedures; (4) would have a significant economic impact on a substantial number of small entities; (5) would not create unnecessary obstacles to the foreign commerce of the United States; and (6) would impose an unfunded mandate on State, local, or tribal governments, or on the private sector by exceeding the threshold identified above. These analyses are summarized below.

Benefits of the Rule

During the past 20 years, there have been over 18 aviation accidents caused by pilot error where pilot fatigue was a factor. NTSB has identified five accidents where the flight crew started the day in a state of fatigue. We statistically identified 4.6 accidents where the flight crew became fatigued during a long flight-duty period (NTSB cited pilot fatigue as a contributing factor in three of those accidents). We have also statistically estimated that some of the 6.2 accidents that occurred between midnight and 6 a.m. involved some degree of pilot fatigue. Two of these have already been accounted for in the previously discussed analyses. There were also three accidents where the pilot became fatigued due to being awake for many hours. Lastly, there were two accidents where chronic fatigue was a contributing factor. In summary, we project there would be at least 18.8 accidents (13 passenger airplane accidents and 5.8 cargo airplane accidents) during the next 20 years where pilot fatigue would be a contributing factor to the accident.

Having projected the possible extent of fatigue based on the historical record, we estimate the likelihood of accidents happening in the future using simulation techniques. We also use simulation techniques to estimate future casualties, which we monetize. In this way, we estimate the potential benefits of the proposed rule. Finally, we model risk of fatigue for current pilot schedules, and compute the number of hours in higher risk categories with and without the rule. The projected reduction in fatigue exposure is corroborating evidence supporting this proposal. Pilot fatigue is a serious problem. If nothing is done about this problem, we can expect from one to possibly six aviation accidents a year where pilot fatigue will be a contributing factor. Pilot fatigue will be a contributing factor in many accidents that could potentially cost billions of dollars.

Using simulation analysis, the mean is 28.9 airplane accidents in a ten-year period. These accidents would result in a mean of 174.7 deaths. The estimated cost of these accidents would be a mean value of $1.581 billion ($1.121 billion, present value). These numbers represent an estimate of the likely number of future accidents, deaths, and costs from future accidents with fatigue as a factor.

The above analysis establishes an estimate of the number and range of fatigue related accidents if no action is taken to address the problem. It is seldom the case that a rule is 100 percent effective at addressing an identified problem. In particular, fatigue is rarely a primary or sole cause of an accident, and therefore this rule, if adopted, is not likely to prevent all future accidents that include fatigue as a factor.

FAA reviewed all NTSB accident reports on part 121 accidents that occurred from 1990 through 2009 to assess the likely capacity of the NPRM to have averted those accidents. The FAA's Office of Accident Investigation & Prevention assessed the effectiveness of this rule to prevent accidents like those in the historical database. Most reports on major accidents (hull losses or non-hull losses that resulted in multiple fatalities) provided extensive data on flight crews' duty tours and recent rest periods, which facilitated relatively strong assessments.

The FAA's Office of Accident Investigation and Prevention (AVP) rated each accident by conducting a scoring process similar to that conducted by the Commercial Aviation Safety Team (CAST), a well documented and well understood procedure. All the accidents that have had final National Transportation Safety Board (NTSB) reports published have been scored against the CAST safety enhancements. When these accidents were not well defined in the probable cause or contributing factors statements of the NTSB reports, AVP used a Joint Implementation Monitoring Data Analysis Team (JIMDAT)-like method.

Following this scoring, the proposed rule would be 40 percent effective at preventing passenger airplane accidents where pilot fatigue was a contributing factor and would be 58 percent effective at preventing cargo airplane accidents where pilot fatigue was a contributing factor. Accordingly, the above estimate of the benefits of avoiding passenger airplane accidents where pilot fatigue was a causal factor have been reduced from their above stated values. The revised estimated benefits of avoiding passenger and cargo airplane accidents would be a mean value of $659.4 million ($463.8 million, present value).

Cost of the Rule

The total estimated cost of the proposed rule is $1.25 billion ($804 million present value using a seven percent discount rate) for the ten year period from 2013 to 2022. The FAA classified costs into four main components and estimated the costs for each component. We obtained data from various industry sources; the sources of the data used in cost estimation are explained in each section. We were very fortunate that several carriers ran two alternatives to the proposed rule through their crew scheduling programs. Their estimates provided some comparison data to calibrate and validate our costing approach. Without their help, we would have likely missed some cost elements. The table below provides a summary of the four main cost components. Flight operations cost makes up about 60 percent of the total cost of the rule. Each of the main cost components are explained in-depth in the following sections of this document.

Summary of Costs

Cost Component	Nominal Cost (millions)	PV Cost (millions)
Flight Operations	$ 760.3	$ 484.2
Schedule Reliability	$ 4.9	$ 3.0
Fatigue Training	$ 262.3	$ 167.2
Rest Facilities	$ 226.6	$ 149.1
Total	**$ 1,254.1**	**$ 803.5**

In addition to the costs presented in this table, there may be costs of a fatigue risk management system (FRMS). The FAA is not imposing an FRMS programrequirement on Part 121 carriers, but is allowing them the option of developing and implementing such a program. Operators might do this for ultralong flights, which have flight time over 16 hours. Operators might develop an FRMS program as an alternative to the flight and duty period rules proposed by this rulemaking when the crew scheduling cost savings equal or exceed the costs of the FRMS program. The FAA estimates that an FRMS program would cost between $0.8 and $10.0 million for each operator over ten years. The FAA believes that about 35 operators have at least partially adopted an FRMS program at this time. The FAA estimates the total cost would be $205.7 million ($144.9 million present value), which would be more than offset by a reduction in crew scheduling costs. Accordingly, the cost is not added to the total costs imposed by this rule. The FAA calls for comment on this aspect of the proposal as it has not assigned a cost to the cumulative maximums.

Summary of Benefits and Costs

Following NTSB recommendations regarding pilot fatigue, labor and industry worked together to provide the basis of this rulemaking. Furthermore, Congress has directed the FAA to issue a rule addressing pilot fatigue. We have validated the need for this rule in the benefit discussion. Based on the expected effectiveness of this proposed rule at preventing fatigue accidents with an averted fatality valued at $6 million, the simulation methodology produced benefits of $659.4 million with $463.8 million in present value. The total estimated costs of the proposed rule over 10 years are $1.25 billion ($804 million at present value). There is over a 7 percent probability that undiscounted cost of avertable passenger airplane accidents would exceed $1.25 billion and over a 10 percent probability the present value of the cost of avertable passenger airplane accidents would exceed $804 million. The benefits from a near term catastrophic accident in a 150-passenger airplane with average load factor exceeds the cost of this rule. If $8.4 million were used for VSL, the undiscounted benefits would be $837 million and the present value of those benefits would be $589 million. When the value of an averted fatality increases to $12.6 million, the present value of the benefits equals the present value of compliance costs. In addition, the FAA has identified two additional areas of unquantified benefits: preventing minor aircraft damage on the ground, and the value of well rested pilots as accident preventors and mitigators. Due to data limitations, the FAA was unable to estimate the cumulative effect of preventing minor aircraft damage on the ground, but if the rule were to reduce damage by about $600 million over 10 years ($340 million present value) it would break even in terms of net benefits using a $6 million VSL. These considerations lend weight towards moving ahead with this proposal. FAA invites comment on this issue.

Alternatives Considered

FAA examined a number of alternatives to the proposed rule, scheduling alternatives and a training alternative. Since crew scheduling costs comprised the largest share of costs, most of the alternative analysis focused on these costs and these will be discussed first. Alternatives were selected using industry-proposed limits resulting from the ARC, as well as FAA-proposed limits. The table below summarizes each of the alternatives. For each of the scheduling alternatives, FAA developed a crew scheduling cost estimate using the same methodology as was used to determine the crew scheduling costs of the proposed rule.

Summary of Crew Scheduling Alternatives

Scenario	Rest Time		Duty Time		Flight Time	
	Minimum Rest Prior to Duty - Domestic	Minimum Rest Prior to Duty - International	Maximum Flight Duty Time - Unaugmented	Maximum Flight Duty Time - Augmented	Maximum Flight Time - Unaugmented	Maximum Flight Time - Augmented
Current Part 121	Daily: 8-11 depending on flight time	Minimum of 8 hours to twice the number of hours flown	16	16-20 depending on crew size	8	8-16 depending on crew size
Proposed Rule	9	9	9-13 depending on start time and number of flight segments	12-18 depending on start time, crew size, and aircraft rest facility	8-10 depending on FDP start time	None
Scenario A	10	12	9-13 depending on start time and number of flight segments	12-18 depending on start time, crew size, and aircraft rest facility	7-9 depending on FDP start time	16
Scenario B	9	11	9-13 depending on start time and number of flight segments	12-18 depending on start time, crew size, and aircraft rest facility	8-10 depending on FDP start time	None

Scenario A

FAA provided a sample of carriers with a draft version of the proposed rule in fall 2009. The carriers estimated the cost of this version of the proposed rule using their own crew scheduling models and processes. FAA also estimated the costs of the same version of the proposed rule for the entire industry using the crew scheduling model and process outlined in the crew scheduling costs sub-section of the flight operations cost section described in the full regulatory evaluation. Scenario A table below presents the annual crew scheduling resource costs for the Scenario A alternative. As we were able to accomplish our safety objectives at a lower cost, we rejected this alternative.

Scenario A Crew Scheduling Resource Costs

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$ 375.7	$ 306.7
2014	$ 354.3	$ 270.3
2015	$ 320.9	$ 228.8
2016	$ 314.0	$ 209.2
2017	$ 307.0	$ 191.2
2018	$ 300.1	$ 174.7
2019	$ 293.2	$ 159.5
2020	$ 286.3	$ 145.5
2021	$ 279.4	$ 132.7
2022	$ 272.5	$ 121.0
Total	**$ 3,103.3**	**$ 1,939.6**

Scenario B

FAA examined another, more restrictive version of the proposed rule. The main difference was that the minimum required rest for international duty periods was eleven hours. Scenario B table presents the final, adjusted crew scheduling resource costs of the Scenario B alternative.

Scenario B Crew Scheduling Resource Costs

Year	Nominal Cost (millions)	PV Cost (millions)
2013	$ 254.7	$ 207.9
2014	$ 240.2	$ 183.2
2015	$ 217.5	$ 155.1
2016	$ 212.8	$ 141.8
2017	$ 208.2	$ 129.6
2018	$ 203.5	$ 118.4
2019	$ 198.8	$ 108.1
2020	$ 194.1	$ 98.7
2021	$ 189.4	$ 90.0
2022	$ 184.7	$ 82.0
Total	**$ 2,103.9**	**$ 1,314.9**

Summary of Crew Scheduling Alternatives

The summary table below provides the ten-year total crew scheduling resource costs for the proposed rule and each of the alternatives. The proposed rule represents the lowest-cost alternative and achieves the FAA safety objectives.

Alternative Scenarios Crew Scheduling Resource Cost Summary

Scenario	Nominal Cost (millions)	PV Cost (millions)
Proposed Rule	$ 1,366.7	$ 854.2
Scenario A	$ 3,103.3	$ 1,939.6
Scenario B	$ 2,103.9	$ 1,314.9

Fatigue Training Cost Analysis of Alternatives to the Proposed Rule

Fatigue training costs account for approximately 20 percent of the total cost of the proposed rule. The FAA examined two scenarios for fatigue training requirements, ultimately selecting the lower-cost scenario for the proposed rule. The table below shows the different fatigue training requirements for each of the two scenarios.

Table 44: Summary of Fatigue Training Requirements Alternatives

Scenario	Initial Fatigue Training (hours)	Annual Recurring Fatigue Training (hours)
Proposed Rule	5	2
Scenario C	8	4

Scenario C

The fatigue training requirements of Scenario C differed significantly from the fatigue training requirements of the proposed rule. The required number of both initial and annual recurring fatigue training hours was substantially higher. Fatigue training was to take place in a classroom rather than through distance learning, which would result in higher costs due to the need to pay instructors, and the need to provide hotel and per diem compensation to flightcrew members receiving the fatigue training. As a result the costs are substantially higher. The FAA reviewed the recommended training requirements and decided to reduce the initial training requirements from 8 hours to 5 hours and reduce the recurrent training hours from 4 to 2 hours.

Alternative Scenario Fatigue Training Cost Summary

Scenario	Nominal Cost (millions)	PV Cost (millions)
Proposed Rule	$ 262.3	$ 167.2
Scenario C	$ 474.2	$ 333.7

The FAA seeks comments on the alternatives analysis conducted to develop this proposal. In addition, it is requesting comments on possible approaches designed to reduce the costs of this rule while maintaining or increasing the benefits.

Regulatory Flexibility Determination and Analysis

The Regulatory Flexibility Act of 1980 (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule would have a significant economic impact on a substantial number of small entities. If the determination is that it would, the agency must prepare a regulatory flexibility analysis as described in the RFA.

However, if an agency determines that a proposed or final rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

The FAA believes that this proposed rule would have a significant economic impact on a substantial number of small entities and therefore has performed an initial regulatory flexibility analysis as required by the RFA. The Small Business Administration small entity criterion for small air carrier operators is 1,500 or fewer employees. The FAA invites comment from affected small entities and others to aid us to make an assessment of these impacts. In particular, the FAA invites more information on the financial stability and competitive positions of small entities.

Initial Regulatory Flexibility Analysis

Under Section 603(b) of the RFA, the initial regulatory flexibility analysis must address:

- Description of reasons the agency is considering the action
- Statement of the legal basis and objectives for the proposed rule
- Description of the record keeping and other compliance requirements of the proposed rule
- All federal rules that may duplicate, overlap, or conflict with the proposed rule
- Description and an estimated number of small entities to which the proposed rule will apply
- Analysis of small firms' ability to afford the proposed rule
- Conduct a disproportionality analysis
- Conduct a competitive analysis
- Estimation of the potential for business closures
- Description of alternatives considered

Reasons the Rule Is Proposed

The objective of the proposed rule is to increase the margin of safety for passengers traveling on U.S. part 121 air carrier flights. Specifically, the FAA wants to decrease diminished flight crew performance associated with fatigue or lack of alertness brought on by the duty requirements for flightcrew members.

The Legal Basis and Objectives

The legal basis for the proposed rule is found in 49 U.S.C. Section 44701 *et seq.* Specifically 49 U.S.C. Section 44701 (a)(4) requires the Administrator to promote safe flight of civil aircraft in air commerce by prescribing regulations in the interest of safety for the maximum hours or periods of service of airmen and other employees or air carriers. Among other matters the FAA must consider as a matter of policy the maintaining and enhancing of safety in air commerce as its highest priority (49 U.S.C. Section 40101(d)).

The Projected Reporting, Recordkeeping, and Other Compliance Requirements of this NPRM

This proposed rule would increase reporting and recordkeeping. In addition to changes in crew schedules, there would be a minor increase in documenting crew rest.

All Federal Rules That May Duplicate, Overlap, or Conflict With the Proposed Rule

There are no Federal Rules that may duplicate, overlap, or conflict with the proposed rule.

Description and an Estimated Number of Small Entities

The proposed rule would apply to all certificate holders operating under part 121. There are 96 such operators of which 45 operators have fewer than 1,500 employees. Among these 45 operators, 25 are small entities that provide all air-cargo scheduled service competing with larger operators, code-share passenger service for large operators, and charter service.

Affordability

The FAA expects wide variability in cost impacts on small entity operators. The sample crew scheduling changes provide only a rough proxy for the impact on pilots' time and availability. Current crew schedules vary by operator, labor contract, and size of pilot pools. The agency understands that many smaller operators have maximized their pilot time in the cockpit and may have little flexibility with potential new flight and duty regulations. Operators needing to hire more pilots would incur the cost of hiring, wages, overhead, and training. Some captains from smaller operators could be lured away by other operators, especially the larger operators with better benefit packages. That outcome might be mitigated by the recent extension of pilots being able to work to age 65 and the inherent flexibility of the larger carriers.

The FAA requests that small entity operators provide estimated impacts of the proposed changes on their existing crew schedules. The FAA requests that all comments be accompanied by clear supporting data. For now the agency expects some small operators would likely need to hire more pilots. This increase in the demand for pilots may eventually raise pilot wages. Based on small operators who would need to hire more pilots and the resulting pressure on overall wages, there could be a significant economic impact.

Disproportionality Analysis

Part 121 operators would need to provide more rest for pilots which overall could result in the need to hire more pilots. The proposed changes to flight and duty time would be more difficult to accommodate for operators with small pilot staffs. While the changes to flight and duty may be measured in hours per week for operators with small, fully employed staffs, such changes can be difficult to accommodate. To be in compliance with the proposed changes small airlines may need a fraction of a new pilot's time to meet requirements. In this case, the airline would need to hire and train an additional pilot or reduce the number of operations. This added pilot would account for a larger percentage of the cost of pilots for the small airline than is likely to be the case for a major airline. The FAA believes that this may be the case for many small operators. Moreover, the smaller the operator, the more likely this situation will occur. Thus, the proposed rule is likely to have a disproportionate economic impact on small entities.

Competitiveness Analysis

The competitiveness analysis examines whether a small airline is under a competitive disadvantage from the implementation of the proposed rule. This proposed rule would impose significant costs on some small entities, and as a result it is likely to worsen such entities relative competitive position.

A major criterion in a competitiveness analysis is the ability of an airline to pass on the costs imposed by the rule to their customers. The extent to which an airline can pass costs on to its customers is determined by the elasticity of demand of the service by the customer. The elasticity of demand for a product is a measure of the responsiveness to price that consumers have in their buying habits. The elasticity of demand is defined as the percentage change in quantity demanded resulting from a 1 percent change in price. If the demand for airline travel is relatively elastic, then the airlines would have less capacity to transfer the added cost of the rule to their passengers without losing significant revenue. For operators with a niche market, the demand for their services will be less elastic and more of the cost can be transferred. For instance, specialty cargo carriers have niche markets and some ability to pass on costs. Other operators would have little flexibility. In the most extreme case are operators who provide scheduled service for larger carriers generally under contract. Overall the disproportionate impact is likely to weaken small entity operators' competitive situation, but the FAA is unable to provide a measure of how much.

While the preceding discussion points out potential impacts of the proposed rule on the competitiveness of small entities, the FAA is uncertain about this impact on the level of competition within the U.S. airline industry. The FAA has very little firm-specific flight crew schedule data and route structure market data to refine this analysis and asks commenters to provide information on the impact this proposed rule would have on the continued capacity of small airlines to compete in their current markets. The FAA invites comment from affected airlines and other parties that might better inform the agency on this competitiveness issue.

Business Closure Analysis

Even if there is a disproportionate impact and a loss in competitive positioning does not mean a firm would have to close because of this proposed rule. While small entity operators are likely to experience a significant economic impact, changes to crew schedules are difficult to assess. Further complicating this business closure analysis are the external changes as upswings in traffic demand or declines in the price of fuel quickly improve the bottom-line.

The FAA solicits comments from the aviation community regarding the likelihood of business closure. As noted previously, the FAA requests that all comments include supporting data.

Alternatives Considered

In accordance with the RFA, the FAA considered alternatives to the proposed rule to mitigate or eliminate significant economic impacts on small entities.

Alternative One—The FAA is promulgating this rule because the status quo alternative subjects the society to an unacceptably high aviation accident risk.

Alternative Two—The FAA considered extending the compliance time, but again the purpose of this proposed rule is to reduce the accident risk and postponing the compliance period extends this risk.

Alternative Three—The FAA did consider expanding the rule to include part 135 operators. All or nearly all of these operators are small entities. As the economic impact may be more severe, the agency wants to study the impact on these operators before proposing a rulemaking.

The FAA has tentatively determined that there are no reasonable alternatives to this rulemaking that would lessen the potential impact on a substantial number of small entities. The agency seeks comment on this assessment.

Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action." The FAA currently uses an inflation-adjusted value of $143.1 million in lieu of $100 million. This proposed rule contains such a mandate; therefore, the requirements of Title II apply. The alternatives considered by the FAA are discussed above in the Summary of Benefits and Costs section.

Paperwork Reduction Act

This proposal contains the following new information collection requirements. As required by the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)), the FAA has submitted the information requirements associated with this proposal to the Office of Management and Budget for its review.

Title: Flightcrew Member Duty and Rest Requirements.

Summary: The FAA is proposing data collection from air carriers certificated under Title 14 Code of Federal Aviation Regulations (14 CFR) part 121 as prescribed in 14 CFR part 117, Flight and Duty Limitations and Rest Requirements: Flightcrew Members. Two sections in the proposal drive this requirement, 14 CFR part 117, § 117.7 Schedule Reliability and § 117.31 Operations in Unsafe Areas. In accordance with these two sections, each affected air carrier is required to submit a report to the FAA detailing:

- Schedule reliability for each air carrier ongoing reportable of 2-month intervals,
- For those air carriers conducting operations under contract for the United States Government and exceeding the proposed requirements, ongoing reportable periods of 2-month intervals, and
- For those air carriers conducting operations not under contract for the United States Government and exceeding the proposed requirements, within 14 days of each occurrence, the air carrier relied on the relief granted under § 117.31 to reposition the aircraft to a safe region.

Use of: Maintaining schedule reliability is a critical element to fatigue mitigation. Air carriers build flight schedules projected to meet the constraints of individual FDP. If, however, actual flight time exceeds the projected (scheduled) flight time, the validity of the air carrier's scheduling process may come into question. This proposal places accountability upon each air carrier with regard to their scheduling practices and provides a means for the FAA to oversee the reliability of the air carrier's scheduling process relative to the flightcrew members actual FDP as opposed to the flightcrew member's scheduled FDP.

The proposal defines a flight duty period as a period that begins when a flightcrew member is required to report for duty that includes a flight, a series of flights, or positioning flights, and ends when the aircraft is parked after the last flight and there is no intention for further aircraft movement by the same flightcrew member. If the air carrier's system-wide actual FDPs exceed the scheduled flight by more than five (5) percent or any actual FDP that exceeds the pairing-specific schedule by more than twenty (20) percent, the air carrier will be required to make adjustments to its schedule factoring in the actual time exceeded in order to reflect a more realistic schedule based upon actual data. Under the proposal, each air carrier must make scheduling reliability adjustments to its schedule any time the aforementioned limitations have been exceeded. Additionally, each air carrier must submit an ongoing report on 2-month intervals detailing its overall schedule reliability and pairing-specific reliability.

This proposal provides relief for air carriers conducting operations into unsafe areas and repositioning the aircraft to another region for safety or a safe location where another crew can relieve the current crew from duty. As a result, these circumstances may result in a flightcrew member's FDP being exceeded for the day. The proposed section grants the air carrier authority to operate beyond the limits of the flightcrew's FDP to the extent of reaching a safe location where the crew must be relieved and/or go into required rest. However, by exercising such relief, the air carrier must report the occurrence to the FAA. The reporting requirements are different for air carriers operating under a contract with the United States Government and those who are not.

Air carriers under contract with the United States Government must submit a report every sixty (60) days detailing the number of times during the reporting period the air carrier relied on this relief, and for each occurrence, the reason for exceeding the FDP, the extent the FDP was exceeded and the reason the operation could not be completed consistent with part 117. If an air carrier does not rely on the proposed relief, there would be no obligation to report. If the air carrier is not under contract with the United States Government and relies on the proposed relief, it must submit a report within fourteen (14) days of each occurrence detailing the reason the FDP was exceeded, the extent the FDP was exceeded and the reason the operation could not be completed consistent with part 117.

Respondents (including number of): The number of likely respondents is 92. The likely respondents to this proposed information requirement are part 121 certificate holders.

Frequency: The FAA estimates each part 121 certificate holder will need to provide schedule reliability data every two months. Certificate holders regularly providing service to the United States government into unsafe areas may need to file reports as often as every two months. The FAA anticipates that certificate holders would only rarely need to fly into unsafe areas for reasons other than in support of U.S. government operations and estimates that fewer than five such reports would be filed each year.

Annual Burden Estimate:

This proposal would result in an annual recordkeeping and reporting burden as follows:

a. *Number of respondents:* 92.

Scheduling and Schedule Reliability Reporting: 92.

b. *Total annual responses:* 552.

(92 carriers reporting 6 times each year: $92 \times 6 = 552$)

Scheduling and schedule reliability reporting: 552.

1. *Percentage of these responses collected electronically:* 100%.

Scheduling and Schedule Reliability Reporting: 100%.

c. *Total annual hours requested:* 4,416 hours.

(92 air carriers requiring 1 employee 8 hours to complete report:

$92 \times 1 \times 8 = 4,416$ hours).

Scheduling and schedule reliability reporting: 4,416.

d. *Current OMB inventory:* 0 hours.

Scheduling and schedule reliability reporting: 0.

e. *Difference:* 4,416 hours.

Scheduling and Schedule Reliability Reporting: 4,416.

Annual reporting and recordkeeping cost burden (in thousands of dollars)

a. *Total annualized capital/startup costs:* $20,645.

Scheduling and Schedule Reliability Reporting: $15.

Fatigue Training.

Fatigue Risk Management Systems: $20,630.

b. *Total annual cost ((O&M):* $23,902.

Scheduling and Schedule Reliability Reporting: $482.

Fatigue Training: $23,420.

Fatigue Risk Management Systems: $0.

c. *Total annualized costs requested:* $44,547.

Scheduling and Schedule Reliability Reporting: $497.

Fatigue Training: $23,420.

Fatigue Risk Management Systems: $20,630.

d. *Current OMB inventory:* $0.

Scheduling and Schedule Reliability Reporting: $0.

Fatigue Training: $0.

Fatigue Risk Management Systems: $0.

e *Difference:* $44,547.

Scheduling and Schedule Reliability Reporting: $497.

Fatigue Training: $23,420.

Fatigue Risk Management Systems: $20,630.

The agency is soliciting comments to—

(1) Evaluate whether the proposed information requirement is necessary for the proper performance of the functions of the agency, including whether the information will have practical utility;

(2) Evaluate the accuracy of the agency's estimate of the burden;

(3) Enhance the quality, utility, and clarity of the information to be collected; and

(4) Minimize the burden of collecting information on those who are to respond, including by using appropriate automated, electronic, mechanical, or other technological collection techniques or other forms of information technology.

Individuals and organizations may send comments on the information collection requirement by November 15, 2010, and should direct them to the address listed in the Addresses section at the end of this preamble. Comments also should be submitted to the Office of Management and Budget, Office of Information and Regulatory Affairs, *Attention:* Desk Officer for FAA, New Executive Building, Room 10202, 725 17th Street, NW., Washington, DC 20053.

According to the 1995 amendments to the Paperwork Reduction Act (5 CFR 1320.8(b)(2)(vi)), an agency may not collect or sponsor the collection of information, nor may it impose an information collection requirement unless it displays a currently valid OMB control number. The OMB control number for this information collection will be published in the **Federal Register**, after the Office of Management and Budget approves it.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. The agency has determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, would not have federalism implications.

Environmental Analysis

Environmental Analysis FAA Order 1050.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this proposed rulemaking action qualifies for the categorical exclusion identified in paragraph 312f and involves no extraordinary circumstances.

Regulations That Significantly Affect Energy Supply, Distribution, or Use

The FAA has analyzed this NPRM under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). The agency has determined that it is not a "significant energy action" under the executive order because while a "significant regulatory action" under Executive Order 12866, it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

Additional Information

Comments Invited:

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. It also invites comments relating to the economic, environmental, energy or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. To ensure the docket does not contain duplicate comments, please send only one copy of written comments, or if filing comments electronically, please submit your comments only one time.

The FAA will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. Before acting on this proposal, the agency will consider all comments we receive on or before the closing date for comments. It will consider comments filed after the comment period has closed if it is possible to do so without incurring expense or delay. The FAA may change this proposal in light of the comments we receive.

Proprietary or Confidential Business Information

Do not file in the docket information that you consider to be proprietary or confidential business information. Send or deliver this information directly to the legal contact person identified in the FOR FURTHER INFORMATION CONTACT section of this document. You must mark the information that you consider proprietary or confidential. If you send the information on a disk or CD ROM, mark the outside of the disk or CD ROM and also identify electronically within the disk or CD ROM the specific information that is proprietary or confidential.

Under 14 CFR 11.35(b), when the FAA is aware of proprietary information filed with a comment, the agency does not place it in the docket. It is held in a separate file to which the public does not have access, and a note is placed in the docket that the agency has received it. If the agency receives a request to examine or copy this information, it treats it as any other request under the Freedom of Information Act (5 U.S.C. 552). The FAA processes such a request under the DOT procedures found in 49 CFR part 7.

Availability of Rulemaking Documents

An electronic copy of rulemaking documents may be obtained using the Internet by—

1. Searching the Federal eRulemaking Portal (*http://www.regulations.gov*);
2. Visiting the FAA's Regulations and Policies web page at *http://www.faa.gov/regulations_policies/;* or
3. Accessing the Government Printing Office's Web page at *http://www.gpoaccess.gov/fr/index.html.*

Alternatively, a copy may be requested directly from the FAA by sending a request to the Federal Aviation Administration, Office of Rulemaking, ARM–1, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9680. Make sure to identify the docket number or notice number of this rulemaking.

All documents the FAA considered in developing this proposed rule, including economic analyses and technical reports, are located in the docket for this rulemaking and may be viewed on the internet through the Federal eRulemaking Portal referenced in paragraph (1).

List of Subjects

14 CFR Part 117

Airmen, Aviation safety, Reporting and recordkeeping requirements, Safety.

14 CFR Part 121

Air carriers, Aircraft, Airmen, Aviation safety, Reporting and recordkeeping requirements, Safety.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend Chapter I of Title 14, Code of Federal Regulations, as follows:

1. Part 117 is added to read as follows:

PART 117—FLIGHT AND DUTY LIMITATIONS AND REST REQUIREMENTS: FLIGHTCREW MEMBERS

Sec.

Authority: 49 U.S.C. 106(g), 40113, 40119, 44101, 44701–44702, 44705, 44709–44711, 44713, 44716–44717, 44722, 46901, 44903–44904, 44912, 46105.

§ 117.1 Applicability.

This part prescribes flight and duty limitations and rest requirements for all flightcrew members and certificate holders conducting operations under part 121 of this chapter. This part also applies to all flightcrew members and part 121 certificate holders when conducting flights under part 91 of this chapter.

§ 117.3 Definitions.

In addition to the definitions in §§ 1.1 and 119.3 of this chapter, the following definitions apply to this part. In the event there is a conflict in definitions, the definitions in this part control.

Acclimated means a condition in which a crewmember has been in a theater for 72 hours or has been given at least 36 consecutive hours free from duty.

Airport/standby reserve means a defined duty period during which a crewmember is required by a certificate holder to be at, or in close proximity to, an airport for a possible assignment.

Augmented flightcrew means a flightcrew that has more than the minimum number of flightcrew members required by the airplane type certificate to operate the aircraft to allow a flightcrew member to be replaced by another qualified flightcrew member for in-flight rest.

Calendar day means a 24-hour period from 0000 through 2359.

Certificate holder means a person who holds or is required to hold an air carrier certificate or operating certificate issued under part 119 of this chapter.

Crew pairing means a flight duty period or series of flight duty periods assigned to a flightcrew member which originate or terminate at the flightcrew member's home base.

Deadhead transportation means transportation of a crewmember as a passenger, by air or surface transportation, as required by a certificate holder, excluding transportation to or from a suitable accommodation.

Duty means any task, other than long-call reserve, that a crewmember performs on behalf of the certificate holder, including but not limited to airport/standby reserve, short-call reserve, flight duty, pre- and post-flight duties, administrative work, training, deadhead transportation, aircraft positioning on the ground, aircraft loading, and aircraft servicing.

Duty period means a period that begins when a certificate holder requires a crewmember to report for duty and ends when that crew member is free from all duties.

Fatigue means a physiological state of reduced mental or physical performance capability resulting from lack of sleep or increased physical activity that can reduce a crewmember's alertness and ability to safely operate an aircraft or perform safety-related duties.

Fatigue risk management system (FRMS) means a management system for an operator to use to mitigate the effects of fatigue in its particular operations. It is a data-driven process and a systematic method used to continuously monitor and manage safety risks associated with fatigue-related error.

Fit for duty means physiologically and mentally prepared and capable of performing assigned duties in flight with the highest degree of safety.

Flight duty period (FDP) means a period that begins when a flightcrew member is required to report for duty with the intention of conducting a flight, a series of flights, or positioning or ferrying flights, and ends when the aircraft is parked after the last flight and there is no intention for further aircraft movement by the same flightcrew member. A flight duty period includes deadhead transportation before a flight segment without an intervening required rest period, training conducted in an aircraft, flight simulator or flight training device, and airport/standby reserve.

Home base means the location designated by a certificate holder where a crew member normally begins and ends his or her duty periods.

Lineholder means a flightcrew member who has a flight schedule and is not acting as a reserve flightcrew member.

Long-call reserve means a reserve period in which a crewmember receives a required rest period following notification by the certificate holder to report for duty.

Physiological night's rest means the rest that encompasses the hours of 0100 and 0700 at the crewmember's home base, unless the individual has acclimated to a different theater. If the crewmember has acclimated, the rest must encompass the hours of 0100 and 0700 at the acclimated location.

Report time means the time that the certificate holder requires a crewmember to report for a duty period.

Reserve availability period means a duty period during which a certificate holder requires a reserve crewmember on short call reserve to be available to receive an assignment for a flight duty period.

Reserve duty period means the time from the beginning of the reserve availability period to the end of an assigned flight duty period, and is applicable only to short call reserve.

Reserve flightcrew member means a flightcrew member who a certificate holder requires to be available to receive an assignment for duty.

Rest facility means a bunk, seat, room, or other accommodation that provides a crewmember with a sleep opportunity.

(1) *Class 1 rest facility* means a bunk or other surface that allows for a flat sleeping position and is located separate from both the flight deck and passenger cabin in an area that is temperature-controlled, allows the crewmember to control light, and provides isolation from noise and disturbance.

(2) *Class 2 rest facility* means a seat in an aircraft cabin that allows for a flat or near flat sleeping position; is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation; and is reasonably free from disturbance by passengers or crewmembers.

(3) *Class 3 rest facility* means a seat in an aircraft cabin or flight deck that reclines at least 40 degrees and provides leg and foot support.

Rest period means a continuous period determined prospectively during which the crewmember is free from all restraint by the certificate holder, including freedom from present responsibility for work should the occasion arise.

Scheduled means times assigned by a certificate holder when a crewmember is required to report for duty.

Schedule reliability means the accuracy of the length of a scheduled flight duty period as compared to the actual flight duty period.

Short-call reserve means a period of time in which a crewmember does not receive a required rest period following notification by the certificate holder to report for a flight duty period.

Split duty means a flight duty period that has a scheduled break in duty that is less than a required rest period.

Suitable accommodation means a temperature-controlled facility with sound mitigation that provides a crewmember with the ability to sleep in a bed and to control light.

Theater means a geographical area where local time at the crewmember's flight duty period departure point and arrival point differ by no more than 4 hours.

Unforeseen operational circumstance means an unplanned event beyond the control of a certificate holder of insufficient duration to allow for adjustments to schedules, including unforecast weather, equipment malfunction, or air traffic delay.

Window of circadian low means a period of maximum sleepiness that occurs between 0200 and 0559 during a physiological night.

§ 117.5 Fitness for duty.

(a) Each flightcrew member must report for any flight duty period rested and prepared to perform his or her assigned duties.

(b) No certificate holder may assign and no flightcrew member may accept assignment to a flight duty period if the flightcrew member has reported for a flight duty period too fatigued to safely perform his or her assigned duties or if the certificate holder believes that the flightcrew member is too fatigued to safely perform his or her assigned duties.

(c) No certificate holder may permit a flightcrew member to continue a flight duty period if the flightcrew member has reported himself too fatigued to continue the assigned flight duty period.

(d) Any person who suspects a flightcrew member of being too fatigued to perform his or her duties during flight must immediately report that information to the certificate holder.

(e) Once notified of possible flightcrew member fatigue, the certificate holder must evaluate the flightcrew member for fitness for duty. The evaluation must be conducted by a person trained in accordance with § 117.11 and must be completed before the flightcrew member begins or continues an FDP.

(f) As part of the dispatch or flight release, as applicable, each flightcrew member must affirmatively state he or she is fit for duty prior to commencing flight.

(g) Each certificate holder must develop and implement an internal evaluation and audit program approved by the Administrator that will monitor whether flightcrew members are reporting for FDPs fit for duty and correct any deficiencies.

§ 117.7 Fatigue risk management system.

(a) No certificate holder may exceed any provision of this part unless approved by the FAA under a Fatigue Risk Management System that provides at least an equivalent level of protection against fatigue-related accidents or incidents as the other provisions of this part.

(b) The Fatigue Risk Management System must include:

(1) A fatigue risk management policy.

(2) An education and awareness training program.

(3) A fatigue reporting system.

(4) A system for monitoring flightcrew fatigue.

(5) An incident reporting process.

(6) A performance evaluation.

(c) Whenever the Administrator finds that revisions are necessary for the continued adequacy of an FRMS that has been granted final approval, the certificate holder must, after notification, make any changes in the program deemed necessary by the Administrator.

§ 117.9 Schedule reliability.

(a) Each certificate holder must adjust within 60 days —

(1) Its system-wide flight duty periods if the total actual flight duty periods exceed the scheduled flight duty periods more than 5 percent of the time, and

(2) Any scheduled flight duty period that is shown to actually exceed the schedule 20 percent of the time.

(b) Each certificate holder must submit a report detailing the scheduling reliability adjustments required in paragraph (a) of this section to the FAA every two months detailing both overall schedule reliability and pairing-specific reliability. Submissions must consist of:

(1) The carrier's entire crew pairing schedule for the previous 2-month period, including the total anticipated length of each set of crew pairings and the regulatory limit on such pairings;

(2) The actual length of each set of crew pairings, and

(3) The percentage of discrepancy between the two data sets on both a cumulative, and a pairing-specific basis.

§ 117.11 Fatigue education and training program.

(a) Each certificate holder must develop and implement an education and training program, approved by the Administrator, applicable to all employees of the certificate holder responsible for administering the provisions of this rule including flightcrew members, dispatchers, individuals involved in the scheduling of flightcrew members, individuals involved in operational control, and any employee providing management oversight of those areas.

(b)(1) Initial training for all individuals listed in paragraph (a) of this section must consist of at least 5 programmed hours of instruction in the subjects listed in paragraph (b)(3) of this section.

(2) Recurrent training for all individuals listed in paragraph (a) of this section must be given on an annual basis and must consist of 2 programmed hours of instruction in the subjects listed in paragraph (b)(3) of this section.

(3) The fatigue education and training program must include information on—

(i) FAA regulatory requirements for flight, duty and rest and NTSB recommendations on fatigue management.

(ii) Basics of fatigue, including sleep fundamentals and circadian rhythms.

(iii) Causes of fatigue, including possible medical conditions.

(iv) Effect of fatigue on performance.

(v) Fatigue countermeasures.

(vi) Fatigue prevention and mitigation.

(vii) Influence of lifestyle, including nutrition, exercise, and family life, on fatigue.

(viii) Familiarity with sleep disorders and their possible treatments.

(ix) Responsible commuting.

(x) Flightcrew member responsibility for ensuring adequate rest and fitness for duty.

(xi) Operating through and within multiple time zones.

(c) Whenever the Administrator finds that revisions are necessary for the continued adequacy of a fatigue education and training program that has been granted final approval, the certificate holder must, after notification, make any changes in the program that are deemed necessary by the Administrator.

§ 117.13 Flight time limitation.

No certificate holder may schedule and no flightcrew member may accept an assignment or continue an assigned flight duty period if the total flight time:

(a) Will exceed the limits specified in Table A of this part if the operation is conducted with the minimum required flightcrew.

(b) Will exceed 16 hours if the operation is conducted with an augmented flightcrew.

§ 117.15 Flight duty period: Un-augmented operations.

(a) Except as provided for in § 117.17, no certificate holder may assign and no flightcrew member may accept an assignment for an unaugmented flight operation if the scheduled flight duty period will exceed the limits in Table B of this part.

(b) If the flightcrew member is not acclimated:

(1) The maximum flight duty period in Table B of this part is reduced by 30 minutes.

(2) The applicable flight duty period is based on the local time at the flightcrew member's home base.

(c) In the event unforeseen circumstances arise:

(1) The pilot in command and certificate holder may extend a flight duty period up to 2 hours.

(2) An extension in the flight duty period exceeding 30 minutes may occur only once in any 168 consecutive hour period, and never on consecutive days.

§ 117.17 Flight duty period: Split duty.

For a split duty period, a certificate holder may extend and a flightcrew member may accept a flight duty period up to 50 percent of time that the flightcrew member spent in a suitable accommodation up to a maximum flight duty period of 12 hours provided the flightcrew member is given a minimum opportunity to rest in a suitable accommodation of 4 hours, measured from the time the flightcrew member reaches the rest facility.

§ 117.19 Flight duty period: Augmented flightcrew.

The flight duty period limits in § 117.15 may be extended by augmenting the flightcrew.

(a) For flight operations conducted with an acclimated augmented flightcrew, no certificate holder may assign and no flightcrew member may accept an assignment if the scheduled flight duty period will exceed the limits specified in Table C of this part.

(b) If the flightcrew member is not acclimated:

(1) The maximum flight duty period in Table C of this part is reduced by 30 minutes.

(2) The applicable flight duty period is based on the local time at the flightcrew member's home base.

(c) No certificate holder may assign and no flightcrew member may accept an assignment under this section unless during the flight duty period:

(1) Two consecutive hours are available for in-flight rest for the flightcrew member manipulating the controls during landing;

(2) A ninety minute consecutive period is available for in-flight rest for each flightcrew member; and

(3) The last flight segment provides an opportunity for in-flight rest in accordance with paragraph (c)(1) of this section.

(d) No certificate holder may assign and no flightcrew member may accept an assignment involving more than three flight segments under this section unless the certificate holder has an approved fatigue risk management system under § 117.7.

(e) At all times during flight, at least one flightcrew member with a PIC type-rating must be alert and on the flight deck.

(f) In the event unforeseen circumstances arise:

(1) The pilot in command and certificate holder may extend a flight duty period up to 3 hours.

(2) An extension in the flight duty period exceeding 30 minutes may occur only once in any 168 consecutive hour period.

§ 117.21 Reserve status.

(a) Unless specifically designated otherwise by the certificate holder, all reserve is considered long-call reserve.

(b) For airport/standby reserve, all time spent in a reserve status is part of the flightcrew member's flight duty period.

(c) For short call reserve,

(1) All time within the reserve availability period is duty.

(2) The reserve availability period may not exceed 14 hours.

(3) No certificate holder may schedule and no reserve flightcrew member on short call reserve may accept an assignment of a flight duty period that begins before the flightcrew member's next reserve availability period unless the flightcrew member is given at least 14 hours rest.

(4) The maximum reserve duty period for un-augmented operations is the lesser of—

(i) 16 hours, as measured from the beginning of the reserve availability period;

(ii) The assigned flight duty period, as measured from the start of the flight duty period; or

(iii) The flight duty period in Table B of this part plus 4 hours, as measured from the beginning of the reserve availability period.

(iv) If all or a portion of a reserve flightcrew member's reserve availability period falls between 0000 and 0600, the certificate holder may increase the maximum reserve duty period in paragraph (c)(4)(iii) of this section by one-half of the length of the time during the reserve availability period in which the certificate holder did not contact the flightcrew member, not to exceed 3 hours.

(5) The maximum reserve duty period for augmented operations is the lesser of—

(i) The assigned flight duty period, as measured from the start of the flight duty period; or

(ii) The flight duty period in Table C of this part plus 4 hours, as measured from the beginning of the reserve availability period.

(iii) If all or a portion of a reserve flightcrew member's reserve availability period falls between 0000 and 0600, the certificate holder may increase the maximum reserve duty period in paragraph (c)(5)(ii) of this section by one-half of the length of the time during the reserve availability period in which the certificate holder did not contact the flightcrew member, not to exceed 3 hours.

(d) For long call reserve,

(1) The period of time that the flightcrew member is in a reserve status does not count as duty.

(2) If a certificate holder contacts a flightcrew member to assign him or her to a flight duty period or a short call reserve, the flightcrew member must receive the required rest period specified in § 117.25 prior to reporting for the flight duty period or commencing the short call reserve duty.

(3) If a certificate holder contacts a flightcrew member to assign him or her to a flight duty period that will begin before and operate into the flightcrew member's window of circadian low, the flightcrew member must receive a 12 hour notice of report time from the air carrier.

(e) An air carrier may shift a reserve flightcrew member's reserve availability period under the following conditions:

(1) A shift to a later reserve availability period may not exceed 12 hours.

(2) A shift to an earlier reserve availability period may not exceed 5 hours, unless the shift is into the flightcrew member's window of circadian low, in which case the shift may not exceed 3 hours.

(3) A shift to an earlier reserve period may not occur on any consecutive calendar days.

(4) The total shifts in a reserve availability period in paragraphs (e)(1) through (e)(3) of this section may not exceed a total of 12 hours in any 168 consecutive hours.

§ 117.23 Cumulative duty limitations.

(a) The limitations of this section on flightcrew members apply to all commercial flying by the flightcrew member during the applicable periods.

(b) No certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total flight time will exceed the following:

(1) 100 hours in any 28 consecutive calendar day period and

(2) 1,000 hours in any 365 consecutive calendar day period.

(c) No certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total Flight Duty Period will exceed:

(1) 60 flight duty period hours in any 168 consecutive hours and

(2) 190 flight duty period hours in any 672 consecutive hours.

(d) Except as provided for in paragraph (d)(3) of this section, no certificate holder may schedule and no flightcrew member may accept an assignment if the flightcrew member's total duty period will exceed:

(1) 65 duty hours in any 168 consecutive hours and

(2) 200 duty hours in any 672 consecutive hours.

(3) If a flightcrew member is assigned to short-call reserve or a certificate holder transports a flightcrew member in deadhead transportation in, at a minimum, a seat in aircraft cabin that allows for a flat or near flat sleeping position, the total duty period may not exceed:

(i) 75 duty hours in any 168 consecutive hours and

(ii) 215 duty hours in any 672 consecutive hours.

(4) Extension of the duty period under paragraph (d)(3) of this section is limited to the amount of time spent on short-call reserve or in deadhead transportation.

§ 117.25 Rest period.

(a) No certificate holder may assign and no flightcrew member may accept assignment to any reserve or duty with the certificate holder during any required rest period.

(b) Before beginning any reserve or flight duty period, a flightcrew member must be given at least 30 consecutive hours free from all duty in any 168 consecutive hour period, except that:

(1) If a flightcrew member crosses more than four time zones during a series of flight duty periods that exceed 168 consecutive hours, the flightcrew member must be given a minimum of three physiological nights rest upon return to home base.

(2) A flightcrew member operating in a new theater must receive 36 hours of consecutive rest in any 168 consecutive hour period.

(c) No certificate holder may reduce a rest period more than once in any 168 consecutive hour period.

(d) No certificate holder may schedule and no flightcrew member may accept an assignment for reserve or a flight duty period unless the flightcrew member is given a rest period of at least 9 consecutive hours before beginning the reserve or flight duty period measured from the time the flightcrew member reaches the hotel or other suitable accommodation.

(e) In the event of unforeseen circumstances, the pilot in command and certificate holder may reduce the 9 consecutive hour rest period in paragraph (d) of this section to 8 consecutive hours.

§ 117.27 Consecutive nighttime operations.

No certificate holder may schedule and no flightcrew member may accept more than three consecutive nighttime flight duty periods unless the certificate holder provides an opportunity to rest during the flight duty period in accordance with § 117.17.

§ 117.29 Deadhead transportation.

(a) All time spent in deadhead transportation is considered part of a duty period.

(b) Time spent in deadhead transportation is considered part of a flight duty period if it occurs before a flight segment without an intervening required rest period.

(c) Time spent entirely in deadhead transportation during a duty period may not exceed the flight duty period in Table B of this part for the applicable time of start plus 2 hours unless the flightcrew member is given a rest period equal to the length of the deadhead transportation but not less than the required rest in § 117.25 upon completion of such transportation.

§ 117.31 Operations into unsafe areas.

(a) This section applies to operations that cannot otherwise be conducted under this part because of unique circumstances that could prevent flightcrew members from being relieved by another crew or safely provided with the rest required under § 117.25 at the end of the applicable flight duty period.

(b) A certificate holder may exceed the maximum applicable flight duty periods to the extent necessary to allow the flightcrew to fly to a destination where they can safely be relieved from duty by another flightcrew or can receive the requisite amount of rest prior to commencing their next flight duty period.

(c) The flightcrew shall be given a rest period immediately after reaching the destination described in paragraph (b) of this section equal to the length of the actual flight duty period or 24 hours, whichever is less.

(d) No extension of the cumulative fatigue limitations in § 117.3 is permitted.

(e) If the operation was conducted under contract with an agency or department of the United States Government, each affected air carrier must submit a report every 60 days detailing the—

(1) Number of times in the reporting period it relied on this section to conduct its operations.

(2) For each occurrence,

(i) The reasons for exceeding the applicable flight duty period;

(ii) The extent to which the applicable flight duty period was exceeded; and

(iii) The reason the operation could not be completed consistent with the requirements of this part.

(f) If the operation was not conducted under contract with an agency or Department of the United States Government, each affected air carrier must submit a report within 14 days of each occurrence detailing—

(1) The reasons for exceeding the applicable flight duty period;

(2) The extent to which the applicable flight duty period was exceeded; and

(3) The reason the operation could not be completed consistent with the requirements of this part.

(g) Should the Administrator determine that a certificate holder is relying on the provisions on this section, the Administrator may require the certificate holder to develop and implement a fatigue risk management system.

TABLE A TO PART 117—MAXIMUM FLIGHT TIME LIMITS FOR UNAUGMENTED OPERATIONS

Time of start (Home base)	Maximum flight time (hours)
0000–0459	8
0500–0659	9
0700–1259	10
1300–1959	9
2000–2359	8

TABLE B TO PART 117—FLIGHT DUTY PERIOD: UNAUGMENTED OPERATIONS

Time of start (Home base or acclimated)	Maximum flight duty period (hours) for lineholders based on number of flight segments						
	1	2	3	4	5	6	7+
0000–0359	9	9	9	9.	9	9	9
0400–0459	10	10	9	9	9	9	9
0500–0559	11	11	11	11	10	9.5	9
0600–0659	12	12	12	12	11.5	11	10.5
0700–1259	13	13	13	13	12.5	12	11
1300–1659	12	12	12	12	11.5	11	10.5
1700–2159	11	11	10	10	9.5	9	9
2200–2259	10.5	10.5	9.5	9.5	9	9	9

TABLE B TO PART 117—FLIGHT DUTY PERIOD: UNAUGMENTED OPERATIONS—Continued

Time of start (Home base or acclimated)	Maximum flight duty period (hours) for lineholders based on number of flight segments						
	1	2	3	4	5	6	7+
2300–2359	9.5	9.5	9	9	9	9	9

TABLE C TO PART 117—FLIGHT DUTY PERIOD: AUGMENTED OPERATIONS

Time of start (local time)	Maximum flight duty period (hours) based on rest facility and number of pilots					
	Class 1 rest facility		Class 2 rest facility		Class 3 rest facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000–0559	14	16	13	14.5	12	12.5
0600–0659	15	17.5	14	15.5	13	13.5
0700–1259	16	18	15.5	17	14	14.5
1300–1659	15	17.5	14	15.5	13	13.5
1700–2359	14	16	13	14.5	12	12.5

PART 121—OPERATING REQUIREMENTS: DOMESTIC, FLAG, AND SUPPLEMENTAL OPERATIONS

2. The authority citation for part 121 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 40119, 44101, 44701–44702, 44705, 44709–44711, 44713, 44716–44717, 44722, 46901, 44903–44904, 44912, 46105.

Subpart Q [Removed and Reserved]

3. Remove and reserve subpart Q, consisting of §§ 121.470 and 121.471.

Subpart R [Removed and Reserved]

4. Remove and reserve subpart R, consisting of §§ 121.480 through 121.493.

Subpart S [Removed and Reserved]

5. Remove and reserve subpart S, consisting of §§ 121.500 through 121.525.

Issued in Washington, DC on September 3, 2010.

Raymond Towles,

Acting Director, Flight Standards Service, Aviation Safety.

[FR Doc. 2010–22626 Filed 9–10–10; 4:15 pm]

BILLING CODE 4910–13–P

TAB 5

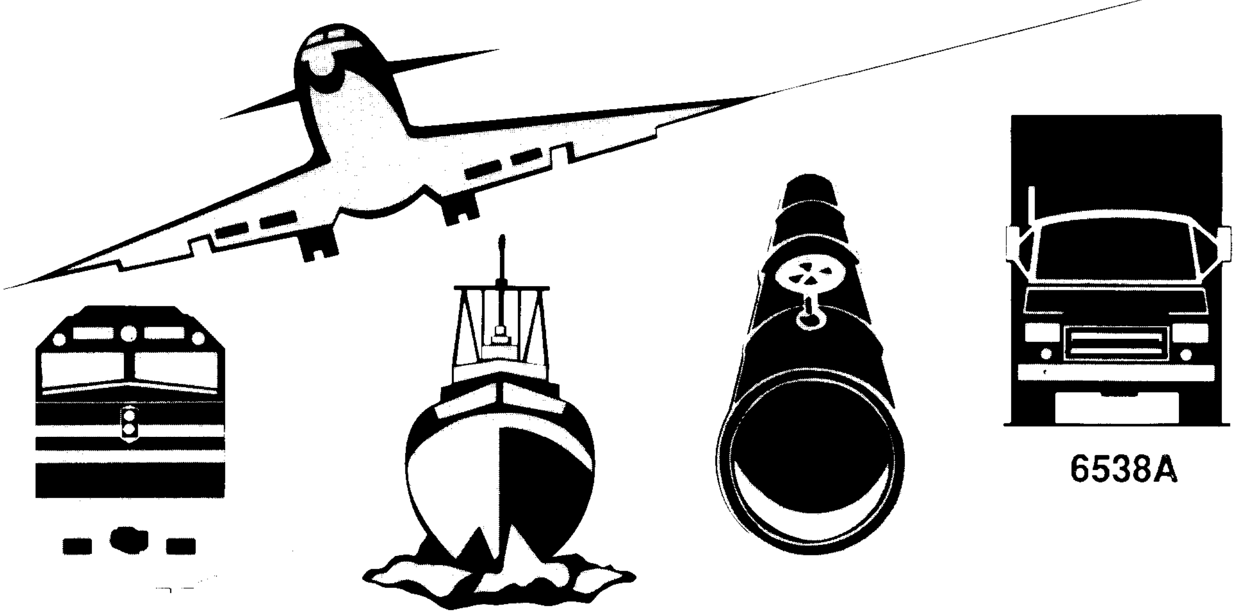
PB95-910406
NTSB/AAR-95/06
DCA95MA020

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

**UNCONTROLLED COLLISION WITH TERRAIN
AIR TRANSPORT INTERNATIONAL
DOUGLAS DC-8-63, N782AL
KANSAS CITY INTERNATIONAL AIRPORT
KANSAS CITY, MISSOURI
FEBRUARY 16, 1995**



6538A

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

Information about available publications may be obtained by contacting:

National Transportation Safety Board
Public Inquiries Section, RE-51
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594
(202)382-6735

Safety Board publications may be purchased, by individual copy or by subscription, from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
(703)487-4600

NTSB/AAR-95/06 PB95-910406

NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

UNCONTROLLED COLLISION WITH TERRAIN
AIR TRANSPORT INTERNATIONAL
DOUGLAS DC-8-63, N782AL
KANSAS CITY INTERNATIONAL AIRPORT
KANSAS CITY, MISSOURI
FEBRUARY 16, 1995

Adopted: August 30, 1995
Notation 6538A

Abstract: This report explains the accident involving an Air Transport International DC-8-63, which was destroyed by ground impact and fire during an attempted takeoff at Kansas City International Airport, Kansas City, Missouri, on February 16, 1995. Safety issues in the report include three-engine takeoff training and procedures, flightcrew fatigue, company crew assignment decisionmaking, and Federal Aviation Administration oversight of the company. Safety recommendations concerning these issues were made to the Federal Aviation Administration and Air Transport International.

CONTENTS

EXECUTIVE SUMMARY

On Thursday, February 16, 1995, at 2027 central standard time, a Douglas DC-8-63, N782AL, operated by Air Transport International, was destroyed by ground impact and fire during an attempted takeoff at the Kansas City International Airport, Kansas City, Missouri. The three flight crewmembers were fatally injured. Visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed. The flight was being conducted as a ferry flight under Title 14 Code of Federal Regulations Part 91.

The National Transportation Safety Board determines that the probable causes of this accident were:

(1) the loss of directional control by the pilot in command during the takeoff roll, and his decision to continue the takeoff and initiate a rotation below the computed rotation airspeed, resulting in a premature liftoff, further loss of control and collision with the terrain.

(2) the flightcrew's lack of understanding of the three-engine takeoff procedures, and their decision to modify those procedures.

(3) the failure of the company to ensure that the flightcrew had adequate experience, training, and rest to conduct the nonroutine flight.

Contributing to the accident was the inadequacy of Federal Aviation Administration oversight of Air Transport International and Federal Aviation Administration flight and duty time regulations that permitted a substantially reduced flightcrew rest period when conducting a nonrevenue ferry flight under 14 Code of Federal Regulations Part 91.

Safety issues discussed in the report focused on three-engine takeoff training and procedures, flightcrew fatigue, company crew assignment decisionmaking, and Federal Aviation Administration oversight of the company. Safety recommendations concerning these issues were made to the Federal Aviation Administration and Air Transport International. Also, as a result of the investigation of this accident, on March 30, 1995, the Safety Board issued Urgent Action Safety Recommendations A-95-38 and -39 to the Federal Aviation Administration concerning practices at Air Transport International.

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

AIRCRAFT ACCIDENT REPORT

UNCONTROLLED COLLISION WITH TERRAIN

AIR TRANSPORT INTERNATIONAL
DOUGLAS DC-S-63, N782AL
KANSAS CITY INTERNATIONAL AIRPORT
KANSAS CITY, MISSOURI
FEBRUARY 16, 1995

1. FACTUAL INFORMATION

1.1 History of Flight

On Thursday, February 16, 1995, at 2027 CST[1], a Douglas DC-8-63, N782AL, operated by Air Transport International (ATI), was destroyed by ground impact and fire during an attempted takeoff at the Kansas City International Airport (MCI), Kansas City, Missouri. The three flight crewmembers were fatally injured. Visual meteorological conditions prevailed, and an instrument flight rules (IFR) flight plan was filed. The flight was being conducted as a ferry flight under Title 14 Code of Federal Regulations (CFR) Part 91.[2]

N782AL landed at MCI on February 16, 1995, after a regularly scheduled cargo flight from Denver (DEN), Colorado. The airplane was loaded with new cargo and was prepared for a departure to Toledo, Ohio. During the engine starting sequence, the flightcrew was unable to start the No. 1 engine. Local maintenance personnel examined the engine and determined that a No. 1 engine gearbox drive gear had failed and that repairs could not be accomplished at MCI. ATI management decided to schedule a three-engine ferry of N782AL to Westover Municipal Airport (CEF), Chicopee, Massachusetts, where repairs could be accomplished. The cargo was then offloaded from the airplane.

---

[1]All times are in central standard time (CST) unless otherwise noted.

[2]Ferry flights are operated under Title 14 CFR Part 91.611, and, under this regulation, do not involve cargo or passengers or produce revenue for the company.

Another DC-8-63, N788AL, was scheduled to be ferried from Dover, Delaware (DOV), to MCI by the captain, first officer and flight engineer, who would later be involved in the accident in N782AL. This flightcrew had completed a regular cargo flight from Germany and were on a off-duty rest break in DOV. AT1 flightcrew scheduling personnel later assigned the captain and his crew to the three-engine ferry operation of N782AL to be conducted from MCI to CEF. The AT1 chief pilot was consulted about this assignment and gave approval for the flight, although flightcrews more experienced in three-engine takeoffs were available at MCI. According to the chief pilot, he telephoned the captain and discussed with him some of the details for the later three-engine ferry flight, including the weather forecast of possible adverse winds during the landing at CEF. Additional discussions occurred concerning a landing curfew at CEF of 2300 eastern standard time and how this would impact the flight. If the captain was unable to arrive before the landing curfew, it was decided to use Bradley International Airport (BDL), Windsor Locks, Connecticut (about 17 nautical miles southwest of CEF), as an alternate.

The captain and his crew departed DOV on the first ferry flight and arrived in MCI at 1739 on the day of the accident. The block-to-block time for the flight was 3.3 hours. AT1 arranged for a qualified airframe and powerplant (A&P) mechanic to fly from DEN to MCI to prepare N782AL for the three-engine ferry. The captain prepared the flight departure papers and discussed fueling requirements with another AT1 captain who had flown N782AL to MCI. Both captains agreed that the fuel load should be 75,000 pounds, to include 30,000 pounds of ballast fuel and 45,000 pounds of usable fuel. The computer flight plan provided to the captain estimated an en route time of 2 hours and 7 minutes for the flight from MCI to CEF. Based on this estimated time, N782AL would have had to take off prior to 1953, in order to arrive at CEF before the curfew. The A&P mechanic, who prepared N782AL for departure, stated that he was present in the cockpit when the captain reviewed the three-engine ferry procedures with the other two crewmembers with the aid of the flight manual.

About 1955, the engine start procedure was initiated. The No. 4 engine would not start on the first attempt because an ignition circuit breaker had inadvertently been left open. The circuit breaker was reset, although some pooled fuel in the cowling did momentarily torch, and a successful engine start was eventually accomplished. All three engines were operating by 2004. Following the fuel torching episode, the captain indicated that he was going to continue the start sequence on that engine until he was reminded by the flight engineer of the starter duty **cycle.**[3]

At around 2005, the captain stated, "Okay, okay, what we are going to need to do too is, ah, get as much direct as we can that will allow us to fly a little bit better than eight zero if we can." He elaborated on this comment by stating, "yeah, because we got, we got two hours to make it to go over there for flight time...and right now it's past." The next statement by the first officer was "Pushin'."

At **2007:39,** the first officer called MCI ground control and requested taxi instructions, indicating that the airplane was "heavy" and that this would be a three-engine departure. Ground control assigned runway **01L** via **taxiway** Bravo. The flightcrew then requested the latest MCI winds, and ground control replied that the wind was from 240 degrees at 4 knots. The flightcrew then requested runway **19R** for departure, but due to conflicting inbound traffic, this request could not be approved. During the taxi, the flightcrew of **N782AL** advised MCI ground control that they would need to hold in position for a "couple of minutes on the runway for a static run-up."

Takeoff data computed by the flightcrew during flight planning (written on the laminated takeoff data card found in the wreckage) included a Vmcg speed [minimum control speed on the ground] of 107 knots, a Vr speed of 123 knots, a V2 speed of 140 knots, a stabilizer trim setting of 5.1 units nose up and a maximum takeoff engine pressure ratio (EPR) setting of **1.9.**[4]

Beginning at **2013:28,** the CVR recorded the following pretakeoff briefing:

2013:28
CAM-l okay this will be a left seat takeoff, we got number one engine

---

[3]**The** engine starter duty cycle limitations for the **JT3D** turbine engine are 1 minute on, 1 minute off, 1 minute on, 5 minutes off. If the operator is only motoring the engine, the cycle limitation is 2 minutes on, 5 minutes off.

[4]**According** to the **ATI** DC-8 three-engine takeoff chart, these speeds would be appropriate for a 220,000 pound, 1,000 foot pressure altitude, 12 degree flap setting, 30 degrees Centigrade takeoff. The temperature at the tune of the accident takeoff was 31 degrees Fahrenheit, or about zero degrees Centigrade. The correct speeds for a zero degrees Centigrade takeoff, under the same conditions, would be Vr - 121 knots, V2 - 141 knots, and Vmcg - 116 knots.

is inoperative, we reviewed the procedures for three engine takeoff and ever and if nobody has any questions --.

2013:50
CAM-2 no questions.

2013:50
CAM-l okay just to review one more time what we're going to do is set max power on number two and number three --.

2013:56
CAM-2 right.

2013:56
CAM-3 right.

2013:57
CAM-l okay and I'll ease in ah number four -.

2014:01
CAM-3 and I'll call increments of point one.

2014:03
CAM-l yeah absolutely and by ah VMCG we'll have max power on number four.

2014:13
CAM-3 right co-pilot er first officer's going to call airspeed-.

2014:16
CAM-2 airspeed alive eighty knots and ten increment to VMCA, then I'll call you rotate--.

2014:21
CAM-l right.

2014:22
CAM-2 positive rate.

2014:23
CAM-l okay and 1'11 ah after rotate I'll call for positive gear ah er positive rate gear up within three seconds **--.**

2014:32
CAM-2 okay.

2014:33
CAM-3 VMCG.

2014:34
CAM-l yes.

2014:34
CAM-2 yes.

2014:35
CAM-l I'll lower, I'll lower, oh pardon me.

2014:38
CAM-3 VMCG is minimum ground control speed.

2014:40
CAM-l right.

2014:41
CAM-2 understood okay.

2014:43
CAM-l at positive rate I'll call gear up I'll lower the nose slightly to gain two ten but still keep about two hundred to four hundred feet a minute climb.

2014:51
CAM-2 right.

2014:52
CAM-l okay then ah when we reach two ten I'll call for max continuous

power.

2014:58
CAM-2 okay.

2014:59
CAM-l okay and then well call ah we'll reduce the flaps like that, we'll climb at V2 all the way up to **three** thousand feet then we'll call for the climb procedures.

2015:09
CAM-2 okay just to verify, I had V2 to four hundred AGL then two ten.

2015:13
CAM-l yeah.

2015:14
CAM-2 okay that's true but we'll take it to three thousand before we okay 1'11 point that **--.**

2015:18
CAM-3 and we won't start flap retraction until two ten.

2015:20
CAM-2 right.

2015:21
CAM-l right okay.

2015:22
CAM-l okay and ah **--.**

2015:23
CAM-2 I'm going to tower.

2015:24
CAM-l all right.

2015:27
(sound similar to frequency change).

2015:28
CAM-l and it'll be the royal three departure -- out of here.

2015:30
CAM-2 that radar **vec-** runway heading radar vectors -- you got it? 1'11 read it to you. ah fly assigned heading and altitude for vectors to appropriate route expect filed altitude ten minutes after departure --.

2015:41
CAM-l okay.

2015:42
CAM-2 then it's got some transitions you don't need to worry about not yet **--*.**

2015:44
CAM-l okay.

2015:47
CAM-3 and ah of course we'll all be watching' real close for loss of directional control.

2015:51
CAM-l yeah and also of any other ah problem that we have okay they said that they had a fire bell on number four okay --.

2015:58
CAM-2 yeah.

2015:59
CAM-l ah I talked with the engineer and I talked with the captain both he they both said that it was a false indication to their knowledge. The mechanic said that he fixed it --.

2016: 10
CAM-3 yeah fire loop lain' on the cowling.

2016:11
CAM-2 you will be running all the throttles right -.

2016:13
CAM-l yes.

2016:14
CAM-2 I won't even touch the throttles.

2016:15
CAM-l I ah that is correct you will ah just set them up ah 'til we're ready there.

2016:21
CAM-3 are you ready to go?

2016:22
CAM-2 I'll let him know it's three engine.

At 2018: 15, the flight was cleared into position and to hold on runway **01L.** The MCI local controller cleared **N782AL** for takeoff at **2019:07** and provided instructions to turn right. to 030 degrees after takeoff. The static run-up was **performed** while in position at the end of the runway, and the takeoff was commenced. At **2020:31,** the flightcrew of **N782AL** stated, "Air Transport 782 we're aborting the takeoff ." The MCI local controller observed the airplane decelerate on the runway and provided instructions to turn right off the runway and contact ground control. In addition, the controller asked if any assistance was needed, to which the **flightcrew** replied negatively. At **2021:41,** the flightcrew contacted MCI ground control and requested clearance to taxi back to runway **01L** for another attempted takeoff. This request was approved.

According to the CVR transcript and the sound spectrum analysis, during this first attempted takeoff, the power on the asymmetric engine was advanced so that full power on the asymmetric engine was obtained at around 100 knots, about 7 knots below the stated but incorrect Vmcg speed of 107 knots. The engine pressure ratio **(EPR)** of 1.5 was called 1 second before the airspeed alive (about 50 to 60 knots) call was made; followed by a call of 1.6 EPR, 1 second before the 80 knots call. Then, 90 knots was called, followed 1 second later by the 1.8 EPR (the target takeoff EPR was 1.91). One hundred knots was called 1 second later, followed by the sound of decreasing engine power, indicating the start of the rejected takeoff.

Following the rejected takeoff, the flightcrew discussed the problems they encountered during the takeoff roll. The conversations that follow were excerpted from the CVR recording:

2021:02
CAM-l I couldn't even get **dev-**

2021:03
CAM-3 well how far were we up close to.

2021:05
CAM-2 we we're about ah --.

2021:06
CAM-3 we were at one six, and then power went all the way up to one ah one nine zero as you ran it up, so it went up real fast.

2021:15
CAM-l yeah it jerked up.

2021:17
CAM-2 you brought it up too fast? or it jerked up or what?

2021:19
CAM-l it just came up too fast is what it did.

2021:22
CAM-3 if you want to try it again I can try **addin'** the power if you like.

2021:24
CAM-l okay let's do it that way yeah ah tell em' **--.**

2021:27
CAM-3 ***.**

2021:29
CAM-2 like to go back and do it again?

2021:29
CAM-l yeah tell 'em that we ah we just ah stand-by one let **me-** oh just tell 'em we'd like to taxi back and have another try at it.

2021:39
RDO-2 Kansas City ground Air Transport seven eighty two's clear we'd like to taxi back and depart one **left** again.

2021:47
GND Air Transport seven eighty two heavy roger taxi one left.

2021:50
RDO-2 one left Air Transport seven eighty two.

202152
CAM- 1 okay.

2021:55
CAM-3 I'll take off before the line.

202157
CAM-2 yes let's back that one up.

202158
CAM-3 you want the anti-skid off?

202290
CAM-l no ah let's just ah --.

2022:02
CAM-3 to the line?

2022:03
CAM-l yeah all the way down to the line.

2022:06
CAM-3 okay, transponder ignition override back to off.

2022: 10
CAM-3 how much rudder were you stickin' in?

2022: 11
CAM-l I had it all the way in.

2022:13
CAM-3 I was lookin' *.

2022: 14
CAM-l that's why I ah -.

2022: 17
CAM-3 okay when do I have to have max power in on the outboard engine?

2022:21
CAM-l one hundred and seven.

2022:23
CAM-3 by VMCG.

2022:24
CAM-l yeah.

2022:24
CAM-3 okay.

2022:26
CAM-l okay ah we didn't use brakes on that so brake energy ah chart should be okay.

2022:31
CAM-3 no.

2022:36
CAM-l it seemed what happened, it was goin' up smoothly and then all of a sudden -.

2022:40
CAM-2 it kinda ah --.

2022:40
CAM-l it jerked and then yeah.

2022:44
CAM-2 a question to consider Captain is ah when we hit when we get near VMCG or get near Vr or VMCG if we're **usin'** all our rudder authority you might **wanta'** consider abort possibly because once we get higher we'regunnarbeinbein even worse trouble correct.

2023:01
CAM- 1 that's correct absolutely.

2023:07
CAM-3 no actually above VMCG you rudder has more authority it's helping you more.

2023:11
CAM-2 I understand.

2023: 14
CAM-3 if we were to lose ah about the time an outboard engine before VMCG -.

2023:18
CAM-2 right.

2023:19
CAM-3 you can't continue the takeoff because you will lose directional control because you other engine is already in.

2023:25
CAM-2 okay yeah you're right you're one hundred percent right.

2023:29
CAM-l okay do me a favor just write down what time we aborted.

2023:32
CAM-3 okay well we aborted at ah about zero?

2023:34
CAM-2 yeah that's about right.

2023:44
CAM- 1 okay.

2023:44
CAM-2 boy it's gettin' tight.

2023:45
CAM-l yeah I know.

2023:48
CAM-2 hay we did our best you know.

2023:51
CAM-l yeah.

The airplane taxied to runway 01L in about 6 rninutes and, at 2024:28, was again cleared for takeoff, with the same instructions to turn right to 030 degrees upon departure. There were no further radio communications with the flight.

On the accident takeoff, the power on No. 4 engine was increased by the flight engineer at a more rapid rate than on the first takeoff. For instance, on the second takeoff, 1.6 EPR was called 1 second before the "airspeed alive" call (50 to 60 knots), whereas on the first takeoff, 1.6 EPR was called 1 second before 80 knots. See figure 7.

Shortly after the first officer called airspeed alive, there was an abrupt turn to the left, followed quickly by a correction to the right. After the first officer called "90 knots," the airplane started to turn left again. Following the 100 knot call, the FDR revealed a pitch change, indicating that the pilot rotated the airplane about 20 knots before the target rotation speed of 123 knots. The left drift continued, and the first officer was heard calling, "we're off the runway." A directional control correction was initiated, and the pitch attitude increased just as the airplane became airborne. The airspeed reached between 120 and 123 knots. This is just about Vmca (minimum control speed air) and is also about the stall speed for that airplane weight. The impact occurred as the airplane rolled to a nearly 90 degree left bank.

The CVR recorded the following sounds and flightcrew words during approximate 4 minutes prior to the accident:

2024:06
CAM-l and you can tell 'em that we'll ah be ready for takeoff again at the end.

2024: 15
CAM-2 tell them now?

2024:20
RDO-2 Kansas City tower Air Transport seven eighty two we'll be ah ready to go at the end of one left.

2024:26
GND roger contact the tower you'll be number one.

2024:27

RDO-2 okay

2024:28
CAM-2 yeah that might **.

2024:32
(Sounds similar to flight switching frequency).

2024:36
RDO-2 Kansas City tower Air Transport seven eighty two be ready to go at the end ah one left ah three engine takeoff.

2024:42
TWR Air Transport seven eighty two heavy tower one left turn right zero three zero cleared for takeoff.

2024:47
RDO-2 okay cleared to go one left after departure zero three zero on the heading Air Transport seven eighty two.

2024:52
CAM-l okay and the checklist.

2024:54
CAM-3 we are to the line.

2024:56
CAM-l okay below the line.

2024:56
CAM-3 transponder?

2024:59
CAM-2 it's on again.

2025:01
CAM-3 ignition override?

2025:02
CAM-2 all engines.

2025:07
CAM-3 exterior lights.

2025:08
CAM-l to go.

2025: 10
CAM-3 ah I'm gunnar need a **minute.**

2025:11
CAM-l yeah.

2025:12
CAM-3 I need to balance fuel out a little bit it's heavy on this side.

2025:15
CAM-l okay.

2025:33
CAM-2 clear left.

2025:43
CAM-3 I'll * I'll let you know when

I have enough there.

2025:46
CAM-l okay.

2025:54
CAM-l I'll line up just a little right of the center line here.

2025:58
CAM-2 good idea.

2026:11
CAM-3 okay outboard fuel is balanced.

2026: 12
CAM-l okay and we're cleared for takeoff, lights are extended and on. checklist is complete?

2026:24
CAM-3 checklist is complete.

2026:24
CAM-l okay.

2026:25
CAM (sound of increasing engine noise).

2026:33
CAM-l make sure that ah two and three is is ah -.

2026:37
CAM-3 at max power?

2026:37
CAM-l yeah.

2026:39
CAM-3 okay.

2026:40
CAM-3 I'll set max power.

2026:46
CAM-3 one one.

2026:49
CAM-3 one two.

2026:50
CAM-3 one three.

2026:52
CAM-3 one four.

2026:54
CAM-3 one five.

2026:58
CAM-3 one six.

2026:59
CAM-2 airspeed's alive.

2026:59
CAM-3 one seven.

2027:01
CAM-1 god bless it.

2027:05
CAM-l keep it goin'.

2027:06
CAM (sound of engine noise increasing).

2027:07
CAM-3 keep it **goin'?**

2027:07
CAM-l yeah.

2027:07
CAM-2 eighty knots.

2027:11
CAM-2 ninety knots.

2027:13
CAM-2 one hundred knots.

2027:17
CAM-l okay.

2027:17
CAM (sound of loud crash).

2027:20
CAM-2 we're off the runway.

2027:21
CAM-l go max power.

2027:26
CAM-l max power.

2027:27
CAM-2 get the nose down.

2027:28
CAM-l max power.

2027:29
CAM-2 you got it.

2027:30
CAM-? we're gunnar' go -.

2027:30
CAM (sound of loud crash).

2027:32
end of recording

The MCI local controller later said, ". ..something did not look right as the airplane was lifting **off...the** lights were out of whack...it didn't look right." He thought the airplane became airborne and then observed a "**fireball.**" Airport crash/rescue units, already out of the firehouse on a night exercise, responded to the accident scene.

There were several other witnesses to the accident. One was a commercial pilot who observed **N782AL** reject the first takeoff and then taxi back for the second attempt. He was on a ramp near the runway midpoint and observed the second takeoff attempt from the start of the takeoff roll. He said that as the airplane rotated, "...the tail dragged and it left quite a lot of sparks. It looked unusually nose high after rotation." He also said that as the airplane passed by him, he could see something like "fire" emanating from the left side of the airplane, about the location of the No. 2 engine. He stated that the airplane became airborne, but "it mushed into the air." He estimated that the airplane reached an altitude of between 50 and 100 feet. At this point there was no more flame from the left side. He saw the airplane enter a slow roll to the left and reach "nearly a 90 degree bank." It then impacted the ground and exploded. The report of another witness was similar, but he added that he heard the "pop of an engine like a compressor stall." He was located on the airport, and also saw the airplane veer to the left and explode upon impact with the ground.

The **ATI** A&P mechanic who prepared **N782AL** for the three-engine ferry also observed the takeoff and impact. He was at the north end of the runway and had a head-on view of the takeoff. He said the airplane obtained an "unusually

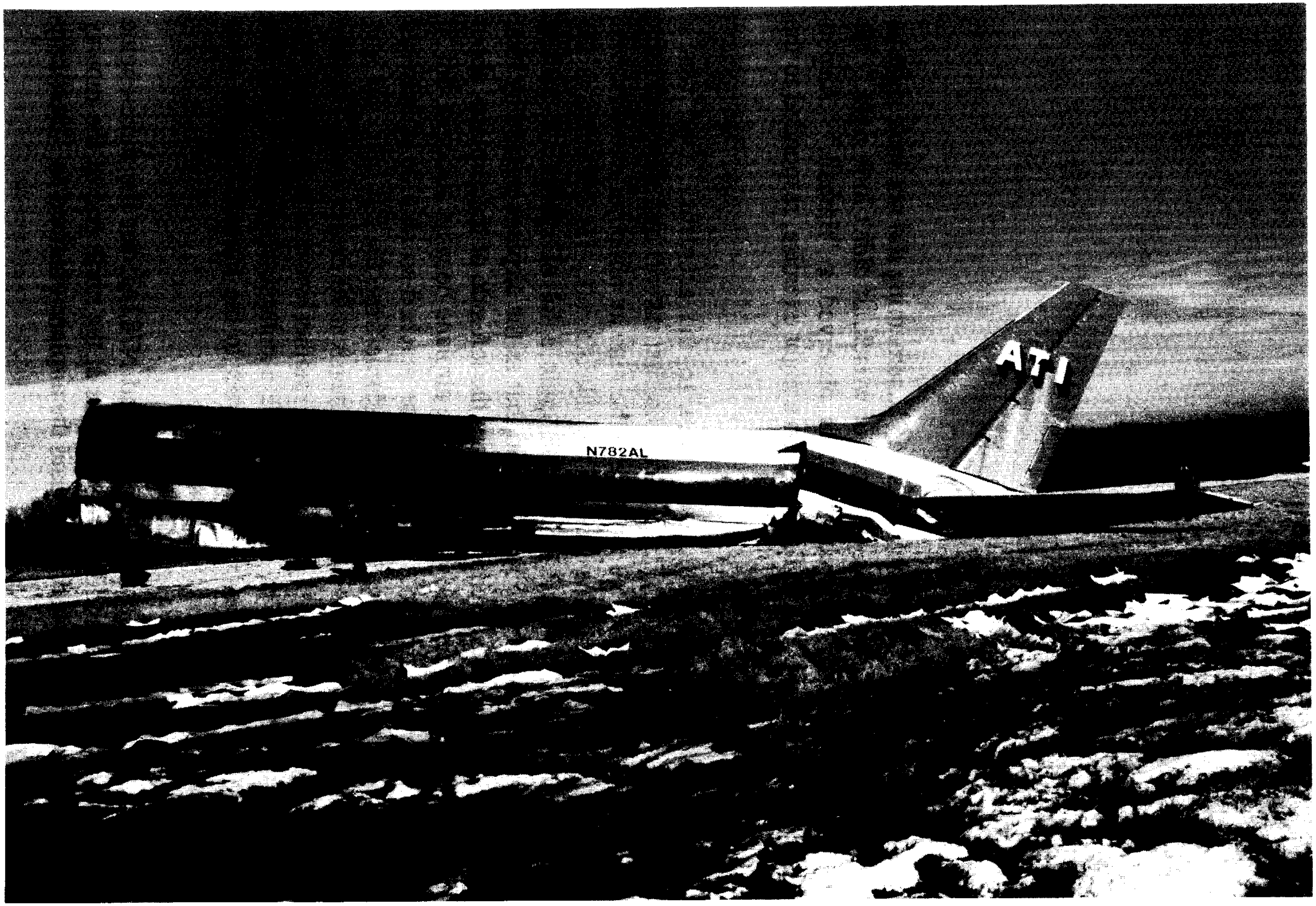


Figure 1.--Ground view of wreckage.

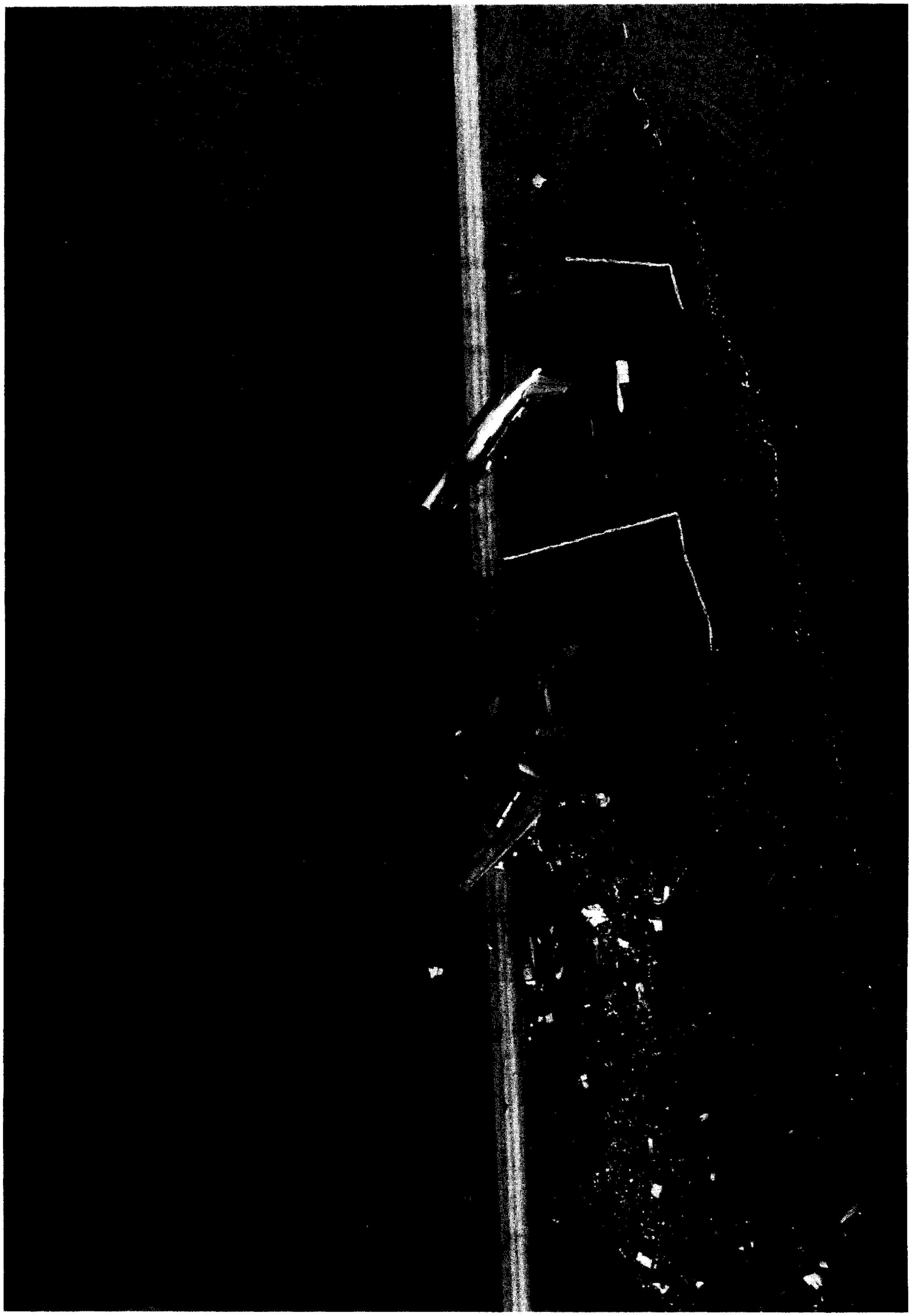


Figure 2.--Aerial view of wreckage.

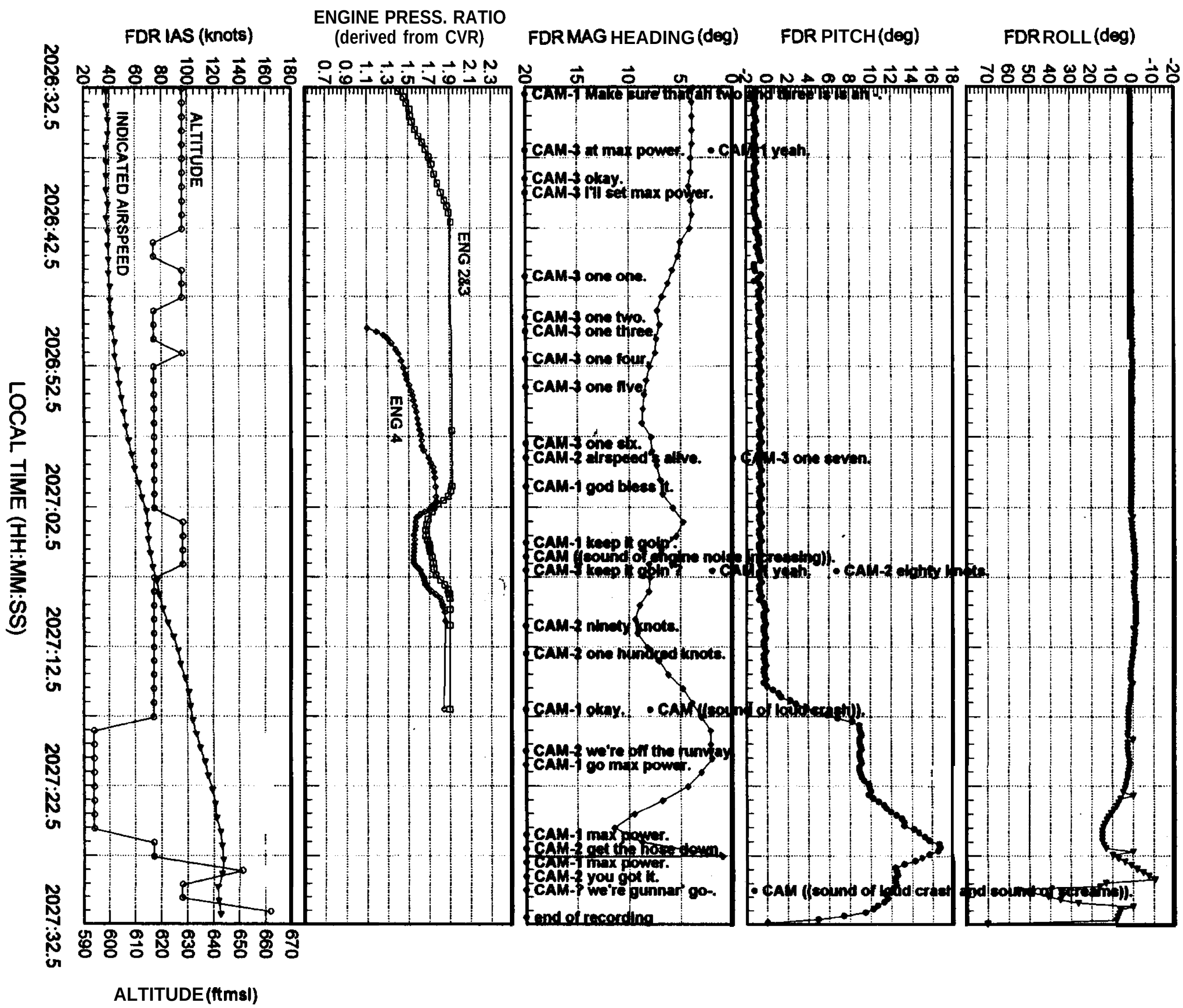


Figure **3.--FDR/CVR** presentation.

nose high attitude during rotation," and he observed a "bright yellowish-orange ball of fire from the exhaust of the No. 2 engine." He then saw the airplane enter a "slowly increasing left bank" just before impacting the ground. See figures 1 and 2.

The accident occurred during the hours of darkness at 39'18'50.4" north latitude and 094'43'51.8" west longitude. Field elevation at this location was 978 feet above mean sea level.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others	Total
Fatal	3	0	0	3
Serious	0	0	0	0
Minor/ None	4	4	0	0
Total	3	0	0	3

1.3 Damage to Airplane

The airplane was destroyed during the impact sequence and postcrash fire. The hull loss value of the airplane was $12,000,000.

1.4 Other Damage

The spilled fuel from the airplane caused environmental damage, which cost $474,000 to clean up.

1.5 Personnel Information

1.5.1 The Captain

The captain, age 48, was born on October 18, 1946. The following are the dates on which he obtained Federal Aviation Administration (FAA) certificates and ratings:

Private Pilot Certificate	September 7, 1970
Instrument Rating	October 4, 1977
Commercial Pilot Certificate (with multi-engine rating)	June 11, 1981

Airline Transport Pilot (ATP) Certificate	August 26, 1985
Type rating in the DC-8	October 21, 1989
Type rating in the DC-6 and DC-7	October 30, 1985
First Class Medical Certificate (must wear and possess corrective lenses for distant and near vision, respectively)	January 11, 1995

On October 13, 1989, an FAA Examiner issued a Notice of Disapproval after the captain (a first officer at that time) failed a DC-8 simulator check. The area graded unsatisfactory was categorized as "other instrument approaches." A recheck was satisfactory on October 21, 1989.

In addition, the captain obtained the following FAA airman certificates:

Mechanic Certificate with A&P Rating	June 1, 1983
Advanced Ground Instructor	November 7, 1983
Flight Engineer (Reciprocating Engine)	January 31, 1984

In the FAA airman records for the captain, there was a Notice of Proposed Certificate Action, dated May 12, 1994. The violation involved a three-engine ferry flight from Belgium to Canada, in which four passengers and 6,250 pounds of company cargo were carried. At the time of the incident, the captain was employed by American International Airways, Inc. (AIA), as a first officer. The operations specification for the airline prohibited carrying any passengers or cargo other than what was essential for the ferry flight. The FAA proposed to suspend his ATP certificate for 45 days. However, after an informal interview with FAA attorneys, the suspension was voided, and action was reduced to a warning letter, which addressed his responsibilities as a first officer to be aware of such limitations and to express these limitations to the pilot-in-command.

The captain's employment records indicated that he flew DC-6 and DC-7 aircraft as a flight engineer and first officer for Trans Air Link, Miami, Florida, from March 1983 until June 1988. He upgraded to captain in these aircraft types in October 1988. He left this company for a position with Rosenbaum Aviation, Inc., in June 1988 and remained with that company until he was furloughed in October 1991. With Rosenbaum, he flew the DC-8 as a first officer until November 1989, when he checked out as a DC-8 captain. No records for training in 1990 could be located, but there was a record of a satisfactory proficiency check accomplished in August 1991.

In February 1992, he was employed by Fiie Airlines, Inc., as a DC-8 captain. He flew with this company until June 1992. In November 1992, he started employment with **AIA** as a DC-8 first officer. He left this company in January 1994, when he was hired by **ATI,** as a DC-8 captain.

An examination of the captain's training records while he was employed by AIA revealed that on October 5, 1993, a check airman entered the following comments after a line check:

> Excellent ride. [This individual] would make a great captain.

On October 20, 1993, another check airman entered these comments after a first officer simulator proficiency training session:

> [This individual], at this time, does not exhibit the confidence and command authority necessary to function as a pilot in command. I do not recommend he be considered for upgrade at this time.

Another check airman, on October 21, 1993, stated in the comments section, after a second first officer simulator proficiency training session:

> Good instrument scan and aircraft control. Weak on procedures. All proficiency training maneuvers completed satisfactorily.

His training by **ATI** consisted of reduced new-hire ground school (48 hours) based on his recent DC-8 experience. This training included basic indoctrination, initial ground school, and two cockpit procedures trainer (CPT) sessions totaling 8 hours. As part of this training, he also received three simulator training periods totaling 12 hours. He shared these sessions with another **ATI** pilot. The **ATI** training manual called for a newly hired pilot-in-command to receive 20 hours of initial simulator flight training to be completed in five simulator sessions. These hours could have been reduced if a pilot successfully completed the listed events and an **ATI** instructor recommended a reduction in training hours. A satisfactory simulator proficiency check (PC) was conducted on February 15, 1994.

The captain's company-optional initial operating experience (IOE) was conducted on 11 flights in the airplane, from February 22 through 26, 1994, and totaled 18.9 hours with 11 landings. An FAA observer was not required because of the captain's previous qualifications. On February 26, 1994, the captain was observed by this second individual for an annual line check, and he was graded satisfactory.

The captain flew with a check airman, in April 1994, to determine his capability to operate internationally. According to a company training supervisor, the check captain did not think that the captain was ready for the international authority; therefore, he did not conduct a line check. It was decided to restrict the captain to domestic routes until he was "more seasoned."

The captain was provided with proficiency training on August 12 and 13, 1994, including two simulator sessions of 4 hours each for a total of 8 hours. Company records showed that the captain then received recurrent training in Denver from February 6 through 11, 1995. Included in the records was documentation of crew resource management (CRM) training, conducted by Hemandez Engineering, Inc., which reflected 16 hours of classroom training, identified as "initial CRM."

The captain was observed on an annual line check on February 14 and 15, 1995, the 2 days prior to the accident, on a round-trip flight to Germany from Dover, Delaware. This was also termed an international line check. All items were rated satisfactory by the check captain. In the comments section, the check captain stated, "Very nice job." The captain was due for a proficiency check in February 1995, with a grace period into March.

The captains training records indicated that he received simulator training in three-engine ferry procedures during training sessions on February 15, 1994, and August 13, 1994. It was noted on the check form, dated February 15, 1994, that Engine Ferry Procedures were graded satisfactory. In addition, pilot logbook entries indicated that the captain was a first officer on three actual three-engine ferry flights in DC-8 airplanes. The last two of these were in November 1993. No record was found that he had performed pilot-in-command duties during a three-engine takeoff.

The following is a summary of the captains flight time:

Total Flight Time	9,711 hours
DC-8 Captain Time	3,129 hours
DC-8 First Officer Time	1,354 hours
Time Last 90 Days (all DC-8)	201 hours
Time Last 60 Days (all DC-8)	120 hours

Time Last 30 Days (all DC-8) **60** hours

1.5.2 The First Officer

The first officer, age 38, was born on August 15, 1956. The following are the dates on which he obtained FAA certificates and ratings:

Private Pilot Certificate	March 22,198 1
Instrument Rating	April 15, 1989
Commercial Pilot Certificate	October 12, 1989
Multi-engine Rating	November 11, 1989
Flight Instructor, Single-engine Land	June 13, 1990
Flight Instructor, Instrument	September 21, 1990
Flight Instructor, Multi-engine	November 9, 1990
Airline Transport Pilot	July 27, 1992
Type Rating in B-737	August 20, 1993
First Class Airman Medical Certificate (with no limitations)	May 19, 1994

On March 20, 1989, a Notice of Disapproval was issued by an FAA Examiner for failed instrument flight check by 'the first officer. The items noted as unsatisfactory were: holding procedures, circling approach, and very high frequency omnidirectional radio range (VOR) approach procedures. A successful recheck was accomplished on April 15, 1989. On July 13, 1992, an FAA Examiner issued a Notice of Disapproval for a failed ATP oral and flight check in a Piper PA-3 l-350. The recheck was successful on July 27, 1992, and the ATP was issued. Another Notice of Disapproval was issued by an FAA Examiner on August 10, 1993, for a failed simulator rating check in a B-737-200. The areas identified as needing reexamination were: V1 engine cut, single engine missed approach and single engine landing. A successful recheck was conducted on August 20, 1993, and a type rating for the B-737 was issued.

The first officer's employment application indicated that he flew with Sunwest Aviation from November 1990 until January 1994. With this company, he flew as a captain in the Beech 99 and PA-31-350. From February 1993 until August 1994, he flew as a captain with Ameriflight, Inc., operating with the same type aircraft. He was hired by ATI on August 22, 1994.

On August 26, 1994, ATI records indicated that the first officer's initial ground training was completed. He was given four CPT sessions of 4 hours each, totaling 16 hours, and six simulator sessions of 4 hours each, totaling 24 hours, completed on October 6, 1994. His oral examination and proficiency check in the DC-8 were completed on October 7, 1994, and on October 9, 1994, he performed the required aircraft landing certification. He completed his IOE and his line check on October 13, 1994, after 26.6 flight hours. The training record reflected three-engine ferry simulator training on October 5, 1994. He was not type rated in the DC-8.

At the time of the accident, the first officer had a total of 4,261 flying hours, had been flying the line as a DC-8 first officer at ATI for 4 months, and had a total of 171 hours in the DC-8. He was still on probation, which, at ATI, is 1 year in duration.

The following is a summary of the first officer's recent flight time:

Time Last 90 Days (all DC-8)	142 hours
Time Last 60 Days (all DC-8)	71 hours
Time Last 30 Days (all DC-8)	39 hours

1.5.3 The Flight Engineer

The flight engineer, age 48, was born on July 20, 1946. The following is a summary of the dates on which he was issued FAA certificates and ratings:

Mechanic Certificate with A&P Rating	January 28, 1989
Flight Engineer Certificate (Turbojet)	February 18, 1990
Second Class Airman Medical Certificate (corrective lenses required for near vision)	March 15, 1994

The flight engineer retired from the USAF in October 1989 as a Senior Master Sergeant. He had about 23 years military service and had accumulated over 4,000 hours on the Lockheed C-141 as a flight engineer. After his military retirement, he was employed by Hughes Technical Services as a flight engineer instructor in the C-141. He was hired by ATI on July 18, 1994. His ATI training records indicated that he completed five CPT sessions at 4 hours each, for a total of 20 hours; and five simulator sessions at 4 hours each, for a total of 20 hours. He completed a proficiency check ride on August 30, 1994, with all items rated satisfactory. The flight engineer's IOE was completed on September 9, 1994, after 29.2 flying hours. His line check was also completed on that day. There was no FAA observer, and one was not required. The flight engineer's records indicated three-engine simulator training on August 8, 1994.

At the time of the accident, the flight engineer had been flying the line as a DC-8 flight engineer with ATI for 5 months. This was his first experience as a commercial air carrier crewmember, although he had accumulated over 4,000 flight hours as a flight engineer in the USAF, and had acquired additional postmilitary experience as a civilian C-141 flight engineer instructor. He was still on probation at ATI.

The following is a summary of the flight engineer's flight time:

Total Flight Time	4,460 hours
Total Flight Time in a DC-8	218 hours
Total Flight Time Last 90 Days (all DC-8)	135 hours
Total Flight Time Last 60 Days (all DC-8)	116 hours
Total Flight Time Last 30 Days (all DC-8)	57 hours

1.6 Airplane Information

1.6.1 General Maintenance History

Reviews of Airworthiness Directive compliance and pilot reports since December 1994 were performed. No discrepancies relevant to the circumstances of the accident were discovered.

Aircraft inspection records showed that the last "A" Check (every 125 hours) was performed on February 11, 1995. The aircraft had accumulated 12 hours since that inspection, at the time of the accident. The last "B" Check (every 700 hours) was performed on November 14, 1994. The aircraft had accumulated 350 hours since that inspection. The last "C" Check (every 3,000 hours) was performed on February 20, 1994. The aircraft had accumulated 1,521 hours since that inspection. The last "D" Check (every 25,000 hours) was performed on June 24, 1988. The aircraft had accumulated 11,040 hours since then. At the time of the accident, total aircraft time was 77,096 hours and 22,404 cycles.

1.6.2 Powerplants

The airplane was equipped with Pratt & Whitney **JT3D-7** axial flow, low bypass, turbofan engines. The engines were rated at 19,000 pounds takeoff thrust at 84 degrees F. They were configured with Stage 2 hush kits manufactured by the Nacelle Corporation.

The operator performs no engine maintenance, other than routine servicing and line maintenance. The Gas Turbine Corporation, East Granby, Connecticut, performs all other engine maintenance and inspection for the operator. A review of the aircraft discrepancy records provided by the operator revealed no history of engine-related discrepancies or deferred maintenance on the engines or engine accessories.

1.6.3 Rudder System Description

The rudder and rudder tab are movable control surfaces that provide directional control. The rudder control system is hydraulically actuated and mechanically controlled from the cockpit rudder pedals. During normal operation, rudder pedal movement is transmitted by cables to the rudder hydraulic power unit, which repositions the rudder while the rudder tab remains **faired.** If hydraulic pressure drops, or the rudder hydraulic power shutoff control lever is moved to the off position, a power-to-manual reversion mechanism unlocks the rudder tab. Rudder pedal movement then causes the rudder tab to deflect, and aerodynamic forces on the tab cause the rudder to move.

Rudder trim is controlled by a mechanical system that changes the neutral position of the rudder load-feel mechanism. A cable drum on the load-feel mechanism is connected to the rudder trim control knob in the flight compartment. Rotating the trim control knob causes the load-feel mechanism to reposition the rudder and rudder pedals to a new neutral position. Full rudder travel **(+/-** 32.5" when unrestricted) is available regardless of rudder trim setting.

1.7 Meteorological Information

The Kansas City International Airport automatic terminal information service **(ATIS)** information Zulu provided the weather conditions at 1950 as: clear skies, visibility 20 miles, temperature 31 degrees F, wind 210 degrees at 4 knots. When the **flightcrew** of **N782AL** called for taxi instructions, the winds were reported by the ground controller as 240 degrees at 4 knots. There were no reports of convective weather activity. Other pilots interviewed described the weather as "beautiful...clear...light winds."

1.8 Aids to Navigation

No aids to navigation were used by the flightcrew during the takeoff attempts.

1.9 Communications

No communications difficulties were reported or identified.

1.10 Aerodrome Information

Kansas City International Airport, certificated under 14 CFR Part 139, is 15 miles northwest of the city. The airport elevation is 1,026 feet above mean sea level. Runway 01L/19R, the principal instrument runway, is 10,801 feet long and 150 feet wide. It is not equipped with distance remaining markers, has no significant grade, and was dry at the time of the accident. This runway, used by the accident flight, is equipped with runway centerline, touchdown zone, and edge lighting. At the time of the accident, this lighting was set at step 3. The accident airplane began its takeoff runs at the approach end of runway 01L.

1.11 Flight Recorders

1.11.1 General

The airplane was equipped with a Fairchild Model Al00 cockpit voice recorder (CVR), S/N 2325, and a Sundstrand digital flight data recorder (DFDR), P/N 980-4100-60US, S/N 7768. Both units were mounted in a compartment in the aft fuselage below the cargo bay floor. Both units were found separated from their mounts. Only minor dents in the outer cases were seen. There was no evidence of fire damage. DFDR information is included in figure 3, and a transcript of the CVR recording is included in Appendix B.

Eleven parameters were recorded by the DFDR: time, altitude, airspeed, vertical acceleration, longitudinal acceleration, magnetic heading, pitch attitude, roll attitude, elevator position, engine revolutions per minute (rpm), and microphone keying. The DFDR was upgraded from five parameters to eleven parameters by Aircraft Systems and Manufacturing, Inc. Documentation of this upgrade was found to be incomplete and difficult to interpret. Documentation for elevator position was not sufficient to convert the raw values to engineering units. Engine rpm data was spurious and unusable. All engine data for this accident was derived from the CVR sound spectrum.

1.11.2 Sound Spectrum Analysis

During the acceleration portion of the takeoff, sounds were recorded by the cockpit area microphone (CAM) that could be associated with the spooling up and down of the aircraft's engines. During the rejected takeoff, the sound signatures were identifiable from idle engine through maximum engine speed to the reverser operation at the end of the rejected takeoff. During the accident takeoff, the sound signatures associated with the engines were identifiable from the start of the takeoff until 2027:12 when the background noise in the cockpit increased. From this time, until the end of the recording, the increase in the background noise prevented the identification of any engine signatures. Engine No. 4's acceleration rate during the accident takeoff attempt was derived from this sound spectrum analysis and is included in figure 3. It is also in the analysis section of this report in figure 7. The engine pressure ratio callouts recorded on the CVR were close to those derived from the sound spectrum analysis.

1.12 Wreckage and Impact Information

1.12.1 General Debris Field Description

Two sets of tire marks attributed to the accident airplane's rejected and accident takeoffs were surveyed on the runway. The second set of marks could be followed from the start until the airplane became airborne. Runway marks were further correlated with N782AL's tires after comparison with known dimensions of the airplane's landing gear and tires. Some of the runway marks from N782AL's tires were consistent with skid marks, scuff marks made by a tire that is both rolling and sliding sideways.

Some marks attributed to the rejected takeoff were consistent with skid marks from the nose landing gear (NLG) tires. No other tire marks from the rejected takeoff were observed. The first evidence of tire marks was observed on the runway centerline 590 feet from the threshold of runway 1L. The marks deviated to the left for most of the ground track. The latter portion of the marks deviated back to the right slightly before ending. The last surveyed mark from the rejected takeoff was located 14 feet left of runway centerline and 2,772 feet from the threshold. The tire marks from the rejected takeoff were continuous from beginning to end.

The runway marks attributed to the airplane's second takeoff attempt were consistent with skid marks from the NLG and main landing gear (MLG) tires. Marks in the grass from the right MLG tires were also documented, as were marks on the runway and in the ground adjacent to the runway from the tail skid. The first surveyed tire mark was from the right NLG tire and was located 9 feet right of centerline and 451 feet from the threshold. The tail skid mark began 29 feet left of centerline and 3,779 feet from the threshold. Several pieces of the tail skid casting and fairing were found along the tail skid ground scar. The ground scar ended 144 feet left of centerline and 5,174 feet from the threshold. This was determined to be the takeoff point of the airplane. No additional ground scars or airplane parts were documented until the beginning of the ground scars at the main wreckage site.

The airplane fuselage broke into two large sections and the cockpit. All four engines and pylons and the landing gear assemblies separated from the airplane during the crash sequence. The location of significant ground scars and debris is shown in figures 4 and 5.

Several ground impact scars, containing pieces of left wing, were observed near the main wreckage site. The first of these ground scars began 1,470 feet from the end of the tail skid scar. Fuel was spilled throughout the area of the initial ground scars, and most of the grass in this area was burned. A large trench began approximately 300 feet from the initial ground scar. The trench was generally oriented along a magnetic heading of 350 degrees, although it curved to the west slightly.

A large crater was located beyond the trench. Pieces of cockpit side window, a nose landing gear door, forward fuselage, a main cargo door latch assembly, and pieces of the No. 2 engine were found in and around the crater. A IO-foot section of the left wing tip was located near the crater. This piece had been heavily damaged by fire, and the outboard tip structure was mangled and bent. Also found just beyond the crater were a 19-foot-long piece of outboard left lower skin and most of the main cargo door. Examination of the door revealed that it was latched and locked. Pieces of red lens were found between the initial left wing

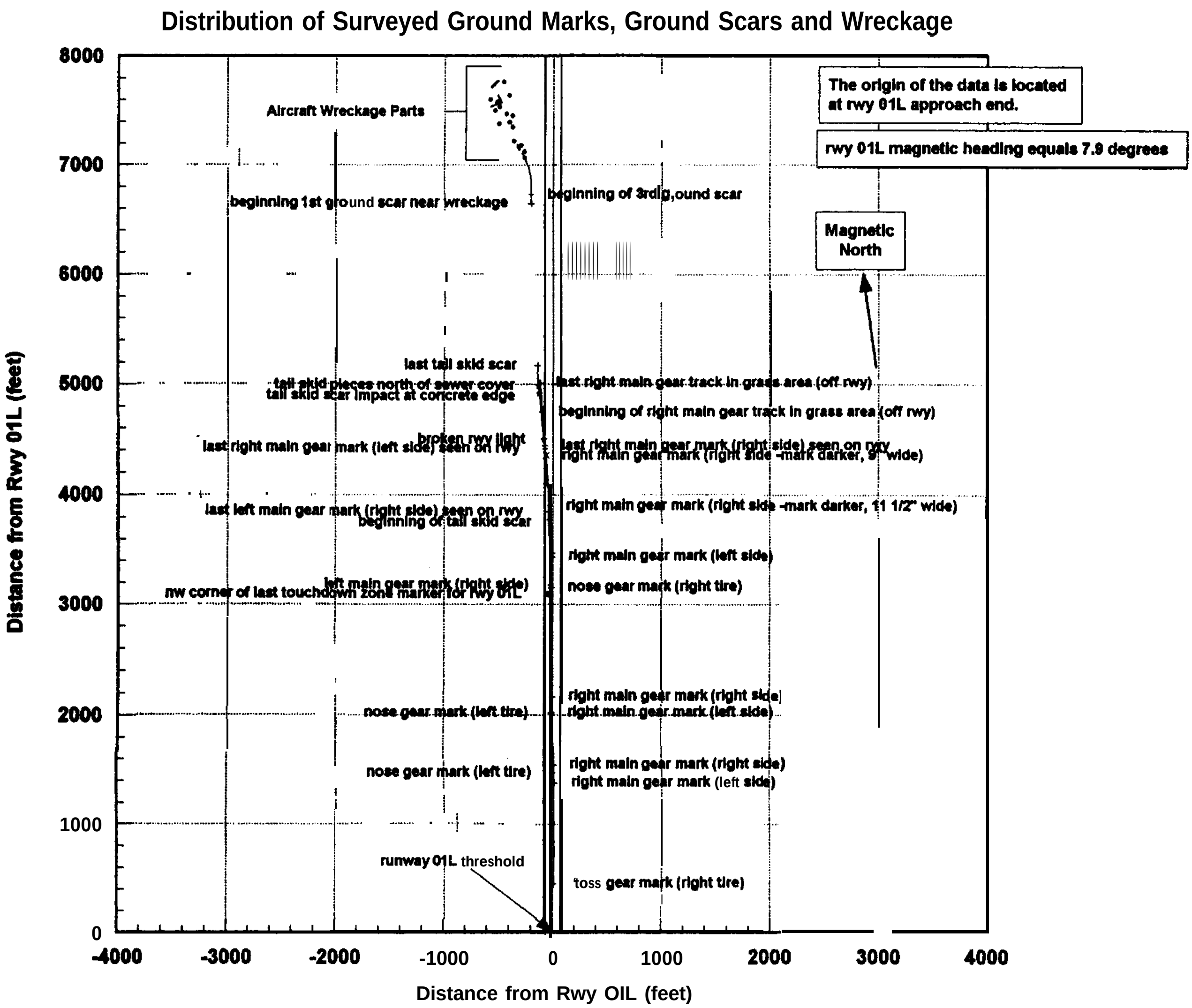


Figure **4.--Ground** scars, ground marks, and wreckage.

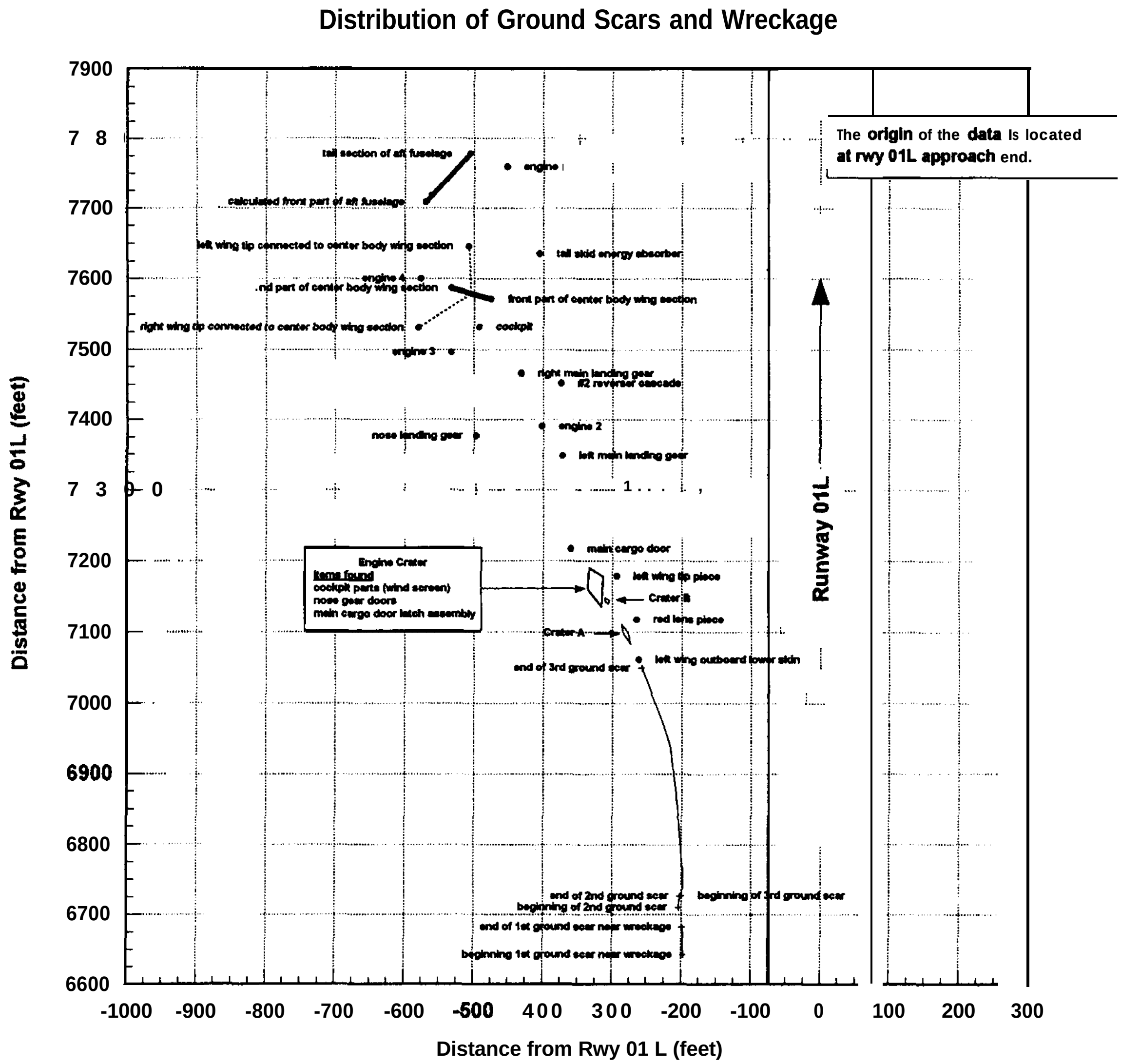


Figure 5.--Ground scars and wreckage.

ground scars and the left wing tip.

1.12.2 Fuselage

The cockpit and forward fuselage suffered severe impact damage. The upper cockpit structure remained recognizable, but the lower cockpit structure, radome, and fuselage were mostly broken into smaller pieces. The upper, forward section of the cockpit was found upside down, and the front windows were shattered.

The forward fuselage remained intact and attached to the wing structure. The left and right sides were sooted, more so on the left side and near the wings, but no soot and only minor deformation were observed on the interior of the fuselage. The forward fuselage section came to rest on a magnetic heading of 125 degrees.

The aft fuselage section remained intact, and with the empennage attached. Some postcrash sooting was observed. The cabin structure remained intact, with no fire penetration. The fuselage belly sustained considerable crushing damage. The section came to rest on a magnetic heading of 240 degrees.

1.12.3 Wings

The full span of the right wing was intact. All right flight control surfaces were found attached to the wing or adjacent to it. The left wing remained attached from the fuselage to just outboard of the No. 1 pylon attachment point. The wing exhibited upward and rearward bending at the break. All left wing flight control surfaces either remained attached or were found adjacent to the wing structure.

1.12.4 Empennage

The empennage exhibited a vertical crack aft of the pressure bulkhead and circumferentially around the fuselage, but it remained attached to the fuselage strllcture. The tail cone was buckled, with the left elevator. jammed into the structure. The rudder was buckled at midspan above the trim tab. The rudder, rudder trim tab, horizontal stabilizer, elevators, and elevator trim tabs remained attached to the mounting hardware. The vertical stabilizer was cracked at the dorsal fairing.

1.12.5 Engines[1]

1.12.5.1 Engine No. 2

The exterior of the engine case was lightly sooted. It was located in an area that was exposed to a low intensity grass fire. There were no apparent inside-to-outside penetrations of the nose cowl. The thrust reverser assembly and exhaust nozzle were separated from the engine but were intact, with the reverser buckets in the stowed positions.

A borescope examination revealed mud, dirt and grass in the gas path from the inspection hole rearward. Fuel was present in the system and in each examined component from the fuel boost pump to the fuel manifold. The throttle lever position on the fuel control was between 3/4 to full open. The fuel shutoff lever was in the full forward position. Both anti-ice valves were closed. The compressor bleed valve was closed.

1.12.5.2 Engine No. 3

The engine cowling, thrust reverser assembly, and exhaust nozzle remained with the engine. The thrust reverser buckets were in the stowed position. Viewed through the exhaust nozzle, the fourth stage turbine was intact, and there was no visible evidence of foreign object passage through the turbine gas path.

All first and second stage fan blades, except for seven second stage blades from 11 to 2 o'clock, were found broken off adjacent to the blade root above the platform. The seven blades remaining in the disk were deformed in the direction opposite rotation. There was uniform distribution of grass and mud on the fan exit and inlet vanes. Borescope examination aft showed a uniform distribution of mud and grass on the leading edges of all visible vanes back to the high pressure discharge. The fuel pump filter screen contained a small amount of particulate. There was some residual fuel in the inlet filter screen housing. The fuel control inlet filter screens were clean. The fuel control fuel shutoff lever was about 2/3 of the way toward the rear stop. The anti-ice valves were closed. The compressor bleed valve was open.

---

[1]According to ATI sources, engine No. 1 experienced a constant speed drive failure previous to the takeoff attempts. It was secured and intentionally not operating at the time of the accident. Its further condition is not considered in this report.

1.12.5.3 Engine No. 4

The No. 4 engine was separated from the pylon, and the pylon was separated from the wing. The thrust reverser assembly and exhaust nozzle were separated from the engine and were located forward of the right wing. The thrust reverser buckets were found in the stowed positions. There was a small amount of vegetation visible in the inlet case forward of the first stage fan, but no visible damage was observed on the first or second stage fans, the inlet guide vanes or first stage vanes. There was no visible damage to the fourth stage turbine. The fourth stage turbine turned freely by hand, and the fan and low pressure compressor turned with it. The blanking plate for the hydraulic pump mount pad, and the pressurization and dump valve were not recovered. All other engine-mounted accessories appeared to be intact.

There was no visible damage to the inlet guide vanes. There was no visible foreign object damage to the fan section. There was evidence of a tip rub on the first stage fan rub strip located from the 7 to 8 o'clock position that covered an arc of six inlet guide vanes. The fuel control fuel cutoff lever was against the forward stop. The fuel control throttle lever was midrange. The pushrod between the fuel control throttle lever and the engine stub shaft crank was bent slightly near the stub shaft end. There was a witness mark on the engine stub shaft throttle crank and a complimentary witness mark in the clevis of the fuel control-to-stub shaft throttle pushrod that mates when the throttle control is in the full forward position. Borescope examination revealed no apparent internal damage. There was no evidence of foreign object travel through the turbine gas path. A fuel sample obtained from the engine was clear and had no visible water. The anti-ice valves were closed and the compressor bleed valve was open.

1.12.6 Fuel Samples

Fuel samples were obtained from the airplane, the vendor service tanks, and the filter of the fuel tanker that serviced the airplane. These samples were analyzed by Cleveland Technical Center, Kansas City, Missouri. The laboratory report resulting from this examination revealed normal levels of contaminants.

1.12.7 Landing Gear

All three landing gear were separated from the fuselage. The left and right main truck brake stacks were compressible and showed no evidence of melting, fusing, or exposure to fire. All brake hydraulic lines were normally attached, and all the brake stacks appeared to have ample brake wear remaining. All of the left and right main tires showed deep tread grooves, and none had evidence of flat spots or unusual wear. The nose gear was found fully extended and locked in the centered position. Both tires had deep tread grooves remaining.

1.12.8 Hydraulic System

A hydraulically powered nose wheel steering system provides directional control of the nose wheel and is actuated by a nose wheel steering wheel or the rudder pedals. The two hydraulic cylinders in this system, one on each side of the nose gear shock strut to provide the steering input to the nose wheels, remained attached to the nosegear and appeared normal. There was no evidence of damage to or leakage from the associated hydraulic lines.

In addition, both anti-skid junction boxes and the brake hydraulic fuses were inspected and appeared normal. Several hydraulic accumulators (general system and standby rudder system) were visually inspected and appeared normal.

1.12.9 Rudder System

The rudder was deflected trailing edge left and was in contact with the tailcone, which was resting on the ground. The rudder trim tab was deflected approximately 4° trailing edge right. The rudder was movable by hand and could be deflected fully left without restriction. The rudder tab moved in a mechanically geared fashion when the rudder was moved. Damage to the tailcone prevented the rudder from being moved by hand to the right. The hydraulic power unit was visually inspected and appeared normal and undamaged. All control cables to the power unit, as well as the load-feel mechanism, remained attached to their respective components; however, they were broken in several locations consistent with the fuselage breaks.

The rudder load feel mechanism measurement revealed that the distance from the cable drum and the housing was 3/8 inch, which, according to Douglas, corresponds to a trim setting of 3.5 degrees aircraft nose right. There was no witness mark that would have indicated the preimpact distance from the cable drum to the housing. The cable was not intact from the rudder trim handle to the rudder load feel mechanism.

1.12.10 Other Flight Control Systems

The stabilizer trim jackscrews were extended to a point where 18 threads were showing on the right jackscrew and 19 threads on the left jackscrew. According to data provided by Douglas, these extensions corresponded to a trim setting of 5.0 degrees aircraft nose up.

Due to impact damage, it was not possible to measure directly the position of the flaps. The hydraulic system was no longer intact, and the fluid had drained from the hydraulic lines, which allowed the actuators to move freely. However, measurements were made of the extension of the flap lockout cylinders. The inboard cylinder was extended 5.25 inches and was bent in that position. The other lockout cylinders contained no witness marks. According to data provided by Douglas, an inboard cylinder extension of 5.25 inches corresponds to a flap position of 12 degrees. The flap actuator cylinders were inspected but showed no evidence of witness marks.

The control columns were found in the cockpit wreckage and remained attached and interconnected in the longitudinal axis. Both sets of rudder pedals were found in numerous pieces in the cockpit wreckage. All spoiler overcenter links were in the down position, although several spoiler panels were damaged and bent upward. All slot doors were open.

All flight control cables were continuous from the tail to the point at which that section had separated from the midfuselage. Cables were again continuous through the midfuselage to the point of cockpit separation. No corrosion was observed on any of the flight control cables.

1.12.11 Cockpit Documentation

The throttles were found in the following positions: No. 1 - Idle, fuel switch off; No. 2 - 1/4 inches from firewall, fuel switch on; No. 3 - 1 inch from idle, fuel switch off; No. 4 - mid range, fuel switch - on. All throttles were movable and connected to the pulleys beneath the throttle quadrant. The flap handle was found in the 23” position. The flap handle operated normally and engaged all detents. There was no evidence of damage or witness marks on the flap handle assembly or detent track. The rudder trim handle was found three units nose left, and aileron trim was found one unit right wing down. Engine instrument readings varied widely between the four engines.

1.13 Medical and Pathological Information

1.13.1 General

According to his family, the captains health was excellent. They stated that he wore contact lenses and always carried glasses. They also said that he did not take prescription medicine, never drank alcohol, and would not have taken any drugs that would have affected his performance. He carried nonprescription medicine in his flight bag in the event of a cold or headache, but he did not have a cold before the accident. The captains luggage, examined at the accident site, contained disposable contact lenses, a pair of prescription glasses, an unopened pack of cigarettes, and pseudoepedrine tablets (a nonprescription antihistamine medication suitable for flying activities).

According to his wife, the first officer's health was good, and he was always in very good physical condition. She said that he did not drink alcohol or smoke tobacco, and took medicine sparingly when he had a severe headache or allergy difficulties. She said he would not have taken any drugs prior to the accident that would have affected his performance. The first officer's luggage, examined at the accident site, contained no medication.

The flight engineer's family declined to be interviewed by the Safety Board. The flight engineer's luggage, examined at the accident site, contained nonprescription medication for treatment of headache and cold.

According to the Jackson/Platt County Medical Examiner, the cause of death for all three crewmembers was traumatic injury. Toxicological specimens, obtained posthumously, were provided to the FAA's Civil Aeromedical Institute (CAMI) for testing. Tests on urine proved negative for a wide screen of drugs, including alcohol and other major drugs of abuse, for all three crewmembers.

1.13.2 Crew Rest Aspects

A detailed description of the activities of the captain and the first officer in the period prior to the accident is presented in Appendix C. An abbreviated description of the flightcrew's activities from the start of the trip until the accident arc summarized below:

Local Date	Time UTC/Local	Flightcrew Activity
2/14	193511435	The flightcrew met and briefed details of the international operations checkride with the check pilot at Dover, Delaware.
2/14	2230/1730	The international operations checkride flight departed Dover for Ramstein, Germany.
2/15	0528/0628	The flight arrived at Ramstein, Germany. Flight time: 6 hours 58 minutes.
2/15	0815/0915	The flightcrew had breakfast at Ramstein and were in their hotel rooms by 08 15 UTC.
2/15	1800/1900	The flightcrew met for coffee prior to second leg of flight. They spent about 9 hours, 45 minutes in their hotel rooms.
2/15	2028/2128	The flightcrew departed Ramstein for Dover via Gander, Newfoundland. Their arrival in Gander was about 15 hours after their arrival in Ramstein.
2/16	0237/2237	The flightcrew arrived at Gander, Newfoundland. The local date was still **2/15.**
2/16	0328/2328	The flightcrew departed Gander, Newfoundland. The local date was still **2/15.**
2/16	0648/0148	The flightcrew arrived at Dover, Delaware. The total time between Ramstein and Dover was 10 hours, 20 minutes. The total flight time between Ramstein and Dover was 9

		hours 29 minutes.
2/16	**0740/0240**	The flightcrew checked in to a hotel at Dover.
2/16	**0814/0314**	The captain placed one minute phone call to ATI operations.
2/16	**1302/0802**	The captain placed phone call to his home. This call was not related to company business.
2/16	**1530/1030**	The captain received a call from the ATI manager of crew scheduling to notify the crew that they were to ferry aircraft from Dover to Orlando, Florida.
2/16	**1530/1030**	The captain placed a one minute phone call to the ATI ground services contractor at Dover.
2/16	**1545/1045**	The captain received a call from ATI crew scheduling to notify the crew that the Orlando ferry was canceled and that he should go back to sleep and be prepared for a 2300 UTC departure for Orlando or Dayton, Ohio.
2/16	174411244	The captain placed a 2 minute call to AT1 operations.
2/16	**1900/1400**	Two calls were received by the captain from ATI scheduling to notify crew of a proposed departure from Kansas City of a three-engine ferry flight to Dover, Delaware. The chief pilot joined in the second call. The departure time was to be as soon as possible. The captain indicated that he would depart within one hour.
2/16	**1910/1410**	The captain made a one minute call to a local retail establishment. This call was not related to company business.
2/16	**2000/1500**	The crew checked out of the hotel. Their time in the hotel was 12 hours, 20 minutes. The longest period of undisturbed time for the captain was 4 hours, 47 minutes.

2/16	201811518	The crew departed Dover for Kansas City.
2/16	233911739	The crew arrived at Kansas City. The flight time was 3 hours, 21 minutes.
2/17	**0207/2007**	Taxi instructions received for first takeoff attempt. The local date is still **2/16.**
2/17	022712027	Accident. The local date is still **2/16/95.**

1.14 Fire

Several witnesses described fire or flame associated with the No. 2 engine after the airplane rotated to a nose high attitude, but before impact with the ground. Concurrent with the observation of this fire, one of these witnesses described a "pop of an engine like a compressor stall." Another of these witnesses stated that he observed a "bright yellowish-orange ball of fire from the exhaust of the No. 2 engine" as the airplane rotated. Following left wing tip contact with the ground, the fuel tanks in that wing ruptured. Fuel was liberated along the wreckage trail and ignited almost immediately.

The Kansas City Fire Department was holding a night exercise on the airport at the time of the accident, and arrived at the accident site about 1 to 1 **1/2** minutes after the crash. The fire was contained and extinguished shortly thereafter. Fire damage to the airframe is described in a previous section of this report.

1.15 Survival Aspects

All three flightcrew members were in the cockpit at the time of the accident, and fescue personnel reported that seatbelts were worn by all three. During the impact sequence, survivable space within the cockpit was compromised to the point that this accident is considered unsurvivable.

1.16 Tests and Research

1.16.1 Three-Engine Takeoff Procedural Comparison

A comparison was made between the published three-engine takeoff procedures of **ATI,** United Parcel Service, and the Douglas Aircraft Company, with special emphasis on pertinent information about asymmetric throttle application timing and rate.

ATI's DC-8 Cockpit Operating Manual states the following concerning asymmetric throttle application:

> Statically set partial power on the asymmetric engine and near max power on the symmetrical engines. After brake release, Set MAX power on the symmetrical engines and, as soon as possible, smoothly accelerate engine opposite the inoperative engine to MAX power during acceleration to Vmcg. The engine should be set at MAX power upon reaching this speed.
>
> CAPTAIN **-** Maintain directional control with rudder nose wheel steering. Smoothly advance power on the asymmetrical engine during the acceleration to Vmcg speed.
>
> The asymmetrical throttle must be aligned with the symmetrical engine throttles by Vmcg.

UPS's Engine-Out Ferry Manual states the following concerning asymmetric power application:

> Before brake release, set 50 percent **N1,** on asymmetric engine. Then set symmetrical engines at normal takeoff **N1,** (Max. Thrust).
>
> After brake release, use the rudder and rudder pedal steering to maintain directional control. Smoothly accelerate the third engine during acceleration to VMCG speed. The third engine should be set at Max. Takeoff Thrust at or before attaining VMCG.
>
> Do not be in too much of a hurry to bring the third engine power in.
>
> As the third engine power comes in, keep feeding in rudder as needed to maintain directional control.

The Douglas DC-8 Flight Manual states:

Advance symmetrical engines to full takeoff thrust. Set engine opposite the inoperative engine to the maximum EPR which can be tolerated and still maintain control at the start of the takeoff roll. This is approximately 1.1 EPR for a dry, hard surface runway.

Smoothly accelerate the engine opposite the inoperative engine during the acceleration to **VMCg** speed. The engine opposite the inoperative engine should be set at full takeoff thrust at or before attaining **VMCg** speed.

1.16.2 Simulator Experiment

During the course of the investigation, several visits were made to the United Airlines Training Center in Denver, Colorado, to study the accident sequence of events. The Link DC-8-60 series simulator used by the accident flightcrew to train for three-engine takeoffs was used for these studies. This was one of two DC-8 simulators at Denver used by **ATI** and other operators to train flightcrews. The other DC-8 simulator is configured to simulate a DC-8-70 series airplane.

Multiple takeoffs were conducted with an **ATI** check captain in the left seat, a Douglas test pilot in the right seat, and an FAA Air Carrier Inspector in the flight engineer's seat. It became apparent that this particular DC-8 simulator could not accurately simulate the yawing moments associated with intentional three-engine takeoffs. The test pilot stated: "In my opinion the airplane data is not entered into the simulator." The **ATI** check pilot agreed with that assessment. In fact, in this device, with the wheel brakes set, three of four engines could be brought up to takeoff power (with an outboard engine at idle power), the brakes could be released, and runway centerline could be easily maintained by the pilot as the simulator accelerated **from** zero airspeed through ground minimum control speed, rotation speed, and beyond. According to the DC-8 qualified pilots participating in the experiment, under these circumstances, an actual DC-8-63 would experience severe directional control problems during the takeoff roll, until ground minimum control speed was achieved.

1.17 Organizational and Management Information

1.17.1 General

ATI, as it is currently formed, is the result of mergers and acquisitions. The current owner purchased ATI in 1988 and merged it with another airline owned by him, International Cargo Express, on October 1, 1994. The new company operates as a supplemental air carrier. The company headquarters is in Little Rock, Arkansas, and it employs about 400 full-time people. About 135 part-time employees (mostly mechanics at various airports) also work for ATI. There are no flightcrew bases because each flightcrew operates from his/her own residence and reports to the airport from which a trip sequence originates. At the time of the accident, the company was operating 22 DC-8 airplanes, and planned to add 2 DC-8s to its fleet. The company has passenger-carrying authority, but at the time of the accident carried passengers only while operating some military contract flights. Military flights comprised about 15 percent of its business.

The flight operations of ATI are worldwide in scope, including flights to China, Russia, India, and several countries in Africa and Europe. The company flew approximately 43,000 revenue hours in 1994. About 12,000 hours of this flight time involved international operations. The airline recently obtained new contracts that resulted in the addition of more airplanes and flightcrews. For instance, a review of the flightcrew hiring dates revealed that 42 percent of the 64 ATI captains were hired during 1993 and 1994. Also, 93.8 percent of the 80 ATI first officers, and 68 percent of the 73 flight engineers were hired during that same time frame. The Manager of Operations System and Training, the Manager of Flight Standards, and the Denver Training Coordinator were also hired between 1993 and 1994 to enhance management oversight during this period of growth.

According to the chief pilot, the difficulties of the job for an ATI pilot included those typical of the freight industry, such as frequent night work. ATI salaries were midrange when compared to industry standards, he said, but the company provided significant benefits to the pilots that were not available at competitor companies. For instance, the crews were based at home, the company provided free life and health insurance, and the company was run with low debt and a history of financial stability. The workforce is not unionized.

1.17.2 Flightcrew Pairing

ATI's chief pilot developed a policy that addressed the pairing of flightcrews in an attempt to avoid pairing inexperienced flightcrews. At the time this program was instituted, there was no regulatory requirement to do so. The scheduling department examined each flightcrew pairing and evaluated the results, based on a desired total score of **"5"** for the assigned flightcrew. Each flightcrew received a rating number, based on experience. For captains, this number ranged from 1 to 3. For first **officers,** the number was either 1 or 2. For flight engineers, the number was also either 1 or 2. Under this arrangement, the accident flightcrew was rated "7".

1.17.3 Captain Upgrade

The criteria for upgrading to captain were addressed in the Employee Handbook, which stated, in part:

> The first officer must have accumulated 4,000 hours.
>
> First officer must have 1,000 hours as pilot-in-command of transport category aircraft. (Credit is given for first officer time on a 2 to 1 ratio. 2,000 hours in a DC-8 as first officer, counts as 1,000 hours for this requirement.)
>
> The first officer must have 500 hours in type airplane.

First **officers** who bid for a captain position are evaluated in the simulator by an **ATI** check airman. A first **officer** who fails this evaluation may reapply after 6 months. Since August 1994, six first officers have failed the upgrade evaluation, and four who did pass the evaluation failed the upgrade training.

1.17.4 Company Authorization for Three-engine Takeoffs

ATI authorized all line flightcrews to perform three-engine ferry operations, if the flightcrews met the company-established crew pairing criteria and, according to company management, possessed the ability and experience to successfully complete the maneuver. During training, the accident flightcrew was provided with three-engine instruction and performed the takeoff maneuver in the DC-8-60 series simulator at Denver, Colorado.

The Safety Board surveyed nine other cargo operators to determine a sampling of the industry on the matter of which flightcrews are authorized to perform three-engine ferry operations. The following carriers were contacted: Arrow Air, AIA, Evergreen, Emory Air Express, Federal Express, United Parcel Service, DHL, Buffalo Airways, and Zantop Airlines. All but two of these operators restrict such operations to "select flightcrews." One of the two that use all line flightcrews use only "the most experienced and selected" line flightcrews. The majority of these operators further restrict such ferries to test pilots and "daytime only."

Early in this investigation, on March 30, 1995, the Safety Board recommended that the FAA:

> Limit operations of engine-out ferry flights to training, flight test, or standardization flightcrews that have been specifically trained in engine-out procedures. (Class II, Priority Action) (A-95-39)

The full text supporting this recommendation is included as Appendix D.

On June 13, 1995, the FAA stated that it agrees with this safety recommendation and that it will issue a flight standards information bulletin on the subject. The bulletin will direct principal operations inspectors to inform their respective operators to take additional measures to ensure: (1) that aircraft manual requirements for engine-out ferry flights are clear; (2) that flightcrew training segments are clearly outlined for engine-out operations; and (3) that operators use only flightcrews specifically trained and certified for engine-out operations.

The Safety Board is currently evaluating this response to recommendation A-95-39.

1.17.5 Department of Defense (DOD)

ATI carried freight and passengers for the U.S. military under contract, and several of their airplanes were committed to the Civil Reserve Air Fleet (CRAF). The most recent DOD survey of ATI was conducted on October 18 and 19, 1993. At that time, ATI was operating 14 DC-8 aircraft, 5 of which were committed to the CRAF. The survey recommended: ATI be found capable of providing airlift services to the DOD. No below average evaluation subjects and six above average evaluation subjects were noted during this survey.

1.17.6 FAA Oversight and Surveillance

The FAA's Air Carrier Operations Inspector's Handbook, Order 8400.10 describes the principal operations inspector (POI) surveillance duties as follows:

> The POI's are the primary surveillance program planners in the FAA, since they are the focal point for all operational matters between the FAA and the certificate holder. POI's must ensure that there are periodic reviews of all aspects of a certificate holder's operations. They must specifically determine the operator's compliance status by establishing effective surveillance programs, and evaluating previous surveillance data and other related information. POI's must establish a continuing program for evaluating surveillance data to identify trends and deficiencies and to decide upon and take appropriate courses of action.

Another element of the FAA's surveillance of operators is the Geographic Program. This program assists the POI's by providing surveillance of various functions within a specific geographic area. The handbook stated:

> The geographic program managers are responsible for planning and carrying out inspection programs within their area of responsibility and for ensuring the inspection results are accurately recorded. These managers ensure that all of the activities of a certificate holder conducting operations in their geographic area are inspected and the results are reported to the POI through the program tracking and reporting system (PTRS).

FAA Order 8400.10, described the PTRS as a means of "collection, storage, retrieval, and analysis of data resulting from many different job functions performed by inspectors in the field, the regions, and headquarters." When an FAA Air Carrier Inspector conducts any surveillance function, a PTRS form should be completed, and the data entered into a computer data base. This provides information for the POI to evaluate the adequacy of the surveillance of an air carrier.

PTRS records related to ATI were reviewed for the period from February 16, 1994, through February 16, 1995. This review also included records for International Charter Express (ICX), which was owned by the same management, but was operated under a different certificate, until the certificates were merged effective October 1, 1994.

There was one PTRS record that reflected a surveillance of the international operation. This record represented a Department of Defense (DOD) air mobility flight in September 1994. An FAA air safety inspector (ASI), assigned to a northeast FAA geographic unit, conducted an en route cockpit observation on a DOD flight from Germany to Saudi Arabia and return. Also during this flight, the AS1 performed a cabin en route observation. The FAA inspector stated, "I was very impressed with the professionalism of the whole crew and was pleased by the way they conducted all aspects of the flights." No other records were found for international surveillance of operations for the airline.

In the last several years, there has been a reduction in the number of inspectors assigned to the Denver, Colorado, FAA Flight Standards District Office (FSDO). While there were three DC-8 qualified inspectors in the FSDO in 1994, there was one DC-8 qualified person at the time of the accident. Also, at the time of the accident, the FSDO had 56 total inspectors, 23 of which were assigned to geographical inspections. The FSDO manager stated that by the end of the fiscal year, the total number of inspectors was to drop to 47, and the number of geographical inspectors was to drop to 7. Interviews with some of the inspectors revealed that there was confusion about the future of the geographic program within the FAA.

Lastly, several of the Denver geographic program inspectors stated to Safety Board investigators that POIs not assigned to the Denver FSDO often become "defensive" about the certificates they manage, and at times resent hearing negative comments reported by a geographic inspector from a distant FSDO.

The Safety Board noted that all the Denver geographic program inspectors who were interviewed for this investigation stated that they were favorably impressed by the overall operation of ATI. As an example, the manager of the Denver FSDO stated that ATI relations with the FAA were good. Another inspector stated that ATI was "the best of the [nonscheduled] operators" that he helps oversee, and that ATI pilot training was "thorough and very good."

An interview with the Little Rock FSDO POI for ATI revealed that at the time of the interview, he was unfamiliar with ATI's CRM training program, ATI's crew pairing program, and several aspects of ATI's ground training program at

Denver, Colorado. He was unfamiliar with proficiency check ride failure criteria, as outlined in the FAA Order 8400.10. Also, he had no knowledge of what amount of training, if any, could be provided during proficiency check rides. The POI was trained and received a type rating in the DC-8. He has had past experience as a POI with a 14 CFR Part 135 operator. He stated that he has about 13,000 hours of total flight time. He has been the POI for ATI for about 1 year, and the ATI certificate is the only one he oversees.

The POI for ATI was asked how often he had visited the ATI Denver training facility and the Denver FSDO, and he indicated "about three or four times last year." He indicated that funding problems in his office restricted his ability to travel to Denver from Little Rock.

Early in this investigation, the Safety Board issued a priority recommendation to the FAA concerning FAA oversight of ATI. The recommendation follows, and the full text of the recommendation letter to the FAA is included as Appendix D.

> Conduct an immediate in-depth inspection of Air Transport International (ATI) to examine training, operational philosophy, and management oversight. Also, as part of this inspection, examine the effectiveness of the oversight of ATI by the Little Rock and Denver Flight Standards District Offices. (Class II, Priority Action) (A-95-38)

1.17.7 FAA National Aviation Safety Inspection Program (NASIP)

On June 13, 1995, the FAA responded to recommendation A-95-38 by stating that it agrees with this safety recommendation and has conducted an in-depth National Aviation Safety Inspection Program (NASIP) inspection of Air Transport International. The NASIP inspection was completed on April 28, 1995, and focused on the following operational areas: management training, qualifications, procedures, flight control, flight operations, records, and facilities. The NASIP inspection also focused on the following airworthiness areas: management, manuals and procedures, training, records, maintenance programs, and airworthiness directives compliance. The FAA furnished a copy of the NASIP report to the Safety Board.

The FAA also formed a special team from FAA headquarters to conduct an evaluation effectiveness of oversight of ATI by the Little Rock and

Denver FSDOs. It anticipates that the results of this evaluation will be published in September.

The Safety Board is currently evaluating these responses to recommendation A-95-38.

1.17.8 Previous AT1 Accidents

ATI has experienced three catastrophic DC-8 accidents since 1991 .[6] The Safety Board concluded that the probable causes were related to operational factors in the first two accidents.

In the accident that occurred in New York the Board determined that:

> The probable causes of this accident were improper preflight planning and preparation, in that the flight engineer miscalculated the aircraft's gross weight by 100,000 pounds and provided the captain with improper takeoff speeds; and improper supervision by the captain. Factors relating to the accident were an improper trim setting provided to the captain by the flight engineer, inadequate monitoring of the performance data by the first officer, and the company management's inadequate surveillance of the operation.

In the accident that occurred in Ohio, the Safety Board determined that:

> The probable cause of this accident was the failure of the flightcrew to properly recognize or recover in a timely manner from the unusual aircraft attitude that resulted from the captain's apparent spatial disorientation, resulting from physiological factors and/or a failed attitude director indicator.

---

[6]Brief of Accident, JFK International Airport, New York, Air Transport International, March 12, 1991, NYC91-F-A086; Aircraft Accident Report, "Loss of Control and Crash, Swanton, Ohio, Air Transport International, February 15, 1992," NTSB/AAR-92/05; and Kansas City International Airport, Missouri, Air Transport International, February 16, 1995, DCA95MA020, the accident currently under investigation.

1.18 Additional Information

1.18.1 "V" Speeds and Vmcg Calculation

"V" is the symbol used to indicate velocity (speed). In the FAA certification of airplanes, V speeds are used to determine various performance criteria needed for the safe operation of the airplane. Most airline takeoff operations, including those of **ATI,** involve the use of the following V speeds:

V1 - Decision speed: The speed at which the pilot must make a decision, in the event of an engine failure, either to continue the takeoff or to reject the takeoff. The ability to stop the airplane on the runway remaining is assured if the refused takeoff is begun at or prior to **V1.** Conversely, enough runway remains ahead of the airplane at or below **V1** speed to take off safely using the thrust from the remaining operating engines.

Vr **-** Rotation speed: this is the speed at which the pilot rotates the nose of the airplane to the takeoff pitch position in preparation for liftoff. This speed cannot be less than **V1.** The takeoff is considered "committed' after this speed.

V2 **-** Initial climb-out speed: the speed for climb after attaining a height of 35 feet above the takeoff surface during a takeoff with one engine inoperative.

When conducting a three-engine takeoff in a four-engine airplane, such as the DC-8, **V1** speed is not used because the flight is already operating with an engine inoperative. Vmcg is computed during flight planning in place of Vl. For the purposes of this report, Vmcg is defined as follows:

Vmcg **- Minimum** control speed on the ground: the minimum speed at which it is possible to maintain control of the airplane with an engine inoperative, using primary aerodynamic controls alone, and thereafter maintain a straight path parallel to that originally **intended.**[7]

'FAR 91.611, Authorization for Ferry Flight With One Engine Inoperative, paragraph (c) **(3),** states "The takeoff, flight and landing procedures...must be established. The airplane must be satisfactorily controllable during the entire takeoff run when operated according to these procedures."

Vmcg is a function of the airport pressure altitude, airplane flap setting, and ambient air temperature. A chart for 12 degrees flaps is included in the **ATI** DC-8 Cockpit Operating Manual, Chapter 2, Normal Procedures, Section 21, Three-Engine Ferry (figure 6). The **ATI** crewmember determining Vmcg would enter the weight column on the left side of the chart with the weight of the airplane to the nearest 10,000 pounds. Within that weight section, he or she would select the predicted ambient air temperature in degrees C, to the nearest 10 degrees. That weight/temperature line of data is used to select that section of the line that corresponds to the planned pressure altitude to the nearest 1,000 feet. The resulting block of data on the chart would reveal the takeoff distance, Vmcg, Vr, and V2, for the planned three-engine takeoff.

AIR TRANSPORT INTERNATIONAL

DC-8 COCKPIT OPERATING MANUAL
CHAPTER 2 - NORMAL PROCEDURES
SECTION 21 - THREE-ENGINE FERRY

FLAPS 12° — 63 AIRPORT PRESSURE ALTITUDE — FLAPS 12"

	SEA LEVEL					1000 FEET					2000 FEET					4000 FEET					60DD FEET				
WT 1000 LBS	T °C	DIST	VMCG	VR	V2	T °C	DIST	VMCG	VR	V2	T °C	DIST	VMCG	VR	V2	T °C	DIST	VMCG	VR	V2	T °C	DIST	VMCG	VR	V2
	-10	7000	116	120	142	-10	7200	116	120	142	-10	7500	116	121	142	-10	7500	113	121	140	-10	7300	108	117	140
	0	7200	116	120	142	0	7400	116	120	142	0	7600	116	121	142	0	7400	110	116	137	0	7700	106	117	134
200	10	7400	1113	120	142	10	7500	115	120	141	10	7400	113	120	137	10	7300	107	116	134	ID	8200	103	117	133
	20	7700	114	120	141	20	7500	112	119	137	20	7200	109	118	136	20	7200	104	117	133	20	8700	99	118	133
	30	7800	109	118	140	30	7700	107	118	137	30	7500	104	117	134	30	7900	100	117	133	30	9000	96	118	133
	40	7000	104	116	136	40	7200	102	115	136	40	7700	99	117	133	40	8700	95	118	132	40	10000	91	119	132
	-10	7000	116	120	141	-10	7200	116	121	141	-10	7500	116	121	141	-10	7500	113	121	141	-10	7800	108	119	140
	0	7200	116	120	141	0	7400	116	120	140	0	7600	116	120	141	0	7400	110	119	137	0	8300	106	120	138
210	10	7400	116	120	141	10	7500	115	120	140	10	7400	113	119	137	10	7900	107	119	136	10	9000	103	120	138
	20	7700	114	120	140	20	7500	112	119	138	20	7300	109	119	137	20	8300	104	120	136	20	9500	99	121	138
	30	7800	109	118	139	30	7700	107	118	138	30	7600	104	119	137	30	8700	100	120	136	30	9900	96	121	138
	40	7400	104	116	138	40	7800	102	119	139	40	8400	99	120	136	40	9600	95	121	135	40	• C	•	•	•
	-10	7000	116	121	140	-10	7200	116	121	141	-10	7500	116	121	140	-10	7500	113	122	140	-10	8500	108	123	140
	0	7200	116	121	140	0	7400	116	121	141	0	7600	116	122	140	0	7900	110	123	140	0	9100	106	124	139
220	10	7400	116	121	140	10	7500	115	122	140	10	7500	113	122	140	10	6600	107	123	139	10	9600	103	124	139
	20	7700	114	122	140	20	7500	112	122	140	20	8000	109	123	140	20	9100	104	124	139	20	10400	99	125	139
	30	7800	109	122	140	30	7800	107	123	140	30	8300	104	123	139	30	9400	100	124	139	30	10900	96	125	139
	40	8000	104	123	139	40	8500	102	124	139	40	9100	99	124	139	40	10500	95	125	138	40	• C	•	•	•

C=No takeoff allowed at the stated temperature/weight/altitude because three-engine climb requirements would not be met.

Figure **6.--ATI** DC-8 three-engine takeoff data chart.

2. ANALYSIS

2.1 General

The flightcrew was properly certified to conduct this flight in accordance with the Federal Aviation Regulations and company requirements. They were suffering no discernible health problems and were not under the influence of drugs. The emergency response to the accident scene was timely and efficient.

The investigation revealed no evidence of preexisting structural defects in the airframe and no failure of airplane structure prior to ground impact. There was no evidence of any engine problems or in-flight fire other than reports of flame in or around the No. 2 engine. This flame was the result of an engine compressor surge caused by disrupted airflow into the engine during the high angle of attack flight of the airplane immediately after liftoff.

The airplane was inspected and maintained according to currently accepted practices, and all airplane systems appeared to be operating normally during the accident sequence of events. Available engine power was sufficient to successfully complete the takeoff, had the correct procedures been used by the flightcrew.

The presence of the tire marks on the runway indicates that the thrust asymmetry of the three-engine takeoff exceeded the capability of the rudder (and the nose wheel steering, if used) to maintain directional control. It is not known whether the captain utilized the steering tiller during any portion of the takeoff attempts. In addition, data available from Douglas show that the engine power of the No. 4 engine, as indicated on the CVR, would have exceeded the capability of full rudder and nose wheel steering to maintain directional control.

On both takeoff attempts, tire marks began early in the takeoff roll. This is consistent with data from the CVR showing that the thrust on the No. 4 engine was increased too quickly after brake release, resulting in excessive thrust asymmetry during the accident takeoff. FDR heading data and the presence of nose tire marks almost 10 feet to the right of runway centerline on the second takeoff attempt suggest that the captain may have steered the airplane to the right to provide the airplane more room to maneuver as the thrust from the No. 4 engine was increased, anticipating possible problems maintaining directional control.

2.2 Airplane Systems

2.2.1 Brakes, Landing Gear and Tires

The brake stacks were compressible and showed no evidence of melting, fusing or exposure to fire. In addition, there was no evidence of damage or malfunction to the nose wheel steering system, tires, or anti-skid system. No flat spots were seen on the tires, and no melted fuse plugs were observed. The V-shaped splits on the deflated tires are consistent with overload failure at impact. All damage to the landing gear appeared consistent with the gear being down at impact. The Safety Board found no evidence of malfunction of these systems.

2.2.2 Flight Controls

The flap handle in the cockpit was found in the 23 degree position; however, there were no witness marks to indicate its position at impact. The cockpit tumbled during the accident sequence; therefore it is possible that the flap handle changed position. Also, the flap actuators did not contain witness marks and therefore were not conclusive in determining flap position. However, the inboard flap lockout cylinder was found with a witness mark that corresponded to a flap position of 12 degrees at impact. In addition, the CVR recorded the first officer stating that the flaps were set at 12 degrees. Therefore, it is reasonable to assume that the flaps were correctly set to 12 degrees for takeoff.

An attempt was made to determine the rudder trim setting for takeoff. The rudder trim dial was found in a position corresponding to three units nose left trim. However, there were no witness marks associated with the handle which indicated its position at impact. Since the rudder trim system is cable driven, and the cables were stretched and broken during the accident sequence, it is possible that the handle position changed during the impact sequence. Measurement of the rudder load-feel mechanism revealed inconclusive evidence regarding the preimpact trim setting due to the stretching of the cables as the aircraft broke apart. Therefore, due to the nature of the impact and subsequent lack of definitive evidence, the Safety Board could not determine the rudder trim setting.

In summary, the airplane was configured with landing gear down, a stabilizer trim setting of 5.0 degrees aircraft nose up, and flaps set to 12 degrees. All these items were consistent with what was planned by the flightcrew, and were consistent with normal operating practice for a three-engine takeoff. The Safety Board concludes that there was no flight control system malfunction.

2.3 AT1 Operational Supervision

2.3.1 Flightcrew Background

The captain completed his probationary period with the company 1 month before the accident. Although he had an extensive flying background, there was evidence that he had experienced difficulty in the past with some aspects of flight proficiency and command authority. For instance, he failed his first DC-8 simulator rating ride in 1989. Also, while he was working for another operator, that management decided against upgrading him to captain. Following a simulator training session, a check airman for this operator stated that the pilot did not have the command authority needed for a pilot-in-command, and he did not recommend him for upgrade to captain.

About 10 months before the accident, ATI evaluated this captains ability to conduct international operations. After several flights, a check airman decided to restrict him to domestic operations for "more seasoning," because his performance was below that required for international operations. The day before the accident, he did pass an international line check conducted by a different check airman. A review of his personal logbooks revealed 3 three-engine takeoff events, but none in which he was the pilot-in-command; therefore, it is likely that this was the first three-engine takeoff during which he was the flying pilot.

The first officer was still on probation with ATI and had experienced only 4 months of line operations. His background was in much smaller twin engine airplanes, weighing about 7,000 pounds. He had a total of only 171 flying hours in the DC-8. Interviews with captains who had flown with the first officer described him as eager to learn, but lacking large airplane experience and lacking confidence in his own ability to fly large airplanes. There was no evidence that the first officer had ever been involved in an actual three-engine ferry flight.

The flight engineer was also on probation with ATI, with just over 5 months of line operations. He was new to the DC-8, with only 218 hours total time in the airplane, and he was new to any air carrier operations. Although his experience was extensive in the Lockheed C-141, interviews revealed that Air Force procedures did not include three-engine takeoffs except in emergency war-time situations; therefore, it is likely that this was his first three-engine takeoff. The flight engineer had most of his flight experience in the Lockheed C-141. In that airplane, the flight engineer did not advance the throttles during the takeoff; only the pilots move the throttles. Also, C-141 procedures specified that the Vmcg speed be calculated for each takeoff, in anticipation of losing one of the four operating engines. The concept of the use of Vmcg during a takeoff with one engine intentionally inoperative from the beginning of the takeoff roll was probably new to the flight engineer. This may explain the flight engineer's comments about Vmcg that are addressed later in this analysis.

2.3.2 Flightcrew Assignment

The Safety Board believes that the decision by the chief pilot to assign this flightcrew to the three-engine ferry operation did not take into consideration the experience levels of the available flightcrews, although it was within policy established by ATI, and within Federal regulations. ATI management's decision not to assign a more experienced flightcrew to the ferry flight was based upon a desire to minimize the delay of the scheduled revenue cargo flight from MCI to TOL. The accident flightcrew flying from DOV would not have met legal crew rest requirements for the revenue flight because they did not have sufficient crew rest in DOV following their previous Part 121 flight from Europe. They could have legally flown under Part 91 rules for the ferry flights; therefore, the decision was made to use this crew for the Part 91 flight. The Safety Board believes that company scheduling issues took priority, resulting in the less experienced flightcrew being assigned to the accident flight.

The chief pilot telephoned the captain prior to the ferry flight and discussed a possible crosswind problem at the destination airport and the matter of a landing curfew there. He did not, however, review three-engine takeoff procedures with him. The Safety Board believes that had the takeoff been discussed in more detail, it might have become apparent to the chief pilot that the captain did not fully comprehend the three-engine takeoff procedure.

During the investigation, a survey of nine other cargo operators revealed that only two used line flightcrews for three-engine takeoffs, and that one of those two operators restricted three-engine takeoffs to only "the most experienced and selected" flightcrews. Seven of the nine restrict such takeoffs to only management flightcrews, such as check airmen or special maintenance ferry crews. Therefore, the Safety Board concludes ATI's policy of routinely assigning line flightcrews for such operations, when almost all other operators restrict such flights, must be considered inappropriate.

2.4 Flightcrew Performance

2.4.1 Engine Start

The engine start sequence was interrupted because the flightcrew did not ensure that all appropriate circuit breakers were in on the No. 4 engine. While attempting to start this engine, it was obvious that the captain was unfamiliar with the starter duty cycle limitations, and he did not determine the correct limitations by reference to the flight manual. The flight engineer called attention to the matter during multiple start attempts of this engine.

2.4.2 Landing Curfew

The Safety Board believes that the flightcrew was concerned about trying to reach their destination before the landing curfew at Westover Airport, and that the crewmembers were unaware that the curfew time could be extended through ATI management channels. Prior to taxiing, the captain said that they should try to fly direct routes between navigational aids, in order to reduce the en route flight time. After the first takeoff attempt, the flightcrew again discussed the subject of trying to reach the destination airport. The comments by the first officer, "boy it's gettin' tight," followed by, "hey we did our best you know," clearly indicated continued concern over the curfew and their desire to arrive before the airport closed.

In addition, a time and distance calculation revealed that following the turn off the runway after the rejected takeoff, the flightcrew taxied the airplane to the departure end of the runway for another attempt at an average taxi speed of about 26 knots (about 30 miles per hour). The Safety Board believes that this is at, or may even exceed, the limit for a safe taxi speed, especially at night, and during a time when all three crewmembers were talking about the previous rejected takeoff. Therefore, the Safety Board believes that the flightcrew was convinced that they should arrive at their destination prior to the landing curfew, and that they were preoccupied with this goal. This probably influenced their judgment regarding the three-engine takeoff and added an element of stress to the entire decision-making process.

The Safety Board notes that there was no reason for AT1 management to telephone **Westover** Airport and ask for a curfew extension because they were unaware that the flight was behind schedule.

2.4.3 Performance Calculations

The takeoff data card found in the wreckage showed a Vmcg speed of 107 knots rather than 116 knots. The Safety Board believes that during preflight planning, the flight engineer entered the three-engine takeoff chart incorrectly during the calculations of the takeoff data. It appears likely that he used the temperature in degrees Fahrenheit, rather than Centigrade. Most of the **ATI** performance charts (but not the Vmcg chart) are entered using the Fahrenheit temperature scale. The fact that the Vmcg chart (figure 6) is entered in Centigrade temperature, and that the chart is used so infrequently at **ATI,** would make a calculation mistake more likely. **ATI** procedures stated that the captain or first officer will verify the data prior to the pilots setting their airspeed bugs. This apparently was not accomplished.

This error resulted in a Vmcg speed that was 9 knots too low. This meant that the flightcrew believed they should have applied takeoff power on all three operating engines 9 knots earlier, at 107 knots rather than at 116 knots. Directional control of the airplane is difficult if early power is applied on the asymmetrical engine. The faster the airplane is traveling, the more rudder authority will be available, and directional control becomes easier. In fact, if full power on the asymmetric engine is applied before 116 knots, it is impossible for the pilot to continually maintain runway centerline using the rudder alone.

The **ATI** accident in March of 1991 at Kennedy International Airport was also attributed to a miscalculation of performance data, when the flight engineer entered the performance chart with the incorrect aircraft gross weight and obtained V speeds which were too low. The company instituted procedures to improve the calculation and cross-checking of takeoff V speed data, but it appears that these efforts should be revisited.

2.4.4 Taxi and Takeoff

During the taxi for the first takeoff attempt, the captain briefly reviewed the three-engine takeoff and departure procedures. His description of the planned maneuver at this point was correct, as indicated by his statements:

"okay and l'll ease in ah No. four...and by ah Vmcg we'll have max."

During a continued review of the after-takeoff procedures, however, his briefing contained conflicting statements. For example, at one point he said, "at positive rate I'll call gear up I'll lower the nose slightly to gain two ten but still keep about two hundred to four hundred feet a minute climb." He then briefed, "okay then ah when we reach two ten I'll call for max continuous power." A few seconds later, he said, "okay and then we'll call ah reduce the flaps like that we'll climb at V2 all the way up to three thousand feet and then we'll call for the climb procedures." This procedure is incorrect. He should have stated that he would climb at V2 to 400 feet above the ground, then accelerate to 210 knots, retract the wing flaps, continue climb to 3,000 feet at 210 knots, then accelerate to climb speed, before reducing the power.

According to the CVR transcript and the sound spectrum analysis, during the first attempted takeoff, the power was advanced too quickly. In fact, full power on the asymmetric engine was obtained at about 100 knots, about 7 knots below the stated but incorrect Vmcg speed of 107 knots. The engine pressure ratio (EPR) of 1.5 was called 1 second before the airspeed alive (about 50 to 60 knots) call was made; followed by a call of 1.6 EPR, 1 second before the 80 knots call. Then, 90 knots was called, followed 1 second later by the 1.8 EPR (the target takeoff EPR was 1.91). One hundred knots was called 1 second later, followed by the sound of decreasing engine power, indicating the start of the rejected takeoff. Discussions with pilots experienced in three-engine takeoffs confirmed that the power on the asymmetrical engine needs to be applied very slowly, and it is not until much closer to Vmcg that the power can be increased to approach the takeoff EPR.

The Safety Board believes that the company operations manual section describing three-engine takeoffs might have contributed to some of the confusion concerning this procedure. One section of the company operations manual stated, "as soon as possible, smoothly accelerate the engine opposite the inoperative engine to MAX power during acceleration to Vmcg." The Safety Board believes that this particular instruction, taken out of context, implies that early ("as soon as possible") acceleration of the asymmetric engine is desirable. This section also stated, "The engine should be set at MAX power upon reaching this [Vmcg] speed." This sentence may also be open to interpretation by some pilots, especially in light of the earlier instruction. In a later, more detailed section, the manual stated "Smoothly advance power on the asymmetrical engine during the acceleration to Vmcg speed.

The asymmetrical throttle must be aligned with the symmetrical engine throttles by Vmcg." The Safety Board believes that this instruction is reasonably clear and that the throttle alignment portion of the instruction is unambiguous. However, the three-engine procedures taken as a whole, especially the asymmetric engine acceleration rate descriptions, could be made more coherent and should emphasize the proper throttle technique.

Following the rejected takeoff, the flight engineer stated that the EPR for No. 4 engine "went all the way up to one nine zero as you ran it up, so it went up real fast." The captain said, "yeah it jerked up." The first officer asked, "you brought it up too fast or it jerked up or what?" The captain said, "it just came up too fast is what it did." Examination of the engine revealed no discrepancies; therefore, the Safety Board believes the reason for the increase in EPR was most likely the result of the captain's advancing the asymmetric throttle forward at a rate that was too fast. If the flightcrew believed that the engine was not accelerating properly, for whatever reason, a thorough discussion of options should have been in order. However, neither the captain nor the other crewmembers pursued this matter during the 6 minute taxi for a second takeoff attempt. During this post-rejected takeoff taxi, the flight engineer suggested, "if you want to try it again I can try addin the power if you like." The captain quickly responded, "okay let's do it that way yeah...."

This was a procedure that the flightcrew created themselves and was patently incorrect. The operating manual clearly states that the captain should control the throttles. This decision to allow someone else to do so was not challenged or even discussed by the flightcrew. Investigators who experimented with this takeoff procedure in the simulator found it extremely awkward and somewhat disconcerting. The Safety Board believes that allowing someone not even in nominal control of the airplane to apply the asymmetric power required the captain to constantly react to an unknown quantity of thrust and an unknown rate of thrust application during the accident takeoff roll. This increased his mental workload dramatically and probably contributed directly to the accident. The flight engineer could have placed himself in a similar predicament to that of the captain, if he was adding power on the asymmetric engine in response to the directional control inputs of the captain. Lastly, if the captain believed there was any possibility that a mechanical engine acceleration problem existed, the Safety Board finds it difficult to explain why he relinquished control of the throttle to another crewmember.

Shortly after the captain agreed to the unconventional takeoff procedure, the flight engineer asked the captain, "how much rudder were you stickin' in?" The captain replied, "I had it all the way in." This fact should have triggered a thorough, deliberate examination of all facets of the aborted takeoff, including a recalculation of Vmcg. However, there was never a discussion about why directional control could not be maintained, even though the captain used all the available rudder.

Shortly thereafter, the subject of the power increase again came up, when the captain said, "it seemed what happened, it was goin' up smoothly and then all of a sudden...it jerked and then yeah." The first officer then made a statement which clearly indicated that he did not understand the concept of Vmcg. The first officer said, ". ..when we...get near Vmcg or get near Vr or Vmcg if we're usin' all our rudder authority you might wanta' consider abort possibly because once we get higher we're gunnar be...in even worse trouble correct." The captain replied, "that's correct absolutely."

The flight engineer challenged the statement by saying, "No actually above Vmcg you[r] rudder has more authority it's helping you more." The captain did not respond to this statement, which was, in fact, correct. The flight engineer went on to describe a four-engine takeoff with the loss of an engine by stating, "if we were to lose ah about the time an outboard engine before Vmcg...you can't control the takeoff because you will lose directional control because you[r] other engine is already in." This statement, although correct, may have further confused the captain and the first officer, because it was not clear that he was describing a four-engine takeoff, rather than the takeoff at hand.

The first officer then said, "okay yeah you're right you're one hundred percent right." The captain was silent at that point. The Safety Board believes that the only person in the cockpit who had an understanding of the basic concept of a three-engine takeoff was the flight engineer. It is not clear, however, if any of the flightcrew understood the concept of the V speeds as applied to the three-engine takeoff.

The accident takeoff is compared to a Douglas demonstration of an ideal three-engine takeoff in figure 7. On the accident takeoff, the power on the No. 4 engine was increased at a more rapid rate than on the first takeoff. For instance, on the second takeoff, 1.6 EPR was called 1 second before the airspeed alive call (50 to 60 knots), whereas on the first takeoff, 1.6 EPR was called 1 second before

80 knots. This means that directional control was even more of a problem for the captain on the second takeoff.

Following the early rotation, the airplane impacted the ground as the airplane rolled to a nearly 90 degree left bank. The Safety Board believes the early rotation was in response to the fact that the airplane was about to leave the paved surface. The captain believed that he had enough speed to fly, and he elected to attempt to take off rather than risk certain damage to the airplane, and possible injury to the flightcrew.

2.4.4.1 Three-Engine Takeoff Procedure

The high rate of asymmetric throttle application by crewmembers in both the attempted takeoffs precluded successful completion of the maneuver. However, the Safety Board believes that even with the proper application of asymmetric throttle during a three-engine takeoff, the margin of safety is quite small. The procedure now calls for arriving at full takeoff power on the asymmetric engine at the computed Vmcg to provide for the minimum possible takeoff roll. A properly executed three-engine takeoff also entails full rudder application at the computed Vmcg. Any adverse crosswind condition, for instance, would place the flightcrew in a position in which they could not have full control of the airplane due to a loss of rudder authority. In addition, it is very difficult to time the throttle application to arrive at full power at exactly the computed Vmcg given the spool-up lag inherent in turbine engine operation.

A flightcrew, therefore, invariably reaches full asymmetric power early, and accepts a certain loss of directional control, or reaches full asymmetric power late, and accepts a longer takeoff roll. The Safety Board considers the latter to be the safer course of action, and believes that manufacturers should revise one-engine inoperative takeoff procedures to provide adequate rudder availability for correcting directional deviations during the takeoff roll compatible with the achievement of maximum asymmetric thrust at an appropriate speed greater than ground minimum control speed. Performance figures and runway requirements considering these factors should also be determined.

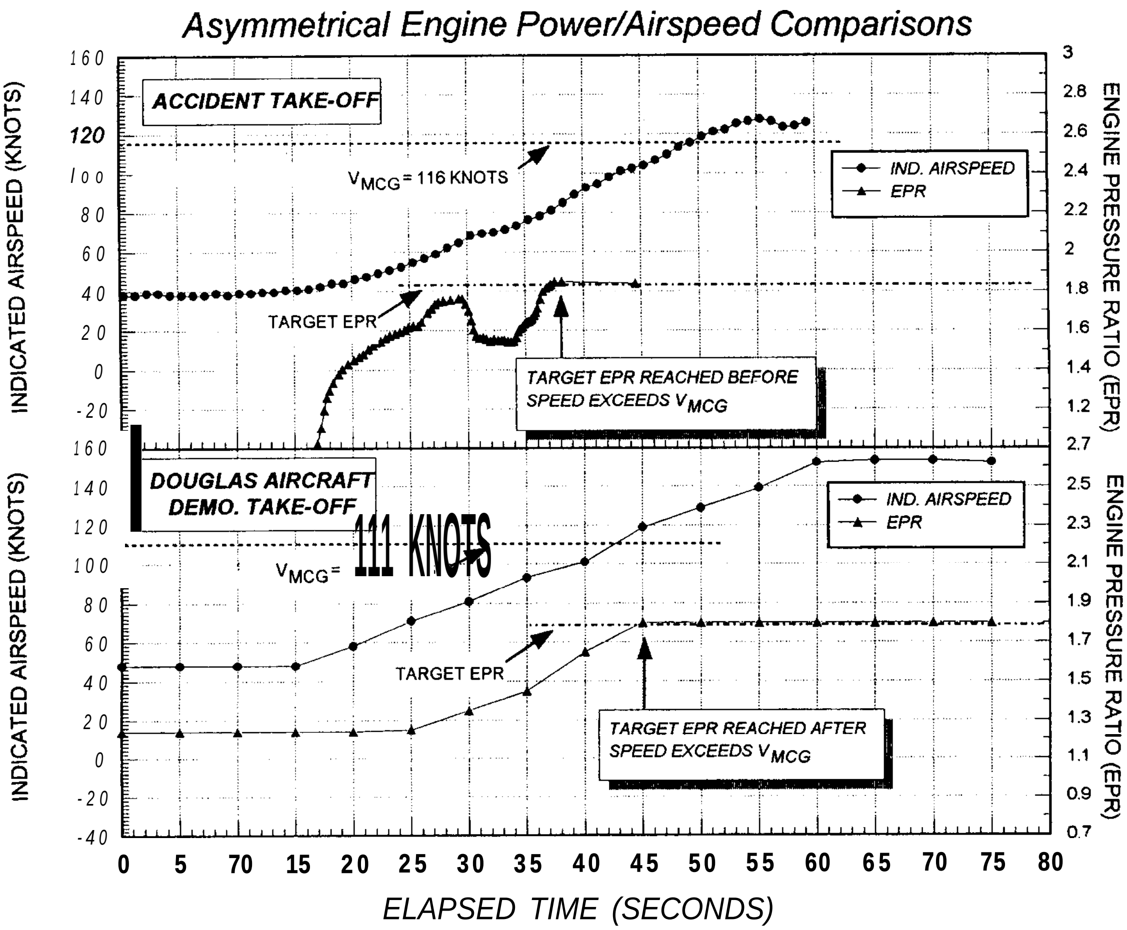


Figure 7.--No. 4 engine EPR/IAS comparison.

2.5 Flightcrew Training

2.5.1 Three-Engine Takeoff Training

The flightcrew had received three-engine takeoff training according to company standards within the 6 months prior to the accident. The last training received by the captain was in August 1994. The first officer had training in October 1994. The flight engineer's training was about the same time. The Safety Board believes that the three-engine takeoff training provided to this flightcrew by ATI was inadequate because of their demonstrated lack of knowledge of the maneuver. This is especially true considering the fact that the training was provided so recently for the entire crew.

2.5.2 Denver DC-8 Simulator

During the investigation, Safety Board investigators operated the DC-8-60 series simulator used by this company for flightcrew training for numerous simulated three-engine takeoffs. The simulator performance was not realistic in that the simulator was very easy to control, no matter how fast the power was applied on the asymmetrical engine during the simulated three-engine takeoffs. Both the company check airman and a manufacturer test pilot assisting in the exercise agreed with this assessment. A second set of three-engine takeoff experiments were accomplished by Safety Board investigators after the simulator had been adjusted by United Airlines Training Center personnel. Afterward, the three engine takeoffs were more realistic, but it was still possible to maintain runway centerline with full power on the asymmetric engine prior to Vmcg. Although there was no way to positively determine that the simulator was providing inaccurate simulation when the accident flightcrew received its three-engine training, the Safety Board concludes that the training conducted in this simulator probably did not provide the accident flightcrew with an accurate, realistic rehearsal for an actual three-engine takeoff.

2.6 Fatigue

Just before their assignment to the accident trip, the crew had completed a demanding round-trip flight to Europe that also was a potentially stressful international line check for the captain. These flights crossed multiple time zones (there are 6 time zones between Dover and Ramstein) in a short period of time. This, and the fact that the Dover-Ramstein-Gander-Dover legs were flown at night following daytime rest periods, caused the crew to experience circadian rhythm disruption. In addition, the captain's last rest period prior to the accident was repeatedly interrupted by the company.

According to the flight time limits and rest requirements of 14 CFR 121.503, following their 9 hours and 29 minutes of flying time to Dover, the crew was required to take a rest period of at least 16 hours before they could legally be assigned to any further Part 121 duty. However, only about 12 hours after checking into the hotel, they checked out to assume duty under FAR Part 91 ferry flight rules. There are no flight time limits or rest requirements for Part 91 ferry flights that follow Part 121 revenue flights.

Because the crewmembers were alone in the hotel rooms, the Safety Board could not positively establish the length or quality of sleep that the first officer and flight engineer received. However, in the case of the captain, telephone records and other evidence indicate that his opportunity to sleep in the hours before the accident was considerably disturbed. His longest uninterrupted rest period was 4 hours and 47 minutes. Therefore, the Safety Board believes that he was experiencing fatigue at the time of the accident. Many scientific studies indicate that fatigue degrades all aspects of performance, especially alertness and judgment. The captain's performance in the accident reveals many areas of degradation in which fatigue is probably a factor.[8] Similar considerations apply to the other two crewmembers, who were also subject to the same schedule and were most likely fatigued at the time of the accident. Several areas of performance degradation exhibited by the crew are characteristic of fatigue, such as the crew's difficulties in setting proper priorities and their continuation of the takeoff attempt despite disagreement and confusion on important issues.

The crew could not legally have flown a revenue trip at the time of the accident. The Safety Board believes, however, that the fact that the flight was legal under the terms of the Part 91 ferry flight provisions does not reduce the amount of rest needed to prevent crew fatigue. The Safety Board therefore concludes that the crewmembers were not properly rested. However, because of the deficiencies in

[8]Rosekind, Mark R, Gregory, Kevin B; Miller, Donna L; Co, Elizabeth L; and Lebacqz, J. Victor; *Analysis of Crew Fatigue Factors in AIA Guantanamo Bay Aviation Accident* as Appendix E of Aircraft Accident Report, "Uncontrolled Collision With Terrain, American International Airways, Guantanamo Bay, Cuba, August 18, 1993," NTSB/AAR-94/04.

training and procedures noted previously, the extent to which their fatigue contributed to the accident could not be determined.

Regarding flight time limits and rest requirements, on May 18, 1994, the Safety Board issued two safety recommendations to the Federal Aviation Administration:

> A-94-105
> Revise the applicable subpart of 14 CFR, Part 121 to require that flight time accumulated in noncommercial "tail end" ferry flights conducted under 14 CFR Part 91, as a result of 14 CFR, Part 121 revenue flights be included in the flight crewmember's total flight and duty time accrued during those revenue operations.
>
> and
>
> A-94-106
> Expedite the review and upgrade of flight/duty time limitations of the Federal Aviation Regulations to ensure that they incorporate the results of the latest research on fatigue and sleep issues.

These recommendations were issued as a result of the Safety Board's investigation and report on the August 18, 1993 accident at Guantanamo Bay, Cuba, involving a Connie Kalitta Services, Inc., DC-8-61 freighter.

The FAA **first** responded to these recommendations on July 13, 1994, stating that it was considering the issuance of a Notice of Proposed Rulemaking to address both Safety Recommendations A-94-105 and -106. The Safety Board replied on August 11, 1994, classifying both recommendations "Open--Acceptable Response," pending the completion of rulemaking action. To date, the rulemaking action is still pending.

Because of the fatigue issues uncovered in this and other accidents, the Safety Board believes that it is critical for the FAA to expedite the finalization of the review of current flight and duty time regulations and to revise the regulations, as necessary, within 1 year to ensure that flight and duty time limitations take into consideration research findings in fatigue and sleep issues. Further, the new regulations should prohibit air carriers from assigning flightcrews to flights conducted under 14 CFR Part 91 unless the flightcrews meet the flight and duty time limitations of 14 CFR Part 121 or other appropriate regulations. Accordingly, the Safety Board is classifying Safety Recommendations A-94-105 and -106 "Closed--Acceptable Action/Superseded" and is issuing a new recommendation (see section 4).

2.7 Organizational and Management Information

The Safety Board believes that several actions by the company were commendable. The company developed a crew pairing policy and had begun to provide training in crew resource management when they were not required by regulation. All crewmembers and management staff interviewed during the course of this investigation appeared satisfied with their jobs. The company had also hired qualified new management to expand oversight in response to a period of rapid expansion of operations.

The Safety Board believes, however, that the circumstances of the accident revealed shortcomings in the company's training and scheduling programs. None of the three flight crewmembers had previously executed a three-engine takeoff, although the captain had been present during several such takeoffs. Unlike the majority of other operators, the company authorized all flightcrews to perform three-engine takeoffs. The company provided regular training in this procedure, but the poor description of the maneuver in the operations manual, and the inaccurate simulator portrayal, lessened the effectiveness of this training. All three crewmembers demonstrated a lack of understanding of this procedure in their comments during the two takeoff attempts.

Perhaps most disturbing, the crew did not calculate or verify the accuracy of the takeoff data prior to the first takeoff attempt and then did not recalculate the data after the first takeoff attempt failed. The company suffered a previous accident due to the flightcrew determining incorrect takeoff data, and the evidence indicates that the company did not instill a proper concern among flightcrews for the accuracy of takeoff information during the time period between the two accidents.

Also, the company scheduled the ferry flight without regard to the shortened crew rest time allowed for this crew, despite the fact that a more experienced, rested crew was already available in Kansas City. The crew scheduler also interrupted the captain's rest period with telephone calls. Therefore, the Safety

Board believes that the company failed to provide a **flightcrew** sufficiently experienced, trained, or rested to perform the nonroutine ferry flight operation.

2.8 FAA Oversight of AT1

The Safety Board believes that the FAA **POI** was not performing his oversight responsibilities adequately. He did not have sufficient knowledge of the surveillance that was being performed by FAA geographic units, both in the international operations and at the Denver training facility. Additionally, he was not aware of other important facts, such as the new CRM program, which **ATI** had started in the recurrent training program, and he had no knowledge of the existence of an **ATI** crew pairing policy. With the growth in the number of new pilots, he should have been keenly interested in this matter.

He was hampered by restricted funding for travel to DEN to monitor simulator and ground training. Additionally, he maintained that a lack of funding limited the number of other oversight activities, such as en route observations, especially observations of international operations performed by **ATI.** While the company was expanding rapidly and hiring large numbers of new pilots, the **POI** was immersed in the administrative detail of merging two certificates. This limited his time available for other important surveillance functions.

The Safety Board is concerned about the decrease in the number of inspectors assigned to the geographical program at the Denver FSDO. Interviews with DEN geographic inspectors indicated that there was confusion in that FSDO about the future of the geographic program. The Safety Board is also concerned that the pending cutbacks may further weaken the surveillance of supplemental air carrier training functions at the United Airlines Training Center.

An accident in 1994, involving another supplemental air **carrier,**[9] revealed a serious lack of geographic support. The Safety Boards report stated:

> Many of the flight safety issues brought to the attention of the FAA and the Safety Board were problems that had occurred away from the home base. Due in part to budget constraints, the FAA was dependent upon geographic support for oversight and surveillance

‘Refer to Aircraft Accident Report, “Uncontrolled Collision With Terrain, American International Airways, Guantanamo Bay, Cuba, August **18, 1993,” NTSB/AAR-94/04.**

> of the worldwide operation....the geographic surveillance was vital to the POI's oversight responsibility and should have carried a high priority, considering the fact that foreign operations...required different operational rules and regulations.
>
> The Safety Board is concerned that the lack of geographical support required to fulfill the surveillance requirements of the operations, are detrimental to the overall ability of the individual inspectors...to ensure that the operations are conducted in accordance with FARs.

Some of the problems with surveillance of supplemental cargo air carriers are that most of their flights are at night, much of the flying is to overseas destinations, and the schedules frequently change. Inspectors must make significant modifications in their work schedules in order to conduct en route observation flights of these operators. The FAA does not appear to take these factors into consideration at this juncture.

Additionally, the communication lines between the POI and the geographic inspectors appear to be occasionally characterized by hostility and resistance to criticism. It was reported that POIs often become "defensive" about the certificates they manage, and at times resent hearing negative comments reported by a geographic inspector from a distant FSDO. The Safety Board believes that this behavior detracts from their effectiveness in achieving the assigned mission.

If the FAA plans to continue the geographic program, changes should be considered, including:

> Better communication links between the POI's and the geographic inspectors.
>
> Adequate staffing of the geographic position.
>
> Increase funding of POI and geographic unit budgets to permit inspectors to schedule flights on supplemental air carriers that occur at nor-routine airports, at nonroutine times.

3. CONCLUSIONS

3.1 Findings

1. The airplane was properly certified and maintained in accordance with existing regulations. It was also properly prepared for the three-engine departure by maintenance personnel.

2. There was no evidence of any systems malfunction that may have contributed to the accident. Specifically, there was no evidence of malfunction of the flight controls, landing gear, tires, brakes, or nose wheel steering system that would have led to directional control difficulties on the runway.

3. The flightcrew was properly certified for the flight in accordance with existing regulations.

4. The flightcrew assigned to the ferry had a shortened rest break after performing an international trip. Federal regulations permit companies to eliminate these rest periods after flying a 14 CFR Part 121 operation when the flight will be conducted as a ferry operating under 14 CFR Part 91.

5. At the time of the accident, the flightcrew was suffering from fatigue as a result of the limited opportunities for rest, disruption to their circadian rhythms, and lack of sleep in the days before the accident. However, the Safety Board was unable to determine the extent, if any, to which their fatigue contributed to the accident.

6. The flightcrew did not have adequate, realistic training in three-engine takeoff techniques or procedures because the DC-8 simulator with which they trained was not programmed to replicate actual yaw forces, and the three-engine takeoff procedure description in the airplane operating manual was confusing.

7. There was no record that the captain had previously performed a three-engine takeoff as pilot in command, and it is unlikely that the other flight crewmembers had ever assisted in a three-engine takeoff prior to the accident takeoff.

8. The flightcrew did not adequately understand the three-engine takeoff procedures, including the significance of Vmcg.

9. Another more experienced flightcrew was available to conduct the ferry flight.

10. Flightcrew comments on the CVR prior to the accident suggested that they were operating under self-induced pressure to make a landing curfew at the destination airport, and that this may have influenced their decisionmaking.

11. The flight engineer improperly determined the Vmcg speed, resulting in a value that was 9 knots too low. Neither the captain nor the first officer detected the error.

12. During the first attempted takeoff, the captain was not able to maintain directional control because he applied high power to the asymmetrical engine too soon, and he rejected the takeoff. During the taxi back for a second takeoff, he and his crewmates did not properly analyze the reasons for the loss of control.

13. The captain agreed to modify the three-engine takeoff procedure by allowing the flight engineer to advance the throttle on the asymmetrical engine, a deviation of the prescribed procedure. The captain was unable to maintain directional control on the second takeoff, decided not to reject the takeoff, and rotated the airplane early in an attempt to take off prior to departing the paved runway surface.

14. FAA oversight of **ATI** was inadequate because the AT1 **POI** and the geographic inspectors were unable to effectively monitor domestic crew training and international operations, respectively.

15. Existing FAR Part 121 flight time limits and rest requirements that pertained to the flights that the flightcrew flew prior to the ferry flights did not apply to the ferry flights flown under FAR Part 91. This permitted a substantially reduced flightcrew rest period when conducting the nonrevenue ferry flights.

16. Current one-engine inoperative takeoff procedures do not provide adequate rudder availability for correcting directional deviations during the takeoff roll compatible with the achievement of maximum asymmetric thrust at an appropriate speed greater than ground minimum control speed.

3.2 Probable Cause

The National Transportation Safety Board determines that the probable causes of this accident were:

(1) the loss of directional control by the pilot in command during the takeoff roll, and his decision to continue the takeoff and initiate a rotation below the computed rotation airspeed, resulting in a premature liftoff, further loss of control and collision with the terrain.

(2) the flightcrew's lack of understanding of the three-engine takeoff procedures, and their decision to modify those procedures.

(3) the failure of the company to ensure that the flightcrew had adequate experience, training, and rest to conduct the nonroutine flight.

Contributing to the accident was the inadequacy of FAA oversight of ATI and FAA flight and duty time regulations that permitted a substantially reduced flightcrew rest period when conducting a nonrevenue ferry flight under 14 CFR Part 91.

4. RECOMMENDATIONS

As a result of the investigation of this accident, the National Transportation Safety Board makes the following recommendations:

--to the Federal Aviation Administration:

Review the effectiveness of the geographic unit oversight program, with particular emphasis on the oversight of supplemental air carriers and their international operations, and the improvement of overall communications between principal operations inspectors and geographic inspectors. (Class II, Priority Action) (A-95- 110)

Evaluate the surveillance programs to ensure that budget and personnel resources are sufficient and used effectively to maintain adequate oversight of the operation and maintenance of both passenger and cargo air carriers, irrespective of size. (Class II, Priority Action) (A-95-l 11)

Require airplane manufacturers to revise one-engine inoperative takeoff procedures to provide adequate rudder availability for correcting directional deviations during the takeoff roll and provide performance figures and runway requirements compatible with the achievement of maximum asymmetric thrust at an appropriate speed greater than ground minimum control speed. (Class II, Priority Action) (A-95-l 12)

Finalize the review of current flight and duty time regulations and revise the regulations, as necessary, within 1 year to ensure that flight and duty time limitations take into consideration research findings in fatigue and sleep issues. The new regulations should prohibit air carriers from assigning flightcrews to flights conducted under 14 Code of Federal Regulations (CFR) Part 91 unless the flightcrews meet the flight and duty time limitations of 14 CFR Part 121 or other appropriate regulations. (Class II, Priority Action) (A-95-l 13)

--to Air Transport International:

Review the ATI DC-8 operating manual discussion on three-engine takeoffs to ensure that it is understandable to all pilots who must accomplish such takeoffs. This section of the manual should emphasize the specifics of proper throttle application technique. (Class II, Priority Action) (A-95-l 14)

Discontinue the company policy of routinely assigning line flightcrews for three-engine ferry operations. Allow only specifically designated, highly experienced crewmembers to perform such operations. (Class II, Priority Action) (A-95-l 15)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

James E. Hall
Chairman

Robert T. Francis II
Vice Chairman

John Hammerschmidt
Member

John J. Goglia
Member

August 30, 1995

5. APPENDIXES

APPENDIX A

INVESTIGATION AND HEARING

1. Investigation

The National Transportation Safety Board was notified of the accident about 2130 on February 16, 1995. An investigative team was dispatched the next morning and arrived in Kansas shortly thereafter. Investigative specialists for operations/human performance, airplane performance, structures, wreckage documentation, systems, and power-plants gathered evidence on scene for about 1 week. Investigative groups for the cockpit voice recorder and the flight data recorder were also formed in Washington, D.C. Safety Board Chairman Jim Hall accompanied the investigative team to Kansas City.

Parties to the investigation included Air Transport International, the Kansas City, Missouri, Aviation Department, the Douglas Aircraft Company, United Technologies Pratt and Whitney, and the Federal Aviation Administration.

2. Public Hearing

There was no public hearing conducted in conjunction with this investigation.

APPENDIX B

COCKPIT VOICE RECORDER TRANSCRIPT

1957:17	
	start of recording
1957:17	
	start of transcript
1957:19	
CAM-2	oh where landing lights okay.
1957:27	
INT-3	hello.
1957:32	
INT-3	can you hear me?
1957:33	
INT-4	yeah ground power's off.
1957:35	
INT-3	okay we've got we've got pressure in and we got clearance to start.
1957:40	
INT-4	you got it .
1957:41	
CAM-2	okay turnin' three.
1957:42	
INT-3	startin' three.
1957:43	
CAM-l	turning.
1957:43	
INT-4	clear.
1957:44	
CAM-3	valve's open .
1957:45	
CAM-l	rotation.
195748	
CAM-2	here's your ● .
1957:49	
CAM-l	yeah.

1957:51
CAM-3 oil pressure, N-l, *
pneumatics.

1957:56
CAM-l yeah .

1957:57
CAM-2 fifteen percent.

1957:58
CAM-l . set, fuel flow, light up,
EGT.

1958:10
CAM-l thirty five percent starter's
released.

1958:11
CAM-3 valve's closed.

1958:12
CAM-1 ready on four.

1958:15
INT-3 start four.

1958:16
CAM-3 ready four.

1958:17
INT-4 clear.

1958:17
CAM-l turning.

1958:18
CAM-3 start valve's open.

1958:18
CAM-l rotation .

1958:24
CAM-2 I'm watching three.

1958:25
CAM-3 oil pressure - pressure's
holding twenty seven.

195829
CAM-3 N-l.

1958:30
CAM-l fifteen percent fuel, flow,
and --.

1958:39		
CAM-2	come on baby.	
195844		
CAM-l	we got fuel flow?	
1958:46		
CAM-2	you got fuel flow here.	
195848		
CAM-3	fuel flow.	
1958:50		
CAM-l	we don't have a light up.	
1958:53		
CAM-3	so you want to turn this off. continue to motor right?	
1958:55		
CAM-l	yeah.	
1958:56		
CAM-3	we got ten seconds.	
1958:57		
CAM-l	okay tell, yeah --.	
1958:59		
CAM-3	fuel flow.	
1959:00		
CAM-l	yeah we don't have a light up or EGT okay it's comin' down just tell him that we --.	
1959:06		
INT-3	we're stop start on number four.	
1959:08		
INT-4	all right.	
1959:10		
CAM-3	I'll give you time for thirty seconds.	
1959:12		
CAM-l	call thirty seconds.	
1959:13		

INT-3 no ignition.

1959:14
CAM-l yeah .

1959:14
INT-4 yeah you're **blowin'** smoke.

1959:15
INT-3 yeah we're we're **motorin'** right now to clear.

1959:32
CAM-3 that's cause we pulled engine ignition number four

1959:34
CAM-2 thirty seconds.

1959:35
CAM-l okay released.

1959:37
INT-3 okay the number four ignition circuit breaker was open instead of number one

1959:39
INT-4 yeah it looks like you're **blowin'** water.

1959:43
CAM-l okay we'll start number two .

1959:45
CAM-3 valve's open.

1959:47
CAM-l just tell him - oh what's he **doin'?**

1959:50
CAM-3 valve's open.

1959:53
CAM-l okay we'll start number two.

1959:58
CAM-3 valve's closed.

2000:01
CAM-l we're not --.

2000:02
INT-3 okay ground this is cockpit.

2000:03
INT-4 yeah.

2000:05
INT-3 okay the reason we didn't get a start on number four is because when we we're preparing for this ferry flight the number four ignition circuit breaker was opened as opposed to number one as it should be I've reset the circuit breakers and we may get a little bit of torch out that when we start number four.

2000:20
INT-4 okay.

2000:22
CAM-I okay .

2000:23
CAM-2 we startin'two?

2000:25
CAM-I yeah we ah have zero on N-l ?

2000:27
CAM-3 four?

2000:28
CAM-I number four.

2000:28
CAM-3 number four?

2000:30
INT-3 is number four stopped turnin'?

2000:32
INT-4 yeah.

2000:33
CAM-I okay we're startin' number four.

2000:34
INT-3 okay starting four.

2000:35
CAM-l turning.

2000:36
INT-4 clear.

2000:37
CAM-3 valve's open.

2000:38
CAM-l rotation.

2000:40
CAM-3 pressure's holding thirty,
twenty eight, oil pressure,
N-l.

2000:47
CAM-l fifteen percent, fuel, flow,
light up, EGT.

2000:53
INT-4 you got a fire you got a fire.

2000:55
CAM-2 you got a fire .

2000:56
CAM-l okay coming down.

2000:58
INT-3 stop start.

2000:59
INT-4 it's blowin' smoke out.

2001 :01
(sound of momentary power
interruption to CVR).

2001:04
CAM-l it's still burning?

2001:05
INT-3 still burnin'?

2001:06
INT-4 no.

2001:09
CAM-l okay.

2001:12

INT-3 how much of a torch did it have?

2001:14
INT-4 oh about three inches.

2001:18
INT-3 a real good one huh ?

2001:19
INT-4 yeah.

2001:20
INT-3 okay that should have cleared most of it out then huh?

2001:22
INT-4 I think it did.

2001:25
CAM-l you got thirty seconds?

2001:26
CAM-3 no, got about another ten.

2001:27
CAM-l okay.

2001:29
INT-3 we're motorin' this one to clear again

2001:31
INT-4 okay you're clear.

2001:35
CAM-l okay -.

2001:35
CAM-3 time.

2001:36
CAM-l okay and we got --.

2001:37
CAM-3 you can release.

2001:38
CAM-l I'm just going to continue it --

2001:41
CAM-3 you going to continue the start again?

2001:42
CAM-l yeah .

2001:43
CAM-3 okay what's the duty cycle on the starter though?

2001:45
CAM-l okay we'll stop , we'll start number two .

2001:46
CAM-3 okay let's give let's give it a rest .

2001:52
CAM-2 okay number two

2001:53
INT-3 okay we're going to start number two and then we'll come back to number four.

2001:55
INT-4 okay you're clear for two .

2001:57
CAM-l okay.

2001:58
CAM-l turning two .

2001:58
CAM-2 turn two.

2001:59
CAM-3 valve's open .

2002:01
CAM-l we'll let that dry out for a moment.

2002:04
CAM-3 * turn, oil pressure .

2002:06
CAM-l yeah rotating.

2002:07
CAM-3 N-l.

2002:10
CAM-l I think it just **torched,** is what happened .

2002:14

CAM-3 that's what happened

2002:15
CAM-l fifteen percent, fuel, flow, light up, EGT, thirty five percent, starter released.

2002:28
CAM-3 ah valve's closed.

2002:30
CAM-l okay.

2002:32
CAM-l we'll try number four.

2002:34
CAM-3 yeah I want to check to see what the starter duty cycle is, -- I don't remember what it is, two minutes on oh two minutes --.

2002:38
CAM-l two minutes on then ah --.

2002:41
CAM-3 then thirty minutes off.

2002:42
CAM-l then thirty minutes off.

200248
CAM-2 so we're within? --.

2002:49
CAM-l yeah we should be within.

2002:51
INT-3 has number four stopped turning?

2002:54
INT-4 hold on for a second.

2002:56
CAM-3 he's going to check.

2002:57
INT-4 yeah its stopped.

2002:59
CAM-l okay we'll try four again.

2003:00
I NT-3 startin' four again.

2003:02
INT-4 you're clear.

2003:03
CAM-l turning.

2003:04
CAM-3 valve's open.

2003:07
CAM-l rotation.

2003:08
CAM-3 oil pressure, N-l.

2003:13
CAM-l fifteen percent, fuel, flow, light up, EGT, I guess it worked, thirty five percent, starter release.

2003 :26
INT-4 looks good .

2003:27
CAM-3 and valve's closed.

2003 :28
CAM-l internal when you can get a chance.

2003:30
CAM-3 okay we are internal.

2003:32
INT-3 you can disconnect air.

2003:33
INT-4 disconnected.

2003:36
CAM-l okay when we talk to the tower we've got to let them know this is a three engine ferry.

2003:41
CAM-2 with ground or with tower? or both?

2003:43
CAM-l both .

2003:47

CAM-2 okay.

2003:47
(sound of two momentary power interruptions to the cvr).

2003:51
CAM-l okay let me see what all of this -- lights

2003:52
CAM-3 we're internal.

2003:59
CAM-l I hate this when I can't find ---

2004:00
INT-3 okay whenever you are ready.

2004:02
INT-4 okay just a second.

2004:04
CAM-2 do we need to call push back here do you know?

2004:06
CAM-l naw its not necessary.

2004:07
INT-4 release brakes.

2004:07
CAM-l brakes are released.

2004:10
INT-3 brakes are released.

2004:11
INT-4 okay.

2004:13
CAM-l okay overhead lights where are they at here this I need and this I need okay .

2004:24
CAM-3 I wanta know why I can't hear # what am I doin' wrong.

2004:28
CAM-3 can you hear okay?

2004:29
CAM-2 yeah all this volume. and I'm on the radio here.

2004:32
CAM-3 no and he can hear though.

2004:33
CAM-l yeah I can hear --.

2004:35
CAM-3 which radio?

2004:35
CAM-2 number one .

2004:36
CAM-3 number one radio.

2004:40
CAM-l okay let's do an after start check.

2004:42
CAM-3 after start check.

200444
CAM-3 door lights are checked out, electrical system checked, hydraulic system?

2004:47
INT-4 what's your block out time?

2004:49
CAM-l stand-by he's ah **callin'** for block out.

2004:51
I NT-3 say again.

2004:52
INT-4 what's your block out time?

2004:54
INT-3 ah zero two zero zero.

2004:56
INT-4 all right.

2005:01
CAM-3 I can hear a hum now.

2005:06
CAM-l oh I know why you've got your interphone still on.

2005:08
CAM-3 I've got my what.

2005:09
CAM-l the interphone's still on, okay it wasn't.

2005:15
CAM-3 okay.

2005:16
CAM-3 yeah just ask for a radio check- .

2005:17
CAM-l okay.

2005:17
CAM-3 hydraulic system?

2005:18
CAM-l checked

2005:20
CAM-3 aileron and rudder power?

2005:22
CAM-2 clear.

2005:23
CAM-l clear.

2005:24
CAM-3 it's on, rain removal?

2005:28
CAM-l checked left light's are out.

2005:29
CAM-2 checked right--.

2005:30
CAM-3 ground equipment to go.

2005:32
CAM-l okay, okay what we are going to need to do too is ah get as much direct as we can that will allow us to fly a little bit better than eight zero if we can .

200545
CAM-2 a little better that eight zero.

2005:46
CAM-I yeah because we got we got two hours to make it to go over there for flight time and right now it's past.

2005:51
CAM-2 pushin'.

2005:52
CAM-I yeah .

2005:54
INT-4 set brake.

200554
CAM-I brakes are set.

2005:55
INT-3 brakes are set.

2005:57
CAM-3 I see what's your sayin'.

2005:58
CAM-I yeah.

2006:02
CAM-3 what was the winds?

2006:04
CAM-I ah they were -- .

2006:10
CAM-3 I wrote it all down some place.

2006:11
CAM-2 ah I'll request either one left or --.

2006:13
CAM-I one ninety at three.

2006:15
CAM-2 one ninety at three?

2006:16
CAM-I yeah .

2006:17
CAM-2 so we'll -- so we'll be usin' okay one nine right?

2006:20		
CAM-2	I'll request the right because you'll get an extra thirteen hundred feet .	
2006:23		
CAM-l	okay.	
2006:24		
CAM-3	is it farther is it a farther taxi though?	
2006:26		
CAM-2	ah no we're right there, we're right here right? one nine right's right there.	
2006:31		
CAM-l	yeah.	
2006:32		
CAM-2	go out bravo three hang a right .	
2006:34		
CAM-l	okay I got the pin.	
2006:38		
CAM-2	I think he needs to show you the --.	
2006:40		
CAM-l	I got the pin.	
2006:41		
CAM-2	oh you got the pin?	
2006:42		
CAM-l	yes.	
2006:56		
CAM-2	this will be a three engine departure.	
2006:58		
CAM-l	yes.	
2007:00		
CAM-l	okay clear on the left.	
2007:02		
INT-2	okay all ground equipment's clear?	

2007:04
INT-4 all ground equipment's clear, have a safe flight.

2007:06
CAM-2 clear on the right.

2007:07
I NT-2 thank you for all of your help -.

2007:08
INT-4 •

2007:09
INT-2 have a nice nap.

2007:09
INT-4 you're welcome.

2007:19
CAM-3 okay ground equipment's clear, gust lock?

2007:21
CAM-2 it's off.

2007:23
CAM-3 after start checks complete.

2007:24
CAM-l okay he's gone .

2007:26
CAM-2 yeah clear on the right left right .

2007:31
CAM-l I don't know what that guy is doing there.

2007:37
CAM-2 ready for the call?

2007:38
CAM-l yeah.

2007:39
RDO-2 Kansas city ground this is Air Transport seven eighty two ready to taxi at ah Burlington and ah we're going to be three engine departure.

200748
GND Air Transport seven eighty two

International ground south on bravo taxi runway one left.

200753
RDO-2 okay south on bravo taxi one left Air Transport seven eighty two - what's the winds?

2007:58
CAM-l what's ah.

2007:59
GND wind's two four zero at four .

2008:00
RDO-2 roger

2008:02
CAM-2 okay it's to one left .

2008:03
CAM-3 that's ah tail wind right?

2008:05
CAM-l yeah.

2008:06
CAM-2 two four zero and we're runnin' into what --.

2008:08
CAM-l five.

2008:09
CAM-3 five knots.

2008:10
CAM-2 just what we need. there's your marshal giving you a left you got that I can see.

2008:15
CAM-l yeah I got it.

2008:21
CAM-2 he said bravo right?

2008:21
CAM-l yes.

2008:22
CAM-3 they wouldn't let us do an opposite direction takeoff.

2008:24
CAM-3 pardon me.

2008:26 CAM-l	we we can ask 'em sure .		
2008:30 CAM-2	I'll ask 'em.		
2008:30 CAM-l	sure . that will get us off right here *.		
		2008:31 RDO-2	ground what's the chance for ah one nine right for Air Transport seven eighty two?
		2008:36 GND	a looks like we'll have a slight delay we've got traffic on ah ten mile final to the left.
200843 CAM-2	you want to go ahead and take it .		
200844 CAM-l	yeah we'll just go down there-- ** okay.		
		2008:45 GND	if you want you can hold short of bravo and I'll check with departure to see if you got a slot after that.
		2008:49 RDO-2	ah roger we'll hold short.
2008:51 CAM-2	hold right here.		
2008:53 CAM-l	okay let's go flaps twelve, taxi check.		
2008:55 CAM-2	twelve.		
2009:01 CAM-3	taxi check.		
2009:02 CAM-2	flaps are twelve.		
2009:04 CAM-3	anti-ice? .		

2009:05
CAM-2 ah where the # is it.

2009:07
CAM-l here.

2009:08
CAM-2 is off.

2009:09
CAM-3 de-ice is off, pitot heat?

2009:17
CAM-2 is on.

2009:19
CAM-3 takeoff data?

2009:20
CAM-l okay this is - stand-by.

200922
GND and Air Transport seven eighty two heavy they got some more inbounds after him also, be unable opposite direction south on bravo one left.

2009:27
RDO-2 south on bravo one left left ah Air Transport seven eighty two thanks

2009:35
CAM-l okay this is ah max takeoff one point niner one speeds Vr is one twenty three, one forty and two ten. VMCG of one oh seven.

2009:47
CAM-2 I got VMC of one oh seven , ah one one twenty three for Vr, and one forty for V2 and then two two ten for the cleanup.

200958
CAM-l set.

2010:02
CAM-3 okay ah stab and trim tabs?

2010:08
CAM-2 okay ah is that a five, put the light up here, yeah okay five point one, zero, zero.

2010:20	
CAM-l	five point one zero zero is set.
2010:24	
CAM-3	fuel levers?
2010:28	
CAM-2	two three four in detent one's down detented.
2010:32	
CAM-3	okay yaw damper?
2010:35	
CAM-2	it's on and it clicked it's checked.
2010:39	
CAM-3	and flight controls and you have the hydraulic gauges.
2010:41	
CAM-l	yes I got them right here.
2010:42	
CAM-2	I need to have the ah spoiler pump on.
2010:46	
CAM-l	okay did it go on.
2010:48	
CAM-2	you ready?
2010:49	
CAM-l	hold on a second here.
2010:50	
CAM-2	okay.
2010:52	
CAM-l	ah okay spoiler pump is on.
2010:54	
CAM-2	aileron, left, neutral.
2010:58	
CAM-l	checked.
2010:59	
CAM-2	aileron right, neutral.
2011:02	
CAM-l	checked.

2011:03
CAM-2 okay lookin' for the EPI gauge, where's that at? okay here it is I got it, down, up.

2011:09
CAM-2 EPI's checked.

2011:10
CAM-l okay rudder right, neutral. did you see that?.

2011:17
CAM-3 what you, you might need to turn one of the one of the spoiler pump off and the rudder -- and one of the engine pumps go to by-pass and then try it.

2011:24
CAM-l okay.

2011:25
CAM-l rudder right, neutral, okay checked rudder left, neutral checked.

2011:31
CAM-2 I got I got now turn them both back on.

2011:34
CAM-l both on.

2011:35
CAM-3 yeah and we're going to have to put the aux pump on as well. might as well do that now while we're thinkin' about it.

2011:39
CAM-l yup good very good.

2011:42
CAM-2 did you see that okay, let me know if you need a light or anything I'll shine it.

2011:48
CAM-l okay continue with the checklist

2011:51
CAM-3 continue with the checklist, flight controls are checked, flight instruments and radios?

2011:55
CAM-l set DME's on .

2011:58
CAM-2 set DME's on.

2012:15
CAM-3 okay altimeters?

2012:17
CAM-l last one was three zero three two and I've got nine hundred and fifty feet and zero set.

2012:23
CAM-2 three zero three two ah thousand and fifteen and zero's set.

2012:29
CAM-3 TC overspeed's checked cabin is secured, long range nav?

2012:33
CAM-l okay data four, okay and aux four, A-F-G okay checked.

2012:50
CAM-3 crew briefing?

2012:51
GND Air Transport seven eighty two heavy you can transition alpha taxiway at your convenience.

2012:55
RDO-2 Air Transport ah seven eighty two roger

2012:58
CAM-2 that must be a hint that he wants us to cut in or somethin'.

2013:00
CAM-l yeah.

2013:04
CAM-2 yeah well.

2013:05
CAM-I just ask him if we can go all the way down -- well that's all right I can see where he --.

2013:10
CAM-2 he said it's at our convenience .

2013:08
CAM-I yeah.

2013:09
CAM-2 ah bra - bravo cuts in at bravo ten and it does - bravo nine might be more preferred because ten kinda back tracks a little bii you got to little zag --.

2013:21
CAM-I well this is it here we can go down this way and then a left turn.

2013:24
CAM-2 yeah that'll work fine.

2013:25
CAM-I okay.

2013:28
CAM-I okay this will be a left seat takeoff, we got number one engine is inoperative, we reviewed the procedures for three engine takeoff and ever and if nobody has any questions --.

2013:50
CAM-2 no questions.

2013:50
CAM-I okay just to review one more time what we're going to do is set max power on number two and number three --.

2013:56

CAM-2 right.

2013:56
CAM-3 right.

2013:57
CAM-l okay and I'll ease in ah number four -.

2014:01
CAM-3 and I'll call increments of point one.

2014:03
CAM-l yeah absolutely and by ah VMCG we'll have max power on number four.

2014:13
CAM-3 right co-pilot er first officer's going to call airspeed-.

2014:16
CAM-2 airspeed alive eighty knots and ten increment to VMCA, then I'll call you rotate--.

2014:21
CAM-l right.

2014:22
CAM-2 positive rate.

2014:23
CAM-l okay and I'll ah after rotate I'll call for positive gear ah er positive rate gear up within three seconds --.

2014:32
CAM-2 okay.

2014:33
CAM-3 VMCG.

2014:34
CAM-l yes.

2014:34
CAM-2 yes.

2014:35
CAM-l I'll lower, I'll lower, oh pardon me.

2014:38

CAM-3	VMCG is minimum ground control speed.
2014:40	
CAM-l	right.
2014:41	
CAM-2	understood okay.
2014:43	
CAM-l	at positive rate I'll call gear up I'll lower the nose slightly to gain two ten but still keep about two hundred to four hundred feet a minute climb .
2014:51	
CAM-2	right.
2014:52	
CAM-l	okay then ah when we reach two ten I'll call for max continuous power.
2014:58	
CAM-2	okay.
2014:59	
CAM-l	okay and then well call ah we'll reduce the flaps like that, we'll climb at V2 all the way up to three thousand feet then we'll call for the climb procedures.
2015:09	
CAM-2	okay just to verify, I had V2 to four hundred AGL then two ten.
2015:13	
CAM-l	yeah.
2015:14	
CAM-2	okay that's true but we'll take it to three thousand before we okay I'll point that
2015:18	
CAM-3	and we won't start flap retraction until two ten.
2015:20	
CAM-2	right.

2015:21
CAM-l right okay.

2015:22
CAM-l okay and ah --.

2015:23
CAM-2 I'm going to tower.

2015:24
CAM-l all right.

2015:27
(sound similar to frequency change).

2015:28
CAM-l and it'll be the royal three departure -- out of here.

2015:30
CAM-2 that radar vec- runway heading radar vectors -- you got it? I'll read it to you. ah fly assigned heading and altitude for vectors to appropriate route expect filed altitude ten minutes after departure --.

2015:41
CAM-l okay.

2015:42
CAM-2 then it's got some transitions you don't need to worry about not yet --•.

2015:44
CAM-l okay.

2015:47
CAM-3 and ah of course we'll all be watching' real close for loss of directional control.

2015:51
CAM-l yeah and also of any other ah problem that we have okay they said that they had a fire bell on number four okay --.

2015:58

CAM-2 yeah.

2015:59
CAM-l ah I talked with the engineer and I talked with the captain both he they both said that it was a false indication to their knowledge. The mechanic said that he fixed it --.

2016:10
CAM-3 yeah fire loop lain' on the cowling.

2016:11
CAM-2 you will be running all the throttles right -.

2016:13
CAM-l yes.

2016:14
CAM-2 I won't even touch the throttles.

2016:15
CAM-l I ah that is correct you will ah just set them up ah 'til we're ready there.

2016:21
CAM-3 are you ready to go?.

2016:22
CAM-2 I'll let him know it's three engine.

2016:23
CAM-l yeah ah let's do the before takeoff down to gust lock.

2016:27
CAM-3 all right.

2016:28
CAM-l down to the line I'm sorry.

2016:29
CAM-2 can I arm this?

2016:30
CAM-l yes oh yea.

2016:33	
CAM-3	where the # okay my rudder pump is on.
2016:36	
CAM-l	okay we did finish the ah --.
2016:40	
CAM-3	taxi checklist's completed yes sir.
2016:42	
CAM-l	taxi checklist okay.
2016:45	
CAM-3	If I can find every thing.
201648	
CAM-3	fuel panel is checked, boost pumps are boost and feed, rudder pump is on, freon, **TC's** are off, spoiler pump ?
2016:57	
CAM-l	is on.
2016:58	
CAM-2	**it's** yours.
2017:00	
CAM-3	and pressure's checked?
2017:02	
CAM-l	pressure's checked.
2017:02	
CAM-3	flight recorder is on, anti-skid?
2017:06	
CAM-2	armed.
2017:07	
CAM-3	reverse pump is on, aux pump?
2017:10	
CAM-l	**it's** on.
2017:11	
CAM-3	for three engine procedures it should be on-.
2017:12	
CAM-?	right.

2017:13
CAM-3 do you have the reverse pump okay.

2017:14
CAM-? yes.

2017:15
CAM-3 on the line.

2017:16
CAM-3 I don't have the reverse pump.

2017:17
CAM-2 where is it?

2017:18
CAM-l right here .

2017:18
CAM-2 okay # is it on.

2017:20
CAM-3 no it's not push down, oh there you go.

2017:23
CAM-l it's on.

2017:24
CAM-3 reverse pump on.

2017:25
CAM-l okay.

2017:27
CAM-3 we're to the line.

2017:28
CAM-l okay ah ya tell them we're ready to go it's a three engine ferry we're gunnar need a couple minutes on the runway for static run up.

2017:35
CAM-2 okay.

2017:38
RDO-2 Kansas City tower Air Transport seven eighty two's ready to go one niner right this is going to be a three engine ah takeoff. we're gunna' need ah couple minutes on the runway for static run up.

		201748 TWR	Air Transport seven eight two roger hold short.
		2017:50 RDO-2	hold short Air Transport seven eighty two
2017:53 CAM-2	I think we have to hold short for him huh.		
2017:55 CAM-l	yeah.		
2017:56 CAM-2	he pretty close.		
2017:56 CAM-l	yeah.		
2017:57 CAM-2	oh we're one left what the # am I saying.		
2018:01 CAM-l	and the length of one left is?		
2018:04 CAM-2	ten ah ten thousand eight hundred feet for one left.		
2018:10 CAM-3	seventy eight hundred foot takeoff distance.		
		2018:17 TWR	Air Transport seven eighty two taxi into position and hold runway one left.
		2018:20 RDO-2	position and hold one left Air Transport seven eighty two
2018:23 CAM-l	below the line.		
2018:23 CAM-3	transponder?		
2018:24 CAM-2	on.		
2018:27 CAM-3	ignition override?		

2018:29
CAM-2 that's all engines.

2018:31
CAM-3 we got the aux pump on?

2018:32
CAM-l pump is on.

2018:33
CAM-3 exterior lights?

2018:33
CAM-l to go.

2018:35
CAM-? go.

2018:42
CAM-l clear left.

2019:07
TWR Air Transport seven eighty two runway one left turn right heading zero three zero cleared for takeoff.

2019:12
RDO-2 okay cleared for takeoff one left and turn right zero three zero for Air Transport seven eighty two

2019:19
CAM-l okay lights are extended and on.

2019:22
CAM-3 before takeoff checks complete.

2019:23
CAM-l okay comin' up, two and three.

2019:25
(sound of engines spooling up).

2019:42
CAM-l there set max power.

2019:46
CAM-2 max power on two and three.

2019:48

CAM-l okay, number four's comin' **up.**

2019:51
CAM-2 okay, one point, start ● *.

2019:56
CAM-3 button's in.

2020:02
CAM-3 one point three.

2020:05
CAM-3 point four.

2020:08
CAM-3 point **-** point four.

2020:11
CAM-3 one point five.

2020:12
CAM-2 airspeed's alive.

2020:13
CAM-3 one point six.

2020:17
CAM-3 one point six.

2020:18
CAM-2 eighty knots.

2020:19
CAM-l ahh.

2020:21
CAM-2 ninety knots.

2020:22
CAM-3 one point eight.

2020:23
CAM-2 hundred knots.

2020:24
CAM-l ah **#**.

2020:25
CAM (sound of decreasing engine noise).

2020:26
CAM-1 abort.

2020:29
CAM-3 call tell 'em we're **abortin'** on the runway.

2020:31
CAM-l spoilers.

2020:32
CAM (sound of increasing engine noise similar to engines in reverse) .

2020:33
RDO-2 Air Transport seven eighty two, we're aborting takeoff.

2020:36
TWR Air Transport seven eighty two roger when able turn right and ah ground point eight off the runway do you need any assistance

202044
CAM-2 negative assistance?

2020:45
CAM-l no negative.

2020:46
RDO-2 negative assistance Air Transport seven eighty two.

202046
TWR Ah ground point eight when you get off.

2020:50
RDO-2 ground point eight when off.

2020 :**54**
CAM-2 I don't worry about **callin'** on the radio when we got another problem, that's the least of our worries.

2021:02
CAM-l I couldn't even get **dev-**

2021:03
CAM-3 well how far were we up close to.

2021:05
CAM-2 we we're about ah **--.**

2021:06

CAM-3	we were at one six , and then power went all the way up to one ah one nine zero as you ran it up, so it went up real fast.			
2021:15 CAM-l	yeah it jerked up.			
2021:17 CAM-2	you brought it up too fast? or it jerked up or what?			
2021:19 CAM-l	it just came up too fast is what it did.			
2021:22 CAM-3	if you want to try it again I can try **addin'** the power if you like.			
2021:24 CAM-l	okay let's do it that way yeah ah tell em' --.			
2021:27 CAM-3	*			
2021:29 CAM-2	like to go back and do it again?			
2021:29 CAM-l	yeah tell 'em that we ah we just ah stand-by one let **me-** oh just tell 'em we'd like to taxi back and have another try at it.			
			2021:39 RDO-2	Kansas City ground Air Transport seven eighty two's clear we'd like to taxi back and depart one left again.
			2021:47 GND	Air Transport seven eighty two heavy roger taxi one left.
			2021:50 RDO-2	one left Air Transport seven eighty two
202152 CAM-l	okay.			

2021:55
CAM-3 I'll take off before the line.

2021157
CAM-2 yes let's back that one up.

202156
CAM-3 you want the anti-skid off?

2022:00
CAM-l no ah let's just ah --.

2022:02
CAM-3 to the line?

2022:03
CAM-1 yeah all the way down to the line.

2022:06
CAM-3 okay, transponder ignition override back to off.

2022:10
CAM-3 how much rudder were you stickin' in?

2022:11
CAM-l I had it all the way in.

2022:13
CAM-3 I was lookin' *.

2022:14
CAM-l that's why I ah -.

2022:17
CAM-3 okay when do I have to have max power in on the outboard engine?

2022:21
CAM-l one hundred and seven.

2022:23
CAM-3 by VMCG.

2022:24
CAM-l yeah.

2022:24
CAM-3 okay.

2022:26
CAM-l okay ah we didn't use

brakes on that so brake energy ah chart should be okay.

2022:31
CAM-3 no.

2022:36
CAM-l it seemed what happened, it was goin' up smoothly and then all of a sudden -.

2022:40
CAM-2 it kinda ah --.

2022:40
CAM-l it jerked and then yeah.

2022:44
CAM-2 a question to consider Captain is ah when we hit when we get near VMCG or get near Vr or VMCG if we're usin' all our rudder authority you might wanta' consider abort possibly because once we get higher we're gunnar be in be in even worse trouble correct.

2023:01
CAM-l that's correct absolutely.

2023:07
CAM-3 no actually above VMCG you rudder has more authority it's helping you more.

2023:11
CAM-2 I understand.

2023:14
CAM-3 if we were to lose ah about the time an outboard engine before VMCG -.

2023:18
CAM-2 right.

2023:19
CAM-3 you can't continue the takeoff because you will lose directional control because you other engine is

already in.

2023:25
CAM-2 okay yeah you're right you're one hundred percent right.

2023:29
CAM-l okay do me a favor just write down what time we aborted.

2023:32
CAM-3 okay well we aborted at ah about zero?

2023:34
CAM-2 yeah that's about right.

202344
CAM-l okay.

2023:44
CAM-2 boy it's **gettin'** tight.

2023:45
CAM-l yeah I know.

202346
CAM-2 hay we did our best you know.

2023:51
CAM-1 yeah.

2024:06
CAM-l and you can tell 'em that we'll ah be ready for takeoff again at the end.

2024:15
CAM-2 tell them now?

2024:20
RDO-2 Kansas City tower Air Transport seven eighty two we'll be ah ready to go at the end of one left.

2024:26
GND roger contact the tower you'll be number one.

2024:27
RDO-2 okay

2024:28
CAM-2 yeah that might ● *.

2024:32
(Sounds similar to flight switching frequency).

2024:36
RDO-2 Kansas City tower Air Transport seven eighty two be ready to go at the end ah one left ah three engine takeoff.

2024:42
TWR Air Transport seven eighty two heavy tower one left turn right zero three zero cleared for takeoff.

2024:47
RDO-2 okay cleared to go one left after departure zero three zero on the heading Air Transport seven eighty two

2024:52
CAM-l okay and the checklist.

2024:54
CAM-3 we are to the line.

2024:56
CAM-l okay below the line.

2024:56
CAM-3 transponder?

2024:59
CAM-2 its on again.

2025:01
CAM-3 ignition override?

2025:02
CAM-2 all engines.

2025:07
CAM-3 exterior lights.

2025:08
CAM-l to go.

2025:10
CAM-3 ah I'm gunnar need a minute.

2025:11
CAM-l yeah.

2025:12
CAM-3 I need to balance fuel out a little bit it's heavy on this side.

2025:15
CAM-l okay.

2025:33
CAM-2 clear left.

202543
CAM-3 I'll . I'll let you know when I have enough there.

2025:46
CAM-l okay.

2025:54
CAM-l I'll line up just a little right of the center line here.

2025:58
CAM-2 good idea.

2026:11
CAM-3 okay outboard fuel is balanced.

2026:12
CAM-l okay and we're cleared for takeoff, lights are extended and on. checklist is complete?

2026:24
CAM-3 checklist is complete.

2026:24
CAM-l okay.

2026:25
CAM (sound of increasing engine noise).

2026:33
CAM-l make sure that ah two and three is is ah -.

2026:37
CAM-3 at max power?

2026:37

CAM-l	yeah.
2026:39 CAM-3	okay.
2026:40 CAM-3	I'll set max power.
2026:46 CAM-3	one one.
2026:49 CAM-3	one two.
2026:50 CAM-3	one three.
2026:52 CAM-3	one four.
2026:54 CAM-3	one five.
2026:58 CAM-3	one six.
2026:59 CAM-2	airspeeds alive.
2026:59 CAM-3	one seven.
2027:01 CAM-l	god bless it.
2027:05 CAM-l	keep it goin'.
2027:06 CAM	(sound of engine noise increasing).
2027:07 CAM-3	keep it goin'?
2027:07 CAM-l	yeah.
2027:07 CAM-2	eighty knots.
2027:11 CAM-2	ninety knots.
2027:13 CAM-2	one hundred knots.

2027:17
CAM-l okay.

2027:17
CAM (sound of loud crash).

2027:20
CAM-2 we're off the runway.

2027:21
CAM-l go max power.

2027:26
CAM-l max power.

2027:27
CAM-2 get the nose down.

2027:28
CAM-l max power.

2027:29
CAM-2 you got it.

2027:30
CAM-? we're gunnar' go -.

2027:30
CAM (sound of loud crash))

CAM (sound of screams).

2027:32
end of recording

APPENDIX C

ACTIVITIES OF THE CAPTAIN AND FIRST OFFICER PRIOR TO THE ACCIDENT FLIGHT

According to his wife, the captain normally went to bed between 2200 and 2230 and awoke between 0700 and 0730 when he was off duty. He attended a 1 week training course in Denver and returned home on Sunday, February 12. His wife met him at the airport (DTW) about 0230. He had been delayed departing Denver because of a storm. The captain slept until 1100. He spent Sunday at home and went to bed at 2300. On Monday, February 13, he awoke at 0730. He spent most of the day at home and departed for the airport with his wife about 1800 to fly to Dover, Delaware. His wife said he seemed "fine." He checked into the crew hotel at Dover at 2330 and made a short telephone call to ATI from his room at 0056, on February 14, and he made another call the following morning, at 1136, to ATI. Prior to flying, he telephoned his wife. She said he stated that the first officer on his upcoming trip was rather new to the company or the airplane, and that this fact would add to his workload.

The first officer's wife said that he normally went to bed between 2230 and 2300 and awoke between 0600 and 0700 when he was off duty. He also took occasional naps. On Friday and Saturday, February 10 and 11, he spent a routine day at home. He went to bed late on Saturday, perhaps after midnight, mountain standard time. On Sunday, he awoke at 0700, went to church, spent time with the family, and went to bed between 2230 and 2300. On Monday, February 13, he awoke about 0700, and his wife drove him to the airport around 1000 to fly to Dover. The first officer checked in to the crew hotel on February 13 at 2330 EST and, at 2336, he made a telephone call to a calling card number from his room. The next morning, at 1054, he telephoned home to say he would be going to Ramstein, Germany. He sounded normal and was very excited because of the international trip, according to his wife.

The activities of the flight engineer prior to the accident trip could not be determined. He checked in to the crew hotel in Dover on February 14 at 1050.

The check pilot met the crew at 1435 to brief the upcoming flight. They departed Dover at 1730 and arrived at Ramstein, Germany about 7 hours later, at 0628 local time. The three crewmembers and the check pilot ate breakfast together at the crew hotel and remained there talking until 0915. They met again for coffee at 1900 prior to their departure from Ramstein at 2128. The flight arrived at Dover about 11 hours later at 0148 local time (following a stop at Gander). The check pilot said that the captain did an excellent job, including good landings in difficult wind conditions at Ramstein and Gander. He said that the first officer was new to the airplane, but that he was eager to learn and that he did well. He described the flight engineer as very conscientious. The crewmembers did not seem fatigued, and there was no evidence that any of them had medical difficulties.

According to hotel records, the three crewmembers checked in to the crew hotel at Dover at 0240 EST on February 16. The captain placed a short call to AT1 from his room at 0314. The next morning, he telephoned home at 0802 and spoke for 25 minutes. His wife said he had just awakened and that he sounded relaxed and very happy because of the successful check ride. The ATI Manager of Crew Scheduling telephoned the captain at 1030 to inform him that a ferry to MCO was scheduled, but he telephoned back in 15 minutes to say that the trip was canceled. The captain sounded fine, according to the manager, although he had probably been sleeping. The captain telephoned AT1 for 2 minutes at 1244. The AT1 Manager of Crew Scheduling telephoned the captain at 1400 and 1410 to arrange the trip to MCI and to ask him to depart as soon as possible. The captain said that he could depart within 1 hour or less. His mood sounded good, according to the manager, and, in response to a question, the captain indicated that he was rested. The ATI Chief Pilot participated in the second telephone call to discuss the possibility of adverse wind conditions for the scheduled three-engine ferry landing at Westover. They did not discuss the three-engine takeoff procedures. The Chief Pilot said that the captain was in good spirits and anxious to get to the airplane.

The three crewmembers checked out of the hotel shortly after 1500. The desk clerk said that all three of them appeared rested and appeared to get along well with each other. The crew departed Dover at 1518 and arrived at MCI at 1739 local time.

The captain, who had flown the accident airplane into MCI, met the three crewmembers briefly at 1825 and spoke with the captain for about 10 minutes (until his own departure on the airplane that the accident captain had delivered). He described the captain's mood as fairly good, and he said that all three crewmembers appeared alert and free from evident medical difficulties. The captain indicated that he had reviewed the three-engine ferry procedures, and the other captain checked and confirmed the captain's ballast fuel figure. The first officer telephoned his wife from MCI to tell her that he was preparing to fly a three-engine ferry flight. She said he sounded normal.

APPENDIX D

SAFETY BOARD RECOMMENDATIONS A-95-38 AND -39

Date: March 30, 1995

In reply refer to: A-95-38 and -39

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On February 16, 1995, at 2027 eastern standard time, a Douglas DC-8-63, operated by Air Transport International (ATI), crashed as the flightcrew was attempting to make a three-engine takeoff from runway 01 left at Kansas City International Airport (MCI), Kansas City, Missouri.

The airplane was to be ferried to a maintenance facility in Massachusetts because the No. 1 engine on the airplane could not be operated due to a mechanical problem. The first takeoff attempt was rejected because of directional control problems on the runway. On the second takeoff, directional control problems also occurred, and the captain rotated the airplane just before the airplane departed the paved surface off the left side of the runway. The tail of the airplane struck the runway and a tail skid mark was found on the paved surface and in the sod to the left of the paved surface.

The operational procedures at ATI for a three-engine takeoff begin by Statically setting near maximum power on the symmetrical engines and partial power on the asymmetric engine. After brake release, maximum power should be set on the symmetrical engines. As soon as possible, the asymmetric engine should be smoothly advanced toward maximum power during airplane acceleration to the precomputed ground minimum control speed. The asymmetric engine should be set at maximum power upon reaching this speed. Rudder pedal steering should be used to maintain directional control. Normal rotation procedures should be followed at the precomputed rotation speed.

According to the ATI DC-8 Cockpit Operating Manual, specific three-engine limitations include a maximum en route speed of 0.84 mach, a maximum takeoff weight of 260,000 pounds, a flap setting of 12 degrees, a maximum takeoff crosswind component of 10 knots, and a maximum tailwind component of 5 knots. Also, all three-engine takeoffs must be made from a dry runway with anti-skid operative, and all air conditioning and anti-ice systems must be off. Lastly, no three-engine takeoff shall be made unless VFR conditions exist at the airport of departure and exist or are forecast for the airport of destination. All of these conditions were met at the time of the attempted takeoff.

Witnesses reported that they observed the airplane rotate to a higher-than-normal pitch attitude. The flight data recorder (FDR) data revealed that the rotation occurred at 103 knots or about 20 knots before the three-engine takeoff rotation speed (123 knots). The airplane briefly became airborne while in an unusually high pitch attitude. It then rolled, catching a wing tip on the ground during a slight descent. The airplane was destroyed by impact forces, and all three flightcrew members were fatally injured. Weather conditions were reported as good.

The Safety Board's investigation of this accident is continuing, and the probable cause(s) have not been determined. However, the investigation has raised several safety concerns that the Safety Board believes the Federal Aviation Administration (FAA) should take immediate action to correct.

As a routine part of this investigation, the Safety Board interviewed the FAA principal operations inspector (POI) for ATI at the Little Rock, Arkansas, Flight Standards District Office (FSDO). The POI has been employed by the FAA as an Aviation Safety Inspector (ASI) for about 12 years, all of which have been at the Little Rock FSDO.

The POI was trained and received a type rating in the DC-8. In addition, he has ratings in the Douglas DC-3 and the Falcon 10. He has had past experience as a POI with a 14 Code of Federal Regulations (CFR) Part 135 operator. He stated that he has about 13,000 hours of total flight time. He has been the POI for AT1 for about 1 year, and the ATI certificate is the only one he oversees. He is responsible for oversight of the certificate by himself, however, two other ASIs in the Little Rock FSDO occasionally help with oversight activities. These ASIs are not qualified in DC-8s. The POI depends upon the Denver FSDO for geographic assistance, since ATI training occurs in Denver, Colorado. The interview revealed, in part, the following information:

The POI was asked about the effectiveness of the crew resource management (CRM) program that ATI had begun offering its flightcrews in January 1995. He was unaware that the company had a formal CRM program and he knew nothing about the classes.

The POI stated that he realized that the company had grown considerably in the past several years, and that he was concerned about its growth. However, when he was asked to describe ATI policies concerning its crew pairing program, he replied that he was not aware of such a program. The Safety Board believes that crew pairing is an important safety issue for an expanding company. It also believes that the POI should be familiar with the FAA's crew pairing standards, especially at a growing company.

The POI was asked to describe the ATI ground training program (this training also has been conducted in Denver since last spring) and how often he monitors it. He replied that he has not monitored ground training, and that he did not know whether the Denver FSDO monitors such training. AT1 uses retired United Airlines instructors as simulator instructors in Denver. The POI replied that he had no knowledge of such an activity. However, a letter from the POI to ATI authorizing this practice was found in AT1 training records.

The POI was unaware of other functions that the Denver FSDO performs concerning oversight of ATI. He was shown a letter from the AT1 training department (dated February 2, 1995) that indicated that two out of 278 ATI airmen proficiency check rides had been conducted by FAA personnel. The POI believed that those numbers were probably accurate. Concerning proficiency check rides, he stated that ATI bypasses him entirely in the scheduling and performance of these check rides and that this procedure expedites this check ride activity. He was unfamiliar with proficiency check ride failure criteria as outlined in the FAA Inspector's Handbook, Order 8400.10. Also, he had no knowledge of what amount of training, if any, could be provided during proficiency check rides.

The POI for AT1 was asked how often he had visited the ATI Denver training facility and the Denver FSDO, and he indicated "about three or four times last year." He indicated that funding problems in his office restricted his ability to travel to Denver from Little Rock. He was asked how often AT1 conducted pilot safety meetings, and he thought that they did, but was unaware of how often. The investigation revealed that AT1 does not hold formal safety meetings. He was asked to provide copies of the AT1 check airmen authorization letters, and he produced seven letters from his files. Company records show that 17 check airmen are currently performing check ride duties.

Based on the interview, the Safety Board believes that the POI's surveillance of AT1 and his knowledge of the company were weak. Because of the growth of the company since 1993, and other factors such as the separate locations of the POI and the training center, he has been unable to monitor the safety level of AT1 adequately.

AT1 has experienced three catastrophic DC-8 accidents since 1991.[10] The Safety Board concluded that the probable causes were related to operational factors in the first two accidents. In the accident that occurred in New York the Board determined that:

The probable causes of this accident were improper preflight planning and preparation, in that the flight engineer miscalculated the aircraft's gross weight by 100,000 pounds and provided the captain with improper takeoff speeds; and improper supervision by the captain. Factors relating to the accident were an improper trim setting provided to the captain by the flight engineer, inadequate monitoring of the performance data by the first officer, and the company management's inadequate surveillance of the operation.

In the accident that occurred in Ohio, the Safety Board determined that:

The probable cause of this accident was the failure of the flightcrew to properly recognize or recover in a timely manner from the unusual aircraft attitude that resulted from the captain's apparent spatial disorientation, resulting from physiological factors and/or a failed attitude director indicator.

Although the analysis of the circumstances of the recent accident is not complete, operational factors, such as computation errors and procedural discrepancies, are involved in the accident sequence of events.

“Brief of Accident, JFK International Airport, New York, Air Transport International, March 12, 1991, NYC91-F-A086; Aircraft Accident Report, Loss of Control and Crash, Swanton, Ohio, Air Transport International, February 15, 1992, NTSB/AAR-92/05; and Kansas City International Airport, Missouri, Air Transport International, February 16, 1995, DCA95MA020, the accident currently under investigation.

AT1 experienced much growth since 1993. For instance, 27 of the 64 line captains currently flying for **ATI** were hired since 1993, 75 of the 80 line first officers were hired since 1993, and 46 of the 73 line flight engineers were hired since 1993. Recently, **ATI's** operating certificate was reissued by the FAA, allowing it to carry passengers. In fact, it does so on some of the military contract flights that make up approximately 15 percent of its missions.

Because of **ATI's** growth rate, the common operational thread that appears to tie the three accidents together, and the apparent weak surveillance and oversight provided by the POI, the Safety Board believes that the FAA should take immediate action to examine **ATI** training, operational philosophy, and management oversight. In addition, the FAA should immediately examine the effectiveness of the oversight process of the Little Rock and Denver FSDOs. This examination of the company and the Little Rock and Denver FSDOs should be accomplished by FAA personnel not associated with any of these entities.

Lastly, all line **ATI** flightcrews are considered qualified to perform engine-out ferry flights, as long as they have been trained to do so in the simulator and appropriate engine-out ferry preflight procedures are followed. The captain involved in the Kansas City accident had a total of 3129 hours of flying time as a DC-8 captain and had just completed his probationary period with **ATI.** The first officer had been a line pilot with AT1 for 4 months and had a total of 171 hours of DC-8 flying time. The flight engineer had been a line flight engineer with the company for 4 months also, and had a total of 218 hours of DC-8 flying time.

The McDonnell Douglas Aircraft Company and most operators of three or four-engine airplanes require that only a specially trained cadre of training, flight test, or standardization flight crewmembers be allowed to perform such engine-out operations. Considering the unusual nature of engine-out operations and the relative infrequency of the need for such operations, the Safety Board believes that limiting the engine-out qualified crewmembers within an organization to those with the most flying experience is critical.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Conduct an immediate in-depth inspection of Air Transport International **(ATI)** to examine training, operational philosophy, and management oversight. Also, as part of this inspection, examine the

effectiveness of the oversight of **ATI** by the Little Rock and Denver Plight Standards District Offices. (Class **II,** Priority Action) (A-95-38)

Limit operations of engine-out ferry flights to training, flight test, or standardization flightcrews that have been specifically trained in engine-out procedures. (Class II, Priority Action) (A-95-39)

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT concurred in these recommendations.

By: Jim Hall
Chairman

APPENDIX E

DOUGLAS, UNITED PARCEL SERVICE, AND AT1 THREE-ENGINE FERRY PROCEDURES

TAKEOFF PROCEDURE: **12°** *Flaps*

The takeoff fleld length charts presented in this appendix are based on the following procedures.

prior to takeoff the pilot should determine the stabilizer setting, engine pressure ratio settings V_{MC_g} V_{MC} *speed, VR speed,* V_2 *speed and that* **sufficient field** *length* **is** *available* **for** *the conditions of gross weight, temperature, altitude,* **wind** *and runway slope of the particular takeoff. All* **cabin-turbo-** *compressors and both freon systems should be turned "OFF" manually prfor to* **applying** *takeoff power. The blow* **away** *jet switch should be turned off* **approximately 5** *seconds after brake release, but before reaching 40 knots. Adjust seat and rudder pedals to assure full rudder pedal control. Secure the inoperatfve englne in accordance with established* **DACo** *procedures: Pneumatic* **"OFF"**, *generator* **disconnected,** *all doors closed. Set rudder,* **aileron** *and stabilizer trim in accordance wfth normal takeoff procedures (rudder and aileron zero and stabilizer set for the proper* **c.g.,** *gross welght and* V_2 *speed). Turn* **"ON" auxiliary** *hydraulic pump.*

Advance **symmetrical** *engines to full takeoff thrust.' Set engine opposfte the inoperative* **engine to** *the maxfmum EPR* **which** *can be tolerated and* **still** *maintain control at the start of the takeoff roll.* **This** *is approximately 1.1 EPR for a dry, hard surface runway. After brake release use the rudder and rudder pedal steering to maintain dfrecttonal control. Rudder pedal steering effectiveness can be Increased by maintaining down elevator during the takeoff roll to the* V_R *speed. Smoothly accelerate the engine opposite the inoperative engine during the acceleration to* V_{MC_g} *speed. The engine opposite the inoperative engine should be set at* **full takeoff** *thrust* **at** *or before attaining* V_{MC_g} *speed. Rotate the airplane in accordance wfth* **normal** *rotationprocedures* at *the VR speed.*

Initiate *gear retraction within three seconds after lift-off. Climb at the* **recommended** V_2 *speed* to *at least 400 feet and accelerate in level* **flight** *until a speed of at least* **200** *knots,* **IAS,** *is attained, Initfate flap retraction at 200 knots* **IAS** *and accelerate to the two-engine final segment climb speed of 208.3 knots* **IAS.**

All cabin turbo-compressors should be "OFF" until a height of 400 feet or a height at which obstacles are cleared, **whichever is** *higher, is attained at which* **time** *two cabin turbo-compressors (one at a time) should be turned "ON". The remaining turbo-compressor may be* turned *"ON" only after power* **is** *reduced to maximum continuous rating. The freon systems may be turned "ON"* at *any time after two turbo-compressors are turned "ON".*

The three engine ferry takeoff EPR settings (set between 40 and 80 knots) presented In this appendix should be used In* **lieu *of comparable four engine* **curves** *presented in the basic* **report, DAC-33163.** *Statically, set the* **EPR** *on* **the symmetrical engines to** *the value shown on* **the** *Takeoff Thrust* **Setting** *Curve* **(for** *airspeeds of 40 to 80 knots) less 0.03.*

TAKEOFF FIELD LENGTH (Flaps 12°)

Charts of minimum takeoff field lengths are shorn for various air temperatures, airport pressure altitudes, alrcraft takeoff velghts, wind components, runway slopes and for a flap setting of 12 degrees.

The wind correction chart Includes factors of 50 percent and 150 percent applied to reported headwinds and tailwinds, respectively. The reported vind is taken as the component along the runway at a height of 50 feet above the runway.

The minimum takeoff field length is 115 percent of the horizontal distance from the start of takeoff to a point 35 feet above the runway at the V_2 speed, assuming two symmetrical engines operating from the start of takeoff, with the third engine being brought in as quickly as possible while maintaining positive control.

Appropriate abnormal bleed corrections are presented on separate charts.

The limitations occur in the following manner:

a. An additional engine failure is not considered prior to completion of takeoff path.

b. V_R must not be less than 1.05 $V_{MC_{air}}$. If the V_R allowed by the lift-off speed is less than 1.05 $V_{MC_{air}}$, it must be Increased to be equal to or greater than 1.05 $V_{MC_{air}}$. A weight equal to or greater than the maximum weight at which this limitation occurs is shown on the chart entitled MAXIMUM WEIGHT AT WHICH TAKEOFF SPEEDS ARE AFFECTED BY MINIMUM CONTROL SPEEDS.

c. V_2 is dependent on V_R; therefore, when the V_R has to be increased, it produces an increase in V_2.

d. Takeoff performance vas calculated for a dry, hard surface runway.

EFFECT OF ABNORMAL BLEED ON TAKEOFF PERFORMANCE

A separate page is presented to determine the effect of additional systems operative on takeoff field length. The procedure for its use is as follows:

Enter temperature-altitude grid for the system operative in question. Read the takeoff field length. Using this value enter the normal bleed Plot at the reference weight and proceed in the same manner as the sample problem.

FLIGHT OPERATIONS PROCEDURES – DC8

<u>NOTE</u>: Authorization for the operation of an engine–out ferry is contained in UPS Operations Specifications D, entitled <u>Special Flight Permit With Continuous Authorization To Conduct Ferry Flights.</u> UPS Operations Specifications D, *UPS* Ferry Permit and this manual comply with UPS and FAA approvals and procedures. This applies to B727, B747 and DC8.

1. <u>Operational Procedures</u>

   A. Certificate Limitations – the limitations contained in this supplement conform to the FAA AFM limitations and the observance of such limitations is required by law. The certificate limitations contained in the UPS AOM are applicable except as amended herein.

      <u>NOTE</u>: UPS Ferry Permit, Form 52–19–014 (GMM) is required. Obey its stipulations. One copy of the permit is to be left with flight documents at airport of departure. One copy is to be kept with Captain's flight papers.

      (1) Weight Limitations – The operating weight should be limited to the minimum necessary for the particular ferry flight (FAR 91.611).

      (2) Maximum Airspeed Limitations – VMO or .84M (AFM); .7 mach max <u>cruise</u> recommended (DACO DC8 OEL #22M 6–15–87).

      (3) Flight Crew – No persons other than required members of the flight crew shall be carried.

         <u>NOTE</u>: A UPS Maintenance Specialist may be designated as a required flight crewmember essential for in–flight engine monitoring, inspection of engines at enroute fuel stops, etc.

   B. Operational Limitations

      (1) The flight must not be dispatched to or operated in regions of forecast or reported icing conditions.

      (2) Takeoff may not be made which would require that the initial climb be made over a thickly populated area.

      (3) Military airfield – appropriate permission from Base Commander.

      (4) If three engine take off weight exceeds 240,000 lbs., an intermediate refueling airport should be considered.

   C. Takeoff Configuration

      (1) Flap setting must be:

         DC–8–73 – 12 degrees
         DC–8–71 – 15 degrees

      (2) Four cowled engines must be installed.

(3) One engine driven hydraulic pump and the auxiliary pumps must be on and operating during takeoff if an inboard engine is inoperative, otherwise both engine driven hydraulic pumps must be on and operating with the auxiliary pump on..

(4) The anti-skid system and auto ground spoilers must be operative.

(5) Ignition "all engines and both" selected.

(6) Both packs must be off until reducing thrust to MCT.

(7) The standby rudder power should be ON.

(8) Yaw damper ON is desirable.

2. Emergency Procedures

The emergency procedures contained in the UPS AOM and QRH are unaltered.

3. Flight Planning and Performance Data

UPS Flight Control and Performance Engineering will provide all takeoff and flight data necessary for the successful execution of the ferry flight. The Captain and Second Officer will compute performance data and compare it with data supplied by Engineering. This data will be approved by the Technical Chief Pilot or designee prior to being supplied to the captain.

4. Normal Procedures

The normal operating procedures contained in the UPS AOM are unaltered with the exception of the following recommended procedures:

A. Before Start

(1) Pull inoperative engine ignition circuit breakers.

(2) Move fire shutoff lever to SELECT AGENT position (full forward).

B. Before Takeoff

(1) Review takeoff speeds, minimum control speeds and climb speeds.

(2) VR and V2 are to be predicated upon the runway limit weight in lieu of the actual takeoff weight.

(3) Review procedures for loss of another engine during takeoff or initial climb. Consideration should be given to the effect of other types of failures, such as hydraulic pump, which may preclude gear and flap retraction and result in loss of power control at a critical time.

(4) Complete normal checklists except:

(a) Standby rudder power – ON.

(b) Aux. Hyd. pump (if inboard engine is inoperative) – ON.

C. Takeoff

(1) The Captain will move the throttles and set the thrust.

(2) Before brake release, set 50 percent N1, on asymmetric engine. Then set symmetrical engines at normal takeoff N1, (Max. Thrust).

(3) After brake release, use the rudder and rudder pedal steering to maintain directional control. Smoothly accelerate the third engine during acceleration to VMCG speed. The third engine should be set at Max. Takeoff Thrust at or before attaining VMCG. Hold nosewheel firmly on the ground until VR.

(4) Use normal rotation procedures.

(5) At liftoff, use rudder and aileron displacement as necessary to maintain directional control. Avoid unnecessary rolling and yawing.

(6) The aircraft should attain V2 at or prior to 35 feet AGL

(7) Climb at V2 to at least 400 feet or 40 feet above an obstacle clearance and accelerate in level flight or a shallow climb, as terrain permits, to obtain two–engine VMCA (VMS) as soon as possible. Accelerate to flap retraction speed, simultaneously retract flaps and set MCT.

(8) Operation at Vms with two engines inoperative on one side below 3,700 feet pressure altitude may require bank angles of 9 degrees to 10 degrees to maintain heading until thrust is reduced from three engine MCT to two engine MCT. After setting two engine MCT, operation at Vms with two engines inoperative on one side may only require bank angles up to five degrees.

(9) The climb, cruise, descent, holding, landing and go–around procedures are contained in the UPS AOM, DC8 AFM and this manual.

(10) Three engine performance data is obtained from UPS Engineering and the performance section of the DC8 AFM, UPS AOM and Operational Engineering Letters.

(11) Three engine enroute data is provided in computer flight plan form from UPS flight control.

5. Takeoff Techniques

A. Keep nose wheel on runway, F/O keeps yoke forward for directional control.

B. Stay on centerline of runway.

C. Do not be in too much of a hurry to bring the third engine power in.

D. As the third engine power comes in, keep feeding in rudder as needed to maintain directional control.

E. Do not use nose wheel steering.

F. Advancing dead engine throttle out of idle will eliminate nuisance "gear not latched" light when airborne.

LIMITATIONS

Air Transport international is authorized to conduct one engine inoperative ferry flights of DC-8 airplanes without the necessity of FAA ferry permit, subject to the following limitations and procedures:

No persons other than the required flight crew or persons essential to the operation shall be carried during the three-engine ferry.

Prior to conducting a three-engine ferry takeoff, consideration should be given to the effect of various types of failures, such as the loss of another inboard engine or hydraulic pump which may preclude retraction of gear and flaps and result in loss of flight control power at a critical time.

If an inboard engine is inoperative, at least one engine driven hydraulic pump and the auxiliary hydraulic pump must be ON and operating during takeoff, otherwise both engine driven hydraulic pumps must be ON and operating.

Planning for a three-engine ferry takeoff and flight should include the normal weather and other considerations as well as careful planning for an early landing at the depanure airport or a suitable nearby or enroute alternate airport. Departure area, enroute terrain, weather, and depanure area congestion should also be taken into account. The two-engine enroute terrain clearance should be checked against the terrain to be crossed to'prepare a plan of action against the possibility of the failure of another engine.

Maximum airspeed: V_{MO}/.84M.

The takeoff runway lengths required by the tables in this section are valid for a dry, level, hard surface runway at the stated temperatures, pressure altitudes and weights; with the engine wind milling, a flat engine plug installed against the inlet guide vanes of the inoperative engine, or a faired nose cover on the inoperative engine. Any change from the stated conditions for runway length and of climb limits will reauire reference to:

1. DC-8-61 AFM, Appendix 1A
2. DC-8-62 AFM, Appendix 16
3. DC-8-63 AFM, Appendix 1B
4. DC-8-71 AFM, Appendix 1B

NOTE: On the 61, when utilizing a flat engine plug installed against the inlet guide vanes or a faired nose cover on thr inoperative engine, the fan reverser doors [Venetian blinds) must be secured in the closed position.

No takeoff shall be made unless VFR conditions exist at the airpon of depanure and exist or are forecast for the airpon of destination. Normal enroute weather minimums shall apply for all three-engine ferry flights. All takeoffs must be made from a dry runway with anti-skid system operative, and all air conditioning end anti-ice systems OFF.

Three-engine ferry maximum takeoff weight range is:

60 series aircraft - 260,000 pounds
70 series aircraft - 280,000 pounds

Takeoff flap settings are:

61/71 - 15°
62/63 - 12°

L(Cont'd)ONS

At takeoff weights below 200,000 pounds, the runway lengths and "V" speeds for 200,000 pounds will apply at the stated temperatures and pressure altitudes. Takeoff weights below 200,000 pounds do not necessarily reduce the runway length 'required for takeoff because of VMC considerations. Takeoff weights below the "MAXIMUM WEIGHT AT WHICH MINIMUM CONTROL SPEEDS AFFECT TAKEOFF SPEEDS AND FIELD LENGTHS, WMC,' ara limited to the runway lengths and takeoff speeds at the weight derived from the noted chart for the expected temperature and pressure altitude. Reference the following:

1. DC-8-61 AFM, Appendix 1 A, Sections IV-A
2. DC-8-62 AFM, Appendix 1B, Section IV
3. DC-8-63 AFM, Appendix 1 B, Section IV
4. DC-8-71 AFM, Appendix 1B, Section IV

The tables in this section are derived with this factor included in the figures presented. This is why, at low weights and low altitudes, the higher temperatures may require shorter runways than the same weight at lower temperatures.

Maximum winds for takeoff: Crosswind - 10 KTS. Tailwind - 5 KTS.

All other limitations listed in this manual apply.

No three-engine ferry flight shall be made without direct authorization from the Director of Maintenance or Director of Quality Control to implement the validity of Operations Specifications 084. Only the Director of Operations, or in his absence the Chief Pilot, can provide the operational release for a three-engine ferry. Refer to Air Transport International's General Operations Manual, Chapter 5.

Before making an engine-out takeoff at a military installation, appropriate Operations personnel (i.e., Base Flying Safety Officer, Base Operations Officer, or Base Operations Duty Officer) will be notified of the captain's intentions.

MAINTENANCE PREPARATION

Maintenance requirements prior to three-engine ferry will be found in Air Transpon International's Maintenance Manual, Chapter Three.

OPERATIONAL PROCEDURES

The runway length and speed tables derived in this section meet three-engine ferry takeoff and climb requirements for altitudes below 6000 feet without specific obstacle restrictions and normal bleed conditions.

Consideration for the use of rain removal, engine or airframe ice protection is not included in these tables.

If the aircraft is likely to depart from higher altitudes, encounter obstacles, or be in conditions requiring the use of any of the pneumatic rain or ice protection systems during depanure or initial climb, the takeoff weights and runway lengths in the table may not be valid. In that event, determine a new takeoff weight from the DC-8 AFM for the conditions to be expected.

Adjust seat and rudder pedals to assure full rudder control. Zero the rudder trim and the aileron trim.

Prior to takeoff, place AUX HYD PUMP and STANDBY RUDDER POWER to START. Check AUX PUMP ON and STANDBY RUDDER POWER lights illuminated.

OPERATIONAL PROCEDURES (Cont'd)

TAKEOFF

The following additional procedures will apply to three-engine takeoff:

Statically set partial power on the asymmetric engine and near max power on the symmetrical engines. After brake release, set MAX power on the symmetrical engines and, as soon as possible, smoothly accelerate engine opposite the inoperative engine to MAX power during acceleration to V_{MCG}. The engine should be set at MAX power upon reaching this speed. (See TAKEOFF PROCEDURES on following pages for details).

Use rudder pedal steering to maintain directional control. Use normal rotation procedures.

Initiate gear retraction within three (3) seconds after lift off (positive rate of climb).

At lift-off, rudder and aileron displacement should be applied with discretion in order to avoid unnecessary rolling and yawing.

About ¼ of the total rudder pedal deflection will be required to maintain heading at lift-off if an outboard engine is inoperative. Aileron displacement will vary, but it normally should not exceed ¼ of the wheel travel away from the failed engine. Rudder and aileron forces are light and require small trim inputs.

As airspeed increases, less rudder and aileron will be required to keep the wings level.

Acceleration on three engines is such that the aircraft will obtain V2 at 35 feet if the correct lift off attitude is maintained.

Climb at V2 to 400 feet AGL and accelerate to the three-engine flap retract speed of 210 KIAS, retract flaps and continue climb at 210 (60) 230 (70) KIAS to 3000 feet AGL. Set climb power when climb airspeed is established. Perform climb check above 3000 feet AGL.

Under normal circumstances, the aircraft rate of climb should not be allowed to exceed 500 feet per minute and not be less than 200 feet per minute during the acceleration to 210 KIAS where the flaps are retracted. This procedure will ensure the five minute restriction for maximum power will not be exceeded.

Operation at maximum weights with the loss of an additional engine may require 9° to 10° bank angles to maintain directional control until thrust is reduced to MCT, at which time bank angles up to 5° may be required.

Climb, cruise, descent, landing and go-around procedures are the same, but use three-engine cruise and go-around data.

THREE-ENGINE FERRY CHECKLIST

Consult 3-Engine Runway Analysis For Takeoff Weight; Do Not Exceed Maximum. Consider Enroute MEA's For Two-Engine Drift Down.

inoperative engine secured for ferry.

Maximum Takeoff Weight - 260,000 Pounds (60), 280,000 Pounds (70).

Minimum Fuel Load - 30,000 Pounds.

Maximum Flap 15° (61/71) 12° (62/63)

Captain's seat adjusted to permit full rudder throw.

Rudder and aileron trim zero.

Normal Checklist Completed.

Auxiliary Hydraulic Pump ON,

First officer will hold full forward on yoke.

(60) Symmetrical engines full power. If the inoperative engine is an outboard, set 1.1 EPR, 80% N2 on the operating engine prior to brake release.

(70) Symmetrical engines at 70% N_1. If the inoperative engine is an outboard, set 50% N_1 on the operating engine prior to brake release.

CAPTAIN - Maintain directional control with rudder nose wheel steering. Smoothly advance power on the asymmetrical engine during the acceleration to V_{MCG} speed. Maintain sufficient forward elevator pressure to aid directional control.

The asymmetrical throttle must 'be aligned with the symmetrical engine throttles by V_{MCG}. Leave hand on throttles to VR then on the yoke. At VR make normal rotation, maintaining required rudder inputs.

F/O - Call airspeed alive, 80 knots and each 10 KTS to V_{MCG} speed. At VR, call "ROTATE,' call V2 and positive rate of climb. Adjust symmetrical throttles after Captain sets initial power to MAX EPR between 40 and 80 KIAS.

F/E - As the Captain adds power to the asymmetrical engine, call EPA in 0.10 increments (1.2, 1.3, etc.) until max power, then call 'MAX POWER SET.'

Initiate gear retraction within 3 seconds after lift off.

Retract flaps at 210 knots. This ensures two engine V_{MCA}.

Auxiliary hydraulic pump OFF after area climb and ON before final or landing.

Maximum ferry speed - V_{MO}/M.84.

RUNWAY CORRECTIONS

The slope and wind corrections on the following chart apply to all weights and attitudes found in this section.

APPENDIX F

FAA INTERVIEW SUMMARIES

Manager, Little Rock FSDO

The manager was asked about the FAA Geographic Program as it relates to oversight of ATI. He stated that the program was designed so that POIs, like the one overseeing ATI, would not have to travel extensively to monitor the airline operation. He said that funding limitations had an impact on the extent to which ASIs could travel. The manager said that when a carrier expanded significantly, there should be additional funding available to the office carrying the certificate to accommodate the needed expenses. The manager was asked his opinion of ATI/FAA relations, and he stated, "They are good."

Aviation Safety Inspector, Denver FSDO

At the time of the accident, he was not performing inspector duties in the DC-8, because his airplane currency had run out, and his new POI responsibilities demanded his full-time attention. Additionally, this AS1 thought that funding was low in the FAA for such recurrent training. In the years 1993 and 1994, he was assigned to perform geographic functions, primarily with the DC-8 operation at the United Airlines Training Center. This involved oversight of several air carriers using the two simulators in Denver, including ATI.

This individual stated that in his opinion, AT1 was "the best of the non-scheds." He felt that the AT1 training was "thorough and very good." He said that the flightcrews were well prepared for checks. Since the change to a new chief pilot, many former problems at AT1 had been eliminated. He said that the ATI check airmen were very good and that there were fewer check ride failures with the ATI pilots than some of those from other carriers. He said that the reason for this was that AT1 would not assign a pilot for a check unless he was ready. ATI did not restrict extra training when needed, in his opinion.

Concerning the use of retired United Airlines' instructors as simulator instructors was discussed. This AS1 said that these contract instructors were, in general, "ok." He thought that a couple of them were not so good, but that overall they did a thorough job.

Concerning three-engine ferry operations, this individual believed that airline management or other select flightcrews should be the only ones performing such takeoffs, and that they should be performed in day, VFR conditions. He characterized the maneuver as "non-routine...something not done everyday...a bad deal to ask line pilots to do things not normally done." He said that the DC-8-61 simulator at the United Training Center was not a good one in which to perform three-engine takeoff training. He thought that the model 61 simulator was not as realistic as the model 71 simulator.

This individual said that he did not have much contact with the ATI POI in Little Rock. He recalled that the POI requested help with checks, but not with other surveillance functions. He said that he would have responded to requests for additional oversight activities, but that he was not asked.

He believed that the FAA geographic program was a good idea, but that it was not being supported by the FAA upper management. He said that the number of inspectors assigned to this activity in Denver had declined nearly 50 percent in recent months, but that the number of airlines needing oversight activity, such as check rides, had not declined. He thought that the geographic program would "die." One of the problems with the geographic concept, in his opinion, was that some POIs were too sensitive or defensive when negative comments were made by the geographic inspectors about the POI's operators. It seemed to him that the geographic inspectors were gradually being reassigned to other duties and were not being replaced, and he believed that this was an error. He said that if the geographic program was diminished or eliminated, there would be a significant reduction in oversight for many types of operations. In his view, the program worked very well in the past, as long as it had the support of senior management. He thought that this support had been lost. He believed that some operators would not be adequately surveilled; specifically some of the "night freighters."

Geographic Unit Supervisor, Denver FSDO

This unit supervisor said that the geographic program was the "eyes and ears of the POI." He said the program was being "gutted, because inspectors were being reassigned to other functions and not replaced." His unit had lost about 19 ASIs. At the time of the interview, he only had one AS1 qualified in the DC-8. He believed that this severely restricted his ability to provide support to the POIs and the operators. There were no plans to add another AS1 to this activity. He thought that there would be increased risk of accidents and incidents when the geographic program faded out completely. This individual also believed that funding restrictions were hurting oversight functions.

Aviation Safety Inspector, Denver FSDO

This individual had been assigned to the FAA Training Center Program since October 1993. This duty involved monitoring the private training schools in the Denver area, such as the United Airlines Training Center. He said that ATI students were very well prepared, and that he was therefore favorably impressed with ATI training.

He stated that the FAA's geographic program was a good concept, but that it had been reduced and appeared to be phasing out. He said the problem with the geographic program mainly involved POIs being overly protective of their operators. They would often resent any reports from geographic inspector that reflected unfavorably on their operator. He pointed out that the geographic inspector did not have any strong allegiance to one carrier, so he could be more objective in evaluating. The geographic inspector was able to "call things as he saw them."

He said that he was the only DC-8-qualified inspector in the Denver area, and that he was "stretched too thin" to adequately perform all the requirements, even just for check rides, not to mention other duties. In addition, he saw this new Aircrew Program Manager duty as the "wave of the future...APMs in different locations."

TAB 6

	Accident	Type	Airport	Date/Time of Accident
1	DCA90MA030	passenger	UNK	6/2/90 9:37
2	DCA91MA010	passenger	DTW	12/3/90 13:46
3	DCA91MA021	cargo	CLE	2/17/91 0:19
4	DCA92MA022	passenger	TOL	2/15/92 3:27
5	DCA92MA025	passenger	LGA	3/22/92 21:35
6	DCA93MA040	passenger	DFW	4/14/93 6:59
7	DCA93RA060	cargo	GAO	8/18/93 16:56
8	DCA94MA022	cargo	HIB	12/1/93 19:50
9	DCA94MA038	passenger	LGA	3/2/94 17:58
10	DCA94MA065	passenger	CLT	7/2/94 18:51
11	DCA95MA006	passenger	RDU	12/13/94 18:34
12	SEA95FA170	passenger	RDD	8/3/95 15:35
13	DCA96MA008	passenger	BRW	11/12/95 0:56
14	DCA96 MA029	passenger	JFK	12/20/95 11:36
15	DCA96RA020	passenger	MIA	12/20/95 21:42
16	FTW96FA118	passenger	IAH	2/19/96 9:02
17	ATL96FA101	passenger	BNA	7/8/96 7:41
18	NYC96FA174	passenger	JFK	8/25/96 7:10
19	DCA96MA079	cargo	MEM	9/5/96 5:55
20	NYC97MA005	passenger	LGA	10/19/96 16:38
21	DCA97MA017	passenger	DTW	1/9/97 15:54
22	NYC97FA045	passenger	BGR	1/10/97 9:23
23	MIA97FA082	passenger	STT	2/8/97 19:30
24	DCA97MA055	cargo	EWR	7/31/97 1:31
25	DCA98MA023	passenger	COS	2/9/98 9:54
26	ANC98MA008	passenger	BRW	11/8/98 8:08
27	NYC99LA052	passenger	HYA	1/23/99 17:19
28	NYC99FA110	passenger	JFK	5/8/99 7:01
29	DCA99MA060	passenger	LIT	6/1/99 23:51
30	DCA00MA030	passenger	BUR	3/5/00 18:11
31	AAR0402	cargo	TLH	7/26/02 5:37
32	FTW03MA160	passenger	AMA	5/24/03 21:36
33	AAR0501	cargo	MEM	12/18/03 12:26
34	AAR0502	passenger	SJU	5/9/04 14:50
35	AAR0603	cargo	CVG	8/13/04 0:49
36	AAR0601	passenger	IRK	10/19/04 19:37
37	A04O0336	cargo	CYOO	12/10/04 22:00
38	AAR0706	passenger	LEX	8/27/06 6:06
39	AAR0801	passenger	CLE	2/18/07 15:06
40	AAR-0802	passenger	TVC	4/12/07 0:43
41	DEN07LA101	passenger	LAR	6/20/07 16:20
42	AAIU-200813	cargo	EBBR	5/25/08 11:31
43	DCAA09MA027	passenger	BUF	2/12/09 22:17

TAB 7

Date	LOC	Carrier	A/c	On Bd	Ftl	Ser	Description
4/12/2007	Traverse City	Pinnacle as NW Airlink	CRJ-200	52	0	0	At 0043 EDT, CRJ-200 from MSO to Traverse City overran on landing during snow. No injury 2 pilots, FA & 49 pax (including 3 lap babies). Substantial. T/O MSP at 2244 central. At 0020 eastern, crew was cleared for ILS 28 by ZMP. Traverse City tower had been closed since 2200 per normal operations. AWOS at 2353: light snow, visibility 1.5 miles, clouds at 900 & 1500, & winds from N/NE at 7. At 0030, visibility had dropped to half mile in snow, with indefinite ceiling & vertical visibility of 400 feet. Snow removal operations were in progress & flight crew communicated directly with airport operations about runway conditions. After landing, A/C overran departure end of runway 28 (6501 feet with paved blast pad 200 feet long beyond threshold). As A/C exited paved surface it was oriented 60 degrees left of runway heading & 30 feet left of center. A/C entered grassy snow-covered field beyond blast pad & nose gear separated 93 feet beyond end of pavement. A/C slewed right & came to rest 20 degrees left of center with right main gear sunk into ground 100 feet beyond pavement. Damage included separated nose gear, skin, frame, & pressurized bulkhead components near nose gear well. Main gear & wing were undamaged. Flaps were found in full down (45 degrees) position. Pax & crew exited by normal entry door/airstair.

5/8/1999	JFK	American Eagle	SF34	30	0	1	RVR went below minimums & crew was issued holding instructions. While flying toward holding fix, RVR increased. ATC specialist offered crew ILS approach, but advised that they might be too high. PIC accepted approach clearance nevertheless, & controller asked if crew would be able to make approach from their position. PIC said yes & continued entire approach with excessive altitude, airspeed, & rate of descent; while remaining above glide slope. This was contrary to company procedures, instrument approach procedure, FAR 91.175, & 4 audible GPWS warnings. During approach, FO failed to make required callouts, including missed approach callout. Landed 7,000 feet beyond approach end, at 157 knots, & overran. During interviews, both pilots said they were fatigued. Crew was working continuous duty overnight schedule. Previous day, they both awoke during morning hours, did not sleep during day, & reported for duty at 2200 for flight scheduled at 2246. Flight was delayed & arrived at BWI at 0100. They were asleep at 0130 & awoke at 0445 for accident flight, which was scheduled to depart at 0610. Substantial; pax serious; no injury 3 crew & 26 pax.
2/16/1995	KCI	ATI	DC-8-63	3	3	0	At 2027, crashed immediately after 3-engine T/O at KCI on ferry flight (for engine-out). Crew had shortened rest break; rest periods not required for ferry flights. Crew fatigued from lack of rest, sleep, & disrupted circadian rhythms. Crew did not have adequate, realistic training in 3-engine T/O techniques or procedures. Crew did not adequately understand 3-engine T/O, including significance of VMCG. FE improperly determined VMCG speed, resulting in value 9 knots too low. On first T/O attempt, PIC applied power to asymmetrical engine too soon, was unable to maintain directional control, & rejected T/O. PIC agreed to modify procedure by allowing FE to advance throttle, deviating from prescribed procedure. FAA oversight of operator was inadequate because POI & geographic inspectors were unable to effectively monitor domestic crew training & international operations. FAR 121 flight time limits & rest requirements that pertained to the flights that crew flew prior to ferry flights did not apply to ferry flights flown under Part 91. Current engine-out T/O procedures do not provide adequate rudder availability for correcting directional deviations to achieve max asymmetric thrust at appropriate speed greater than ground minimum control speed.

8/18/1993	GTMO	Konnie Kallita	DC-8	3	0	3	At 1656 stalled & crashed 1/4-mile short in visual approach at GTMO at night. Runway 10 was in use. Requested standard straight-in approach over water but minutes later decided to take runway 10, a demanding approach. Threshold was 0.75 miles East of Cuban airspace, designated by strobe light, mounted on Marine Corps guard tower at corner of Cuban border & shoreline. Strobe was out that day; neither tower or crew knew that. Flew approach from south, entered right turn for 10 with increasing bank angle in order to line up outside Cuban airspace. At 200-300 AGL, wings started to rock towards wings level & nose pitched up. Right wing stalled, A/C rolled to 90 degrees bank & nose pitched down. Struck level terrain 1400 feet west of threshold & 200 feet left of center. Crew on duty 18 hours, then chose very difficult approach that requires tight turns to avoid Cuban airspace (ATC had offered straight-in). All 3 crew serious including severed limbs. Crew had experienced disrupted carcadian rhythms & sleep loss; had been on duty 18 hours & had flown 9 hrs. PIC did not recognize deteriorating flight path & airspeed due to preoccupation with locating strobe light on ground. Strobe light, used as visual reference for approach, was inoperative; crew was not advised. Repeated callouts by FE stating slow airspeed went unheeded by PIC, who initiated turn from base to final at airspeed below Vref of 147 knots, & less than 1,000 feet from shoreline, & he allowed bank angles in excess of 50 degrees to develope. Stall warning stick shaker activated 7 seconds prior to impact, 5 seconds before A/C reached stall speed. No evidence to indicate PIC attempted corrective action at onset of stick shaker. Operator's management structure & philosophy were insufficient to maintain vigilant oversight & control of rapidly expanding airline.
10/19/2004	Kirksville	Corporate Airlines as American Connexion	BAE-32	15	13	2	At 1937 on LOC/DME final at Kirksville in IMC. Hit trees at 33 feet QFE on center line 1.3nm out. WX: wind 020 at 6, visibility 4, mist & 300 overcast. On final, PIC (PF) maintained constant descent of 1200 FPM until impact (per company SOP but exceeded that recommended by FAA for descent below 1000 AGL). At MDA, PIC said 'I can see ground there' (as PF, he should have been on instruments). Continued through MDA & asked FO 'what do you think?' FO: 'I can't see (expletive).' Seconds later PIC said 'yeah, there it is. Approach lights in sight' just as GPWS called “200” & FO announced 'in sight, continue'. (Both pilots looking out window; nobody on instruments). Never recognized low altitude until seeing trees 2 seconds before impact. Wx complicated approach but crew never seemed too concerned about wx. Flew approach in casual fashion & lack of professionalism: no sterile cockpit (casual conversation); non-standard phraseology; humming; etc. PIC known for sense of humor & was said to 'emphasize fun in the cockpit'. Crew was fatigued: reported for duty at 0514. Accident was near end of 6th sector on 'demanding' day in IMC. Crew had been on duty 14.5 hours & PIC is said to have slept poorly night before.

7/26/2002	TLH	FedEx	B737-300	3	0	3	At 0537 (night), A/C destroyed by impact & post impact fire when it undershot on visual approach to 09, striking trees along extended centreline 3,650 feet short. FO flying. Wx: calm, visibility 8, clouds few at 100 & scattered at 2500. On arrival at TLH, FO briefed for visual approach to 27. Minute later he asked PIC if they should use 09 instead. Some discussion followed but no decision. Ten 10 minutes later, SO asked pilots if they wanted to run approach checklist. FO again raised question of 09 vs 27 & crew decided on 09. Turned onto final 2.5 NM out. At this point PAPI would have indicated 1 white & 3 red (low). But A/C continued to descend below glide slope & was at 200 AGL at 0.9 miles out. PAPI would have shown 4 red. CVR shows no discussion about PAPI or altitude other than comment by FO that '(I'm) gonna have to stay just little bit higher... I'm gonna lose end of runway', to which PIC replied 'yeah... yeah, okay.' About 18 seconds later PIC commented 'it's startin' to disappear in there little bit (isn't) it? Think we'll be alright, yeah.' Then hit trees 11 seconds later. Crew believed they were on glide slope & showed no concern of undershooting. FO later said that 'from time I rolled out (on final), I saw that I was on glide slope... & it never changed.' Approach to 09 is over forest with no ground lights or other visual references (black hole), which can lead pilots to believe they are higher than they really are. Seems to have been case with this approach profile, but NTSB notes that PAPI should have prevented this trap. FO's first class medical noted he had color vision defect. After accident, he failed 7 red/green vision tests. Specialists' report found that he had severe congenital deuteranomaly that could result in 'difficulties interpreting red/green & white signal lights.' Report added that '... he would definitely have had problems discriminating PAPIs... because red lights would appear not to be red at all, ... more indistinguishable from white than red... it would be extremely unlikely that he would be capable of seeing even color pink on PAPI... more likely combination of whites & yellows & perhaps, not even that difference.' Performance of both pilots was deficient & below their usual standard during approach. NTSB believes this was due to fatigue. Besides back-of-clock, both pilots had difficulty getting adequate rest before flight. PIC said his sleep 2 days before had 'not really (been) good' or had been 'marginal' because he kept being awoken by family dog. FO said he had difficulty adjusting his sleep cycle & implied he did not sleep well during day. Friend described FO as looking tired & PIC commented on crew bus that he 'might be little tired.'

2/12/2009	BUF	Colgan Air	DHC-8-Q400	49	50	0	At 2217 Dash 8-Q400 by Colgan Air as Continental Connection crashed on ILS approach to runway 23 at BUF 5 NM NE of airport in Clarence Center. FO arrived EWR on red-eye from West Coast via MEM at 0623. First flight @ 1300 cancelled. Accident flight delayed; T/O EWR at 2120. Newly upgraded PIC (110 hours in M/M); FO (PF) had 700 hours in type. Steady chatter enroute. FO notes little knowledge of icing. Other pilots describe light-moderate rime icing b/ 6,500 & 3,500 but none at 2,300. Accident A/C was in icing about 9 minutes. De-icing system was "on." Cleared to descend & maintain 2,300. Had been bleeding off airspeed & 20 knots slow. A/P disengaged; A/C stalled in turn & crashed into home in dense residential area, 45 degrees wing low, 30 degrees nose low, & little forward speed. Ground fire confined to one house. All 4 crew & 45 pax fatal; 1 ground fatal. Night VMC but crew spoke of icing on CVR, though no other crews reported icing. (Not an icing accident.)

2/18/2007	CLE	Shuttle America	ERJ-170	74	0	0	At 1506 ERJ-170 by Shuttle America as Delta Connection overrun 28 (6017 x 150) on landing at CLE. A/C struck localizer antenna & fence & came to rest 150 feet off end of runway. No injury 2 pilots, 2 FA & 70 pax. IMC. T/O ATL at 1331. FO (PF) was cleared for ILS 24R approach. Ten minutes before landing, ATC changed landing runway to 28 & crew was advised that RVR was 6000 & braking action fair. After passing FAF, crew was told RVR had decreased to 2000 feet. PIC said he had approach lights in sight & at 50 feet AGL he had runway in sight. FO then turned off autopilot to land. PIC said that, at 30 AGL, he momentarily lost sight of runway, then regained runway & A/C landed. PIC added that they encountered strong gusty winds during flare & after touchdown they could barely see runway lights & taxiway turn-offs. Used full reverse & braking but A/C did not seem to slow down & ran off into snow-covered grass where nose gear collapsed. Crew & pax deplaned by ladder with help from fire department. Glideslope for ILS 28 was unusable at time due to snow banks from several feet of snow fall (record snows in CLE). Crew said ATC had advised them of this when they were cleared for approach to runway 28. WX at CLE at 1456: wind 300 at 16, visibility 1/4 mile, heavy snow, broken at 600 & 1500, overcast at 4100; temp/dew -7/-11C. WX at 1517: wind 330 at 13 gusting to 19, visibility 1/4 mile, heavy snow, broken at 300 & 1000, overcast at 1500, temp/dew -8/-11C.
4/29/1993	Pine Bluff	Cont Exp	EMB-120	30	0	0	In IMC with freezing level near 11,500 & cloud tops to 21,000 with potential for icing to 19,000. FA entered cockpit & suggested faster climb so she could begin cabin service. Autoflight set in pitch & heading modes, contrary to company policy. PIC & FA in unrelated conversation for 4.5 minutes as FO entered log data. Then stalled passing thru 17,400. Into inverted spin; recovered at 6,700 when FO lowered gear--drag. Then stalled again at 5,500 due to improper recovery. Left prop shed 3 blades & cowling separated. Shut down left engine on descent & could not maintain level flight. Diverted to Pine Bluff. Landed hot on wet runway closed for construction; acquaplaned into field. Crew had little sleep in 3-day tour, though rest periods were available.

8/27/2007	LEX	Comair	CRJ-200	50	49	1	At 0607 Comair 5191 crashed on T/O from Blue Grass Airport (LEX) for ATL. A/C ran off end of Runway 26 & was destroyed by impact forces & post crash fire. T/O wrong runway; had been cleared to T/O on Runway 22. PIC, FA & all 47 pax fatal; FO serious. Threshold for 22 & 26 are close & common taxiway had construction near thresholds, possibly inviting confusion in darkness after short taxi from nearby terminal. Also, sole controller in tower turned away after clearing A/C for T/O (A/C was the only active A/C on the airport). Runway 22 had minor construction work underway preceding week with NOTAM for "some" lights out. Crew also appeared behind the curve early: approached the wrong RJ on ramp (corrected by ramp personnel); called Toledo tower rather than LEX (corrected by tower); called wrong flight number (corrected by tower); & vocally ran through checklist on taxi so quickly NTSB had to slow CVR read-out equipment to understand it. Crew also taxied through onto darkened, closed short runway (26). Initiated rolling T/O, further reducing chance to recognize wrong runway), crossed intersection with lighted 7000-foot Runway 22 500 feet from start of rolling T/O, continued & rotated just as they ran out of pavement. Ran onto grass & nose lifted slightly (with main gear tracks deepening in grass) just as A/C struck perimeter fence, then rolled at high speed into trees & burned out. PIC, FA & 47 pax fatal; FO serious. CAUSE: crew's failure to use available cues & aids to identify A/C's location on airport surface during taxi & their failure to cross-check & verify that A/C was on correct runway before T/O. Factors: crew's nonpertinent conversation during taxi, which resulted in loss of positional awareness, & FAA's failure to require that all runway crossings be authorized only by specific ATC clearances.

12/20/1995	Cali	American	B757	164	160	4	At 2138 CFIT at 9000; peak at 9190. Night VOR/DME approach from MIA; 2 hrs late. PIC concerned to get cabin crew on ground to meet AAL rules on cabin crew rest (for next day return flight). Cali in long no-so valley; high terrain west & east. Cleared to Cali VOR; readback "cleared direct," entered "direct;" way points go off display. Later cleared to interim Tulua VOR; unsure of location. Fumble with charts & Tulua ID -- already past Tulua. Aircraft began turning back to Tulua; PIC overrode. Then ATC offers direct approach from north (was 01; now 19). Rushed to get down. Put in single-letter ID for ROSO, but Colombia has 2 navaids with single-letter "R." Per ICAO, software defaults to "R" with more traffic (well north at Romeo VOR--Bogota); had to punch in all 4 letters for ROSO. Again A/C began turning back. Crew very confused. FO (PF): "where are we?" PIC says go So/SoE -- east of valley, 13 miles off course & below terrain. Now more confused; reading DME to ROMEO, not ROSO. Stepped down early, configured to land as GPWS sounds. Pulled up but did not retract spoilers; slow climb (184 kts at impact). Hit east slope nose up, skidded over top & down west side. Both pilots, 6 FA & 152 pax fatal; 4 pax serious.
2/17/1991	CLE	Emery	DC-9-15	2	2	0	At 0018 landed after 40 minutes in icing & sat in snow for 35-minute turn at CLE; never inspected for ice. Stalled on t/o; crashed & burned. Neither pilot trained in wing contamination. FAA a causal factor as it was "aware for several years of this DC-9 (& 10) series' [vulnerability] to loss of control by wing contamination, but [no] positive action."

6/20/2007	Laramie	Great Lakes	BE-1900	11	0	0	At 1620 BE-1900D substantial when right prop struck electrical box during high speed turn-off after landing at Laramie Regional, IFR in VMC from Worland, WY. No injury to 2 pilots & 9 pax. Broke 4 blades. Airport manager said A/C landed long & bounced on runway 12 (6300 x 100 dry asphalt). Crew tried to slow A/C but turned onto taxiway at high speed. Right prop struck top of electrical box that powers approach lighting system. Prop blade then broke off & struck right side of fuselage. WX at 1553: winds variable at 5 gusting 22; clear, visibility 10, temp/dew 84/23F. WX at LAR at 1653: wind at 3 knots, clear, visibility 10, temp/dew 82/22F. No anomalies.
6/1/1999	Little Rock	American	MD-82	145	11	45	At 2350 hot & very long in severe wind & T-storm. Controler readout wx all the way on downwind & base leg w/o crew requesting it (indirectly suggesting it was high-risk). Winds then reported gusting to 48 knots; kept coming. CVR shows crew noting they would touch down just as front crossed runway. They were right. Winds reached 78 knots & shifted to quartering tailwind. Overran into stanchions; broke up & fire; burnt out. Most survivors exited from broken A/C. 10 pax & PIC fatal; 41 pax, 3 FA & FO serious; 64 pax & FA minor.

1/22/1999	Hyannis	Colgan Air (Part 91)	BE-1900	4	0	0	At 1719 (dusk), BE-1900 on positioning flight with 2 pilots & 2 company pax with 100-foot ceiling in fog, PIC of Beech 1900D had performed 2 missed approaches to HYA. On third approach, both PIC & FO visually acquired runway. FO said PIC lined up with centerline & requested flaps. FO said A/C floated at 20 feet over runway at normal transition when I heard PIC taking power levers over flight idle gate' by sound of engine/props.' This placed prop in 'BETA' range. A/C then started to sink, & PIC pulled back on control yoke. Main gear struck ground & fractured during +2.9G touchdown, which occurred 2500 feet beyond approach end of 5,252 foot runway. Ran off right side of runway, 4700 feet beyond approach end & stopped. To place throttles in BETA, it was necessary to lift power levers over flight idle stop. Flight manual included warning: 'Do not lift power levers in flight.' On day of accident, PIC had reported for duty at 0535, with first departure from HYA at 0620. He returned to HYA at 0920, after 3 flights & 2:31 flight time. Then with different FO, PIC T/O for Boston at 1100. They flew 5 more flights for 3:53 flight hours, then returned to BOS at 1540. CAUSE: PIC's improper placement of power levers in BETA position while inflight. Factors: fog & dusk conditions.
8/25/1996	JFK	TWA	L1011	262	0	0	Tailstrike on landing. At 0710, on last trip of 3-day tour, crew received vectors for ILS 4R approach. Before reaching FAF, visibility went below minimums for 4R & crew was offered ILS to 4L, which was still above minimums. PIC accepted & FO (PF) transitioned to 4L. On final, A/C passed thru 500 AGL at 151 KCAS with throttles near idle. Continued decelerating to Vref speed. During computer-driven, auto-land flare, nose rotated up, & tail struck runway. TWA's SOPs required go-around unless approach was stabilized at 500. Crew said all checklists had been completed but charts for 4L were not reviewed, crew did not remember making required call outs, & altimeter bugs remained set for 4R. FDR showed wing leading edge slats had not extended with flaps. Green light on PIC's panel & 14 green lights & gauge on F/E's panel were not used to verify slat extension. TWA's expanded landing checklist did not require F/E to use gauge to verify slat extension. TWA manuals did not list possibility of "slat lock," which would not activate any warning lights or aural warnings. Maintenance records showed slats had locked 12 times in preceding 2 years. Inspection methods from Lockheed & adopted by TWA did not adequately specify how to check slat drive system for slack. No injury PIC, FO, F/E, 9 FA & 250 pax.

7/2/1994	CLT	US Air	MD-82	57	37	16	At 0057, in heavy rain & low vis, descended thru 200 AGL 0.6 miles out & tried go-around. Retracted flaps from 40 to 15 & into right turn to avoid wx over runway. Climbed to 350 AGL, then "severe sink rate." Went max power, but continued sink; hit power lines & trees 0.5 miles out & 0.2 miles right in 5-d right bank & 5-d nose-up. Broke up & caught fire. Daylight (1843), but heavy t-storm & gusts. ATC gave windshear alert on approach from LLWAS 2000 feet from runway, but pilot may not have heard. Non-standard brief for the ILS approach by FO (PF) – skipped field elevation, FAF altitude, DH, and MAP altitudes. Non-standard go-around (right turn instead of following runway heading). When FO pitched up 15 degrees (max for normal go-around in POH) & 17-degree right bank, PIC called "down, push it down.' (went from 15 nose-up to 5 nose-down) Three seconds later, PIC responded to ATC & said they were climbing to 3000 & on runway heading; wrong. Within 6 seconds, got GPWS warning, stick shaker & impact. (did not recognize they were so close to ground). (37 pax fatal, 14 pax & 2 FA serious, 1 pax, FA & 2 pilots minor). Lap-baby fatal (lone aft fatality) & second of 2 lap-babies on board serious, also aft.

4/14/1993	DFW	American	DC-10	202	0	2	Requested landing to north due to t-storms & turbulence. Had accurate wx before T/O from HNL. Received accurate updates in flight. Crew never discussed wx. Only indirect reference was on approach when crew discussed cells painted on radar. Heavy rain; winds 25 gusting 40. Crew requested landing to north. ATC requested landing to south. PIC agreed. FO (PF) on approach, suggested go-around at 50 AGL & A/C in 10-degree crab. PIC said "no, no; I got it, I got it." PIC took control, landed 17L strong cross wind, began to weathervane. PIC mismanaged reverse thrust & failed to use sufficient rudder control to regain proper ground track. Fractured nose gear, left main gear & left engine mount; 2 pax serious in evac (one broken neck); 35 pax, PIC & FA minor. T/O HNL at 17:53L for 7-hour flight to DFW. WX report to crew at 06:44 (15 minutes before landing) stated: ceiling 1400 overcast, 2.5 miles visibility, thunderstorms & rain showers.

2/15/1992	Swanton, OH	ATI	DC-8-63	4	4	0	At 0326 FO had made 2 ILS approaches in night fog, rain & high wind. Failed to capture LOC or glideslope in 35-kt X-wind. On 2 approach, got 3 GPWS & sink-rate warnings. PIC took control & made 2nd missed approach but became spatially disoriented on 3rd approach. Got into unusual attitude of up to 80 degrees bank & pitch of 25 deg. FO took control & began leveling wings & raising nose, but impacted before recovery. Operability of PIC's attitude director indicator is uncertain. Crashed about 14 miles west of airport.
12/16/2004	Oshwawa, Canada	Air Cargo Carriers	SD-360	2	0	0	Overran runway 30 on landing at Oshawa Airport, Ontario, Canada. Substantial; 2 crew minor. WX included ceiling of 100-300 overcast, half-mile visibility & wind from 230 at 15. At 2000, FO from TOL to Ottowa, was cleared for localizer backcourse Runway 30 approach. Crew received vectors & then cleared for straight-in approach but FO had difficulty maintaining backcourse localizer, & PIC took control 3 to 4 miles out. While descending, crew selected 15º of flap & maintained VREF + 10 (110 KIAS). At 440 feet AGL, crew saw runway edge lights to right. PIC realigned to runway centreline & continued approach. Landed 1/3 of way down runway. After touchdown, PIC selected full reverse. He noted rate of deceleration was slower than expected & runway end approaching. After 5 to 8 seconds of full-reverse, he called for go-around, & power levers were advanced to TOGA. With little runway remaining & without referencing airspeed indicator, PIC rotated but at end of runway, descended & tail struck airport perimeter fence. A/C flew over marshy area,gear struck rising, hill, & A/C then struck line of forestation, coming to abrupt stop between 2 cedar trees.

8/13/2004	CVG	Air Tahoma	CV-580	2	1	1	At 0049 CV-580 crashed 1 mile south of CVG on approach to 36R. Destroyed by impact. FO fatal, PIC minor. Tahoma Air operating round-robin cargo flight for DHL from MEM-CVG-MEM. T/O MEM at 2329, FO as PF. CVR shows PIC saying he would "balance out fuel here." FO acknowledged. From 0026:30 to 0027:08, PIC discussed weight & balance with FO & stated later that he "couldn't figure out why on landing I was out [of C/G] & I was okay on T/O." He added that "the momentum is 1-6-6-7 & I...put 1-0-6-7 & I couldn't work it," . . . so we were okay all along." (Point is, he had input incorrect data before T/O & thought he was out of C/G - - so why did he T/O? Later figured out his mistake in flight & recognized he was in C/G at T/O - - right outcome for the wrong reasons). At 0030:40, FO stated, "weird." At 0032:31, PIC stated, "okay just let me finish this [weight & balance paperwork]. Two minutes later, he stated, "okay, back with you here." At 0037:08, PIC contacted TRACON & reported 11,000 MSL & FO again stated, "something's messed up with this thing, . . . why is this thing..?" At 0041:21, FO said control wheel felt "funny. Feels like I need lot of force. It is pushing right for some reason. I don't know why...I don't know what's going on." FO then repeated twice that it felt like he needed "a lot of force." PIC did not respond. At 0043:53 at 4000 MSL, PIC advised TRACON "runway in sight" & cleared for visual to 36R. Then FO says sucker is acting so funny." PIC replied, "we'll do full control check on ground." At 004:20 tower cleared him to land. Then as A/C passed through 3200, airspeed began to decrease from 240 KIAS. At 0045:37, at 3000, PIC started in-range checklist. Fo then again: "What is wrong with this plane? It is really funny. I got something all messed up here." PIC replied, "yeah." FO then asked, "can you feel it? it's like swinging back & forth." PIC replied, "We've got an imbalance on this...cross-feed; I left it open." (SOP prohibits cross-feed with valve open.) FO responded, "oh, is that what it is?" Then FO: "we're gonna flame out." PIC responded, "I got cross-feed open. Just keep power on." At 0046:45, CVR recorded decreasing engine RPM. Immediately FO stated, "we're losing power." At 0046:52, FO stated, "we've lost both of them" as A/C was descending at 900 FPM. PIC then advised tower of "engine problem" & impacted at 0049. n of in-range checklist, & crew's failure to monitor fuel gauges & to recognize A/C's changing handling characteristics were caused by fuel imbalance.
7/31/1997	EWR	FedEx	MD-11	4	0	0	At 0130 FedEx MD-11 from ANC crashed on landing on 22R. Destroyed; minor injuries to 5 crew. A/C touched down 1175 feet down runway 22R at 149 knots with 500 FPM descent rate & 1.67g acceleration. A/C bounced, went airborne 8 seconds, yawed & rolled right, & touched down again 2275 feet from threshold, at 1.7g (lateral acceleration 0.4g to right) & dragging #3 engine 238 feet further on. Right roll continued, pinning #3 engine to ground, until right wing's spars broke. MD-11 skidded off right side & ended up on its back 4800 feet from threshold & just short of Terminal B. All 3 engines separated on inverted roll; other parts shed on way; occupants exited thru PIC window. VMC, winds from 260 at 7; landing 22L Landing at descent rate of 500'/min, within design limits. Destroyed by fire. Same A/C (N611FE) had suffered similar incident (bounced on landing) at ANC on 11/4/94.

11/12/1995	BDL	American	MD-83	78	0	0	CFIT at 0057. DEN-ORD-BDL; 2.5 hours late. Initial descent in very heavy night rain. Advised of low level shear & turbulence; also got ATIS. Tower closed for water intake & blown out windows. Used Runway 15 due to crosswinds--VOR/DME only; intercepted approach course at 3500 MSL 10 miles out, configured to land--flaps 40 & gear down. Descended & levelled off at 2000--FAF crossing. Began descent to MDA (908 AGL). FO called MDA & saw base of clouds (below MDA); then "loud report" thought to be turbulence--had hit tree tops on ridge; took out top 20 feet of trees for 200 yards. Pulled flaps back for go-around & "fire-walled" throttles. Lost power in left & partly in right. Aborted go-around. Lowered gear & 40 flaps to balloon; hit ILS antenna at approach end & bounced onto runway. Substantial damage but no serious injuries. On 11/10, crew reported to DCA for 3-day flight sequence. T/O DCA at 1800, flew 3 segments (to BNA, ORD & DEN). Arrived at DEN at 0310 EDT, after 10 hours & 25 minutes of duty time, with 5:53 actual flight time. Due to late arrival in DEN, regularly scheduled layover of 15 hours & 18 minutes was reduced to 13:35 (still over proposed minimum of 10 hours, but very much back-side of-clock & unclear when they reached hotel). Next day, crew left hotel for check-in time of 1700 EDT at DEN. But inbound A/C was late. Delayed departure at DEN & arrived 23 minutes late to ORD at 2047 EDT. Wx then led to another 2-hour delay leaving ORD for BDL. Departed gate at ORD at 2125 EDT. En route, crew received several ACARS messages about conditions at BDL, including "PRESFR" (pressure falling rapidly). On descent, ACARS message cited altimeter of 29.23 inches, indicating QFE. Subsequent message cited 29.42, causing standby altimeter to indicate MSL (use of QNH vs. QFE). At 0031, ACARS also indicated turbulence & windshear on approach. Crew got ATIS, but it was 90 minutes old; tower had closed due to windows having been blown out; staffed only by a lone supervisor. PIC says that at 15 miles out & wx radar on 20-mile radius, he painted no wx & turned radar off. But encountered turbulence & "very heavy rain" approaching FAF.

CAUSE	Comments	Likelihood of Rule's Avoiding Accident	Score x Fatals	Score x Serious
CAUSE: pilots' decision to land at Traverse City without performing landing distance assessment, which was required by company policy because of runway contamination initially reported by TVC ground operations & continuing reports of deteriorating wx & runway conditions during approach. Poor decision-making likely reflected fatigue produced by long, demanding duty day &, for PIC, duties associated with check airman functions. Factors: FAA flight & duty time regulations that permitted pilots' long, demanding duty day; (2) TVC operations supervisor's use of ambiguous & unspecific radio phraseology in providing runway braking information.	On 4/6, PIC & FO completed 2-day OE training trip in MSP, then PIC flew home to Pensacola (PNS) on 4/7. Sleep was interrupted at night by new baby. PIC was scheduled for 3-day trip on 4/7. He awoke at 0305 on 4/10, performed checkride on flight from PNS to MEM (PIC's base), then did PIC line training on MEM-MSP flight. At MSP, PIC learned that scheduling office had assigned him flight extension (i.e., round trip to SDF), then another PIC was assigned in his place. PIC returned to crew lounge & at 1645 he met accident FO for dinner. PIC said he drank alcohol with dinner but, consistent with company requirements, ceased consumption at least 12 hours before scheduled reporting time. Went to hotel at 2200 to 2230 & slept soundly. On 4/11 PIC awoke at 0700. FO had been visiting relatives in SAN. On 4/9, went to bed at 2200 & awoke about 0415 to commute to MSP. Arrived "mid-day," met PIC, had dinner; went to bed 2200 & awoke 0630. Crew had breakfast & took early shuttle (0800) to airport due to bad wx & local traffic. Checked in at 0900. Trip sequence began with MSP-CLE-MSP, with 28-minute turnaround at CLE, then 1:41 layover at MSP, where crew ate lunch at airport fast food outlet. Then flew MSP-DSM-MSP, with 22-minute turnaround at DSM, then 30-minute turnaround at MSP before departure for TVC. PIC added that it was snowing & windy in MSP all day & trip sequence had made them work. FO had flown both out-bound trips from MSP & PIC flew both returns into snow & "difficult crosswinds." Arrived MSP 15 minutes late & crew was advised flight to TVC was delayed & would likely be canceled due to forecast tailwinds at TVC exceeding CRJ's 10-knot tailwind component limit. Uncertainty continued with "rolling delay." He & FO had time only for beverage at MSP. Then at 2044, new wx report brought tailwind within limits & flight was dispatched. But delay required FMS update & finally pushed back at 2144 & T/O 2153 (already 13-hour duty day & 15-15.5 hours awake.) En route, CVR recorded several instances in which pilots indicated they were tired (at 2332, PIC said "yeah, just tired. Too late for this" & at 2342, PIC said "aw I'm tired dude, just (expletive) worn out;" & at 0018:43 "a wet dog ready to go to sleep tonight." Similar comments from FO & several yawns recorded. (Awake 18 hours, delays, demanding wx, limited food, tough combination). Crew was on duty 15 hours as of accident time & 12;44 hours at pushback; NPRM would have precluded this crew from taking this flight.	0.9	0	0

CAUSE: PIC's failure to perform missed approach as required by company procedures. Factors: PIC's improper in-flight decisions, failure to comply with FARs & company procedures, inadequate crew coordination, & fatigue.	Crew was working continuous-duty overnight schedule. Previous day, they both awoke during morning hours, did not sleep during day, & reported for duty at 2200 for flight scheduled at 2246. Flight was delayed & arrived at BWI at 0100. They were asleep at 0130 & awoke at 0445 for accident flight, which was scheduled to depart at 0610. This crew had just over 3 hours of sleep after a long preceding day. Accident flight was the first segment for day 2, early in the morning, & the crew did little right on the approach or preceding the approach. NPRM requires minimum 9 or 13 hours, depending on definition of 'night.' Under NPRM, this crew would have required several more hours rest period; another crew would have taken flight..	0.9	0	0.9
CAUSE: LOC on T/O roll, PIC's decision to continue T/O & rotate below computed rotation airspeed, resulting in premature liftoff, subsequent LOC, & collision with the terrain; crew's lack of understanding of 3-engine T/O, their decision to modify those procedures, & company's failure to ensure that crew had adequate experience, training, & rest for nonroutine flight. Factors: inadequacy of FAA oversight of ATI & FAA flight & duty time regs that permitted substantially reduced crew rest period for nonrevenue ferry flight.	Just before their assignment to accident trip, crew had completed demanding round-trip to Europe that also was potentially stressful international line check for PIC. Both flights crossed 6 time zones between Dover & Ramstein, plus Dover-Ramstein-Gander-Dover legs were flown at night after daytime rest periods (causing "circadian rhythm disruption"). Also, PIC's last rest period prior to accident was repeatedly interrupted by phone calls from company; longest uninterrupted period was 4:47 hours. Then crew checked out of hotel after 12 hours in Dover to take ferry flight. "Therefore, NTSB believes that [PIC] was experiencing fatigue at time of accident." All 3 crew performed poorly & all 3 likely were fatigued, per NTSB, & all 3 exhibited "performance degradation" symptomatic of fatigue (difficulties in setting proper priorities & continuation of T/O attempt despite disagreement & confusion on important issues). NTSB "therefore concludes that crewmembers were not properly rested." Fatigue was a significant player here; scoring can be reduced only due to crew's inadequate training & knowledge of 3-engine T/O. Crew could not legally have flown revenue trip at that time. New rule would have directly addressed many of these issues, albeit not the issues of training or geographically compromised oversight.	0.9	2.7	0

CAUSE: impaired judgement, decision-making, & flying abilities of PIC & crew due to fatigue; PIC's failure to properly assess conditions; loss of situational awareness while maneuvering onto final; failure to prevent loss of airspeed & avoid stall while in steep bank turn; & failure to execute immediate action to recover from stall. Factors; inadequacy of part 121 flight & duty time regulations, supplemental air carrier, international operations, & circumstances that led to extended flight/duty hours & fatigue; inadequate CRM training & inadequate training & guidance by carrier for crew on operations at special airports, such as GTMO; & Navy's failure to provide system that would assure that local tower controller was aware of inoperative strobe light so as to advise crew.	PIC had week off & FO had week off then 4 days training & 3 days off. Trip on 8/16 started at 2300 in ATL & ended at noon on 8/24 at DFW, with 5.6 flight hours. PIC slept from 1300 to 1800, went jogging & had supper, then reported for duty. FO ate “large breakfast” & then slept to 2200. Crew reported for duty at 2300, T/O DFW & landed YIP at 0408. Had 3-hour layover. Ate breakfast with other crews. FO rested in his seat in A/C for 30-60 minutes; PIC did not rest. Met by new FE who had 16 days off, though his sleep was interupted at 0500 by scheduler. T/O YIP at 0620 & landed ATL at 0752. PIC & FO had been on duty 13 hours. FE had layover hotel while PIC & FO planned to go home to sleep. At 0830, before crew left airport, chief scheduler found GTMO flight needed crew & was told “no legal problem” as it was “international flight.” Scheduler determined crew could reposition to Norfolk Naval Base (NGU) pick up A/C, fly to GTMO, then ferry under Part 91 to ATL, & remain just within company 24-hour duty limit. Crew discussed timing & agreed to take trip, though “it was pushing the edge.” At time of accident, PIC & FO had been awake about 24 hours & on duty 22 hours. After such a long day, crew was offered standard straight-in approach over ocean but inexplicably chose very demanding approach in darkness with no strobes.FE had said he got a rush on approach like they were shooting approach to aircraft carrier but FE noted that he was “tired & lethargic” as A/C approached airport & he “believed that the other 2 crew members were fatigued.” NPRM duty-day limits between rest periods would have precluded this crew from taking this flight. NPRM would count Part 91 time.	0.9	0	2.7
CAUSE: failure to follow procedures & improper non-precision instrument approach at night in IMC, including descent below MDA before acquiring runway environment. Factors: non-standard callouts; unprofessional demeanor; & crew fatigue.	Crew had been on duty 14.5 hours & PIC is said to have slept poorly night before. PIC commuted from home in NJ to STL & FO commuted from Ohio. Reported for duty at 1345 on 10/17 (2 days before accident). Flew 3 flights in 8-hour duty day & arrived at over-night destination (Quincy) at 2125. On 10/18, departed Quincy at 1415 after more than 15 hours off. Flew 3 flights & 6:20 duty day. Arrived at over-night destination in Burlington at 1945. On 10/19, duty day began at 0514 after 9 hours off. Departed BRL at 0544 to STL & arrived 0644. Next 2 flights cancelled due to wx. T/O for round-trip from STL-Kirksville (IRK) at 1236. Landed STL at 1745. Accident flight departed STL at 1842 for IRK on 6th flight of day with 6:14 flight time & 14.5-hour day already. Long, brutal day in IMC that started with limited rest period. Crew was familiar with each other & with IRK. WX & PIC's established practive of "fun in the cockpit" also were factors, but fatigue had to be a big player. NPRM could have precluded this crew from taking this flight.	0.75	9.75	1.5

CAUSE: crew’s failure to establish & maintain proper glidepath in night visual approach. Factors: combination of crew fatigue, failure to adhere to SOPs, FO's color vision deficiency & PIC & FO's failure to monitor approach. 3 crew serious	Performance of both pilots was deficient & below their usual standard during approach. NTSB believes this was due to fatigue. Besides back-of-clock, both pilots had difficulty getting adequate rest before flight. PIC said his sleep 2 days before had 'not really (been) good' or had been 'marginal' because he kept being woken by family dog. FO said he had difficulty adjusting his sleep cycle & inferred he did not sleep well during day. Friend described FO as looking tired & PIC commented on same bus that he 'might be little tired.' Even with color-blindness, causal statement justifies concluding that a better rested crew may have avoided the whole scenario early-on in the approach. But unsure exactly how NPRM would have addressed this case, since rest periods were reasonable (even if not well managed) and the accident occurred during a visual approach over a black hole with a color-blind pilot trying to use a PAPI. The strongest argument for fatigue must rely on the notion that a better rested crew might have monitored the glide slope better and/or might have run a more disciplined checklist & pre-landing brief, or that better rested PIC might have chosen the more common instrument approach to 27.	0.75	0	2.25

CAUSE: Captain’s inappropriate response to activation of stick shaker, which led to stall from which A/C did not recover. Factors: (1) crew’s failure to monitor airspeed in relation to rising position of lowspeed cue, (2) crew’s failure to adhere to sterile cockpit procedures, (3) PIC’s failure to effectively manage flight, & (4) Colgan’s inadequate procedures for airspeed selection & management during approaches in icing conditions. NOTE: NTSB Cited fatigue in findings, but not in causal statement because NTSB said it could not determine “the extent of their impairment & degree to which it contributed to performance deficiencies.” But clearly suggests it did contribute. NOTE: NTSB was divided on the issue, with some arguing that the overwhelming issue was skills-based: pulling up to 30 degrees, not pushing power up all the way even well into the stall, and thereby missing several opportunities to allow the aircraft to fly out of the stall. In short, debate is this: though the crew clearly was fatigued, would the outcome have been any different if the same crew were better rested?	Both pilots likely were significantly impaired due to fatigue. Both based at EWR. PIC lived near Tampa & FO lived near Seattle. Neither had “crash pad” at EWR & both regularly used crew room to sleep. PIC tried to bid trips that ensured some nights in hotels at out-stations. At EWR he usually slept in crew room. FO always slept in crew room at EWR & was open about it. PIC, recently upgraded, commuted to EWR on 2/9 from TPA; arrived EWR at 2005 & spent night in crew room. Phone records & log-ins to crew tracking system indicate he got little sleep. Reported for duty at 0530 on 2/10, flew 3 flights & arrived at BUF at 1300 & had hotel room. Left hotel at 0515 on 2/11 to report at 0615. Again flew 3 flights & returned to EWR at 1544; spent rest of day & night in crew room. Again, phone, tracking system & contact with others indicate very little sleep. FO commuted to EWR from SEA. She awoke on 2/11/ at 0900, arrived at PDX at 1730 for FedEx flight to MEM; arrived MEM at 0230 EST (2230 PST); had about 90 minutes of sleep on flight. She then T/O MEM at 0418 & arrived EWR at 0623, sleeping for “much of” 2-hour flight. At EWR, she spent day in crew room & napped, but phone, tracking system & conversations show she got little sleep. On 2/12, crew was scheduled for 3 flights: EWR-ROC; ROC-EWR; and EWR-BUF. First 2 cancelled due to winds at EWR & ground delays. Dispatch estimated departure at 1910 for accident flight. Multiple delays; pushed back at 1945 & finally T/O 2120 for BUF. FO noted multiple times that she was not feeling well & before T/O said she was “ready to be at the hotel” at BUF. Accident had many issues, but fatigue clearly was one of them. Both pilots had to be exhausted when they initiated approach to BUF. PIC was completing 4th day since awakening on 2/ 9. He had opportunity for quality sleep only on night of 2/10, & that was cut short with departure from hotel at 0515 on 2/11. Both pilots essentially stayed up all night on 2/11, with no opportunities for deep sleep, then found themselves operating late-night flight after day-long cancellations & delays. At one level, any rule that might have diminished this crew's fatigue could have been a show-stopper with a very high score. However, crew had other basic problenms. PIC clearly was not well versed in stall recognition nor response to stall (never went to full power, which very likely would have enabled the aircraft to fly out of the stall in at least 2 points during the sequence. Same lack of recognition & knowledge appears true of FO; she raised flaps during a stall. Being well rested would not have provided this crew with any more skill than they already had, nor would it necessarily have averted the chatter sustained throught flight, nor would it necessarily have led crew to enter proper ref speeds for conditions. BUT more rest may have at least kept them tuned in enough to monitor airspeed. That alone could have averted the entire scenario, or perhaps they could have avoided just one of the above issues, which also would have helped significantly. However, too many other fundamental issues to score above 50%.	0.5	25	0

CAUSE: failure to execute a missed approach when visual cues for runway were not distinct & identifiable. Factors: (1) crew's decision to descend to ILS DH instead of localizer (glideslope out) MDA; (2) FO's long landing on short, contaminated runway & crew's failure to use reverse thrust & braking to max effectiveness; (3) PIC's fatigue, which affected his ability to effectively plan for & monitor approach; & (4) carrier's failure to administer attendance policy that permitted crew to call in as fatigued without fear of reprisals.	On accident day, PIC commuted from SDF to ATL to report for 2-day trip. PIC was scheduled to report to SDF at 0525, & flight to ATL had scheduled arrival at 0733. First leg, from ATL to Sarasota-Bradenton (SRQ) was delayed for wx. T/O ATL at 1242. Third leg, (accident flight) T/O on time with new FO from ATL at 1305 & had ETA at CLE of 1451 (first pairing for this crew), so SOP required PIC to fly this leg but PIC said he got just 1 hour of sleep night before, so he asked FO to be PF. FO later said his unstated preference was not to be PF, as he had just completed 3-day, 6-leg trips but he agreed to be PF since PIC's references to fatigue & lack of sleep. In fact CVR captures PIC saying [I am] "so tired … had about an hours sleep last night. I just tossed & turned." (If crew were better rested, presumably a higher performing PIC would have flown leg.) May have (or not) led to go-around but unlikely would have changed confusion over glideslope & ILS DH versus localizer MDA. NPRM would have enabled PIC to opt out of flight. Can't say 75% or 90% effectiveness, because unclear exactly what PIC would have done even with NPRM, but may have opted out.	0.5	0	0
CAUSE: PIC's failure to maintain professional cockpit discipline, his consequent inattention to flight instruments & ice accretion, & his selection of improper autoflight vertical mode, all of which led to stall, LOC, & forced landing. Factors: poor crew discipline, including coordination before stall & crew's inappropriate actions to recover from LOC; & fatigue induced by crew's failure to properly manage provided rest periods.	PIC's duty tour started after 2 days off on 4/27 1328 for 1428 departure. Went off duty at 2246 at JAC; got to sleep about midnight & awoke at 0615. Depart first flight on 2nd day at 0735 & off duty at SHV at 1130. Went sightseeing, lounged by pool & had dinner with other crew. To bed shortly after midnight & awoke at 0500 for 0630 departure. Said he felt rested. Accident occurred on 7th & last flight of day. FO (PNF) had same schedule. Said he went to bed b/ 0000 & 0030 on first night with "reduced layover." On second night he got to bed b/ 2300 & midnight & awoke at 0430 & said he felt rested. Note: had to be suffering cumulative sleep loss (max 9 to 10 hours sleep in 2 nights), then long 3rd day in IMC. NTSB cites fatigue as a factor.	0.5	0	0

CAUSE: crew's failure to use available cues & aids to identify A/C's location on airport surface during taxi & their failure to cross-check & verify that A/C was on correct runway before T/O. Factors: crew's nonpertinent conversation during taxi, which resulted in loss of positional awareness, & FAA's failure to require that all runway crossings be authorized only by specific ATC clearances.	Fatigue likely was not an issue for PIC (PNF) but it may have affected FO's performance (PF). FO began his duty tour on 8/25 at JFK. He drove that morning to FLL near his home for flight to JFK. Departed FLL at 0559 & arrived JFK at 0832. NTB does not note when FO awoke, but it likely would have been no later than 0400. His duty day then began with flight from JFK to ROC at 1305. Return flight to JFK T/O at 1600 but crew had to divert to BDL for fuel & did not land at JFK until nearly 2000. Due to late arrival, crew was asked to reposition A/C to LEX. Departed gate at 2130 but were not able to T/O until 2300; arrived at LEX at 0140. FO reached his hotel at 0210 on 8/26. By the time he got to bed, FO would have had nearly a 23-hour day. On 8/26, FO had day off. He told his wife that morning by phone that he had "slept in" & planned to go to bed early that night. Phone records, hotel key cards, & credit card records indicate normal day of activity through at least 1830, when FO paid for meal in hotel restaurant (probably asleep no earlier than 2000). On 8/27 he & PIC reported for duty at 0515. FO likely had same wake-up call as PIC (0415). Though FO had free day before accident, 8/25 was 23-hour day, with very late time to bed, followed on 8/27 by very early start to his day. Despite "sleeping in" on 8/26, FO clearly would have been coping with some sleep deficit. This could partly explain his confusion or inattention prior to departing gate. It also could have made him more vulnerable to visual confusion caused by minor construction & related barriers, & his failure to respond to visual cues of unlighted runway & crossing active runway that was fully lighted.Yet other factors also may explain these failures. For example, FO had flown into LEX 2 nights before when "lights were out all over the place." That was at end of his 23-hour day; neither he nor that Captain apparently recognized that outages had been NOTAMed on 8/25. On morning of accident, runway end identifier lights were out of service. Closeness of 2 runway ends with single taxiway also increases risk of wrong runway takeoffs. Finally, with terminal close to runway ends, taxi time was short, increasing percentage of head-down time, at least for PNF. But NPRM would have precluded FO from taking positioning flight & extending very long duty day on first day. This may have made him more alert & averted careless errors.	0.35	17.15	0.35

Cause: (Colombian CAA) 1. crew's failure to adequately plan & execute approach to runway 19 & inadequate use of automation; 2. Failure to discontinue approach, despite numerous cues; 3. lack of situational awareness regarding vertical navigation, proximity to terrain, & relative location of critical radio aids; 4. Failure to revert to basic radio nav when FMS-nav became confusing & demanded excessive workload. Factors: 1. crew's ongoing efforts to expedite approach & landing to avoid potential delays from exceeding company duty time limits; 2. execution of GPWS escape maneuvre with speed brakes deployed; 3. FMS logic that dropped all intermediate fixes from display(s) upon execution of direct routing; 4. FMS-generated nav information that used different naming convention from that published in nav charts."	Crew certainly would have been tired, despite this flight's being first of their duty tour. PIC had been awake close to 17 hours & FO had been awake at least 15 hours. Yet even if each had been operating early in the day, they likely would not have sorted out confusion created by single-letter identifier for Rozo & Romeo. Other issues are somewhat clearer. More rested crew may have avoided readback-hearback error related to being cleared "direct" with interim reporting points. Crew clearly recognized that they were very confused, & clearly were uncertain of their position in rugged terrain. Arguably, more alert crew might have responded more appropriately, either by climbing above terrain to sort things out there, or by reverting to radio nav until they re-established their position, or may have recognized that over-ride of northbound turn had pushed them across ridge line, east of valley. Concede that this argument can be somewhat discounted by self-induced pressure to get cabin crew on ground. Bottom line: hard to argue that fatigue was a show-stopper here, but FO (PF) had been awake more than 14 hours, a key threshold in sleep literature, with PIC past 17 hours (second key threshold beyond which performance essentially collapses). Yet, several key factors would have remained present with or without alert crew: non-radar environment; confusion caused by multiple identifiers; self-induced pressure; unexpected change to unfamiliar step-down approach at night in mountainous terrain; & significantly delayed flight, which increases risk. Bottom line rests upon judgment call about degree to which better rested crew might have been able either to avoid some confusion or might have responded to it differently.	0.35	56	1.4
CAUSE: Failure to detect & remove ice contamination from wings, which was largely due to lack of approriate response from FAA, Douglas & carrier to known crtical effect that minute amount of contamination has on stall characteristics of DC-9.	NTSB considered possibility that fatigue influenced pilots' judgment during ground operations at CLE & decision not to conduct exterior preflight inspection of A/C. Crew had flown same night-time schedule for 6 days, between BUF & IND with intermediate stop each way in CLE. PIC had flown 6 successive night flights on same BUF-CLE-IND-BUF route week before. He had 1 day off between 2 duty periods (6 flights, averaging 3.8 hours each night; did not exceed FAA max flight time limits). But PIC's schedule had recently increased from routine of flying for 5 days, then 9 days off at home in CA. Though his family said he was used to night flying, recent increase in duty & flight time could have induced fatigue. Also evidence that PIC suffering from cold. Demanding schedule of 12 nights of flying in last 13 days could have made recovery from illness more difficult & added to effects of fatigue. Pilots' failure to exit A/C for preflight inspection in CLE "suggests PIC's decision making was affected by fatigue." Still, insufficient evidence to reach firm conclusion on this issue." Notwithstanding NTSB's failure to reach "firm conclusion" on fatigue, NTSB did not dispute that fatigue was present. NPRM would have required more rest over 13 days & may have helped avert this accident.	0.35	0.7	0

CAUSE: improper decision, misjudgment of speed & distance, & failure to perform go-around resulting in overrunning & striking electrical box. Factors: improper CRM, FO's failure to intervene before accident occurred, & electrical box.	Crew was on 3rd day of 3-day trip, that had started in Cortez, CO, that morning at 0520. Crew had flown from Cortez to DEN, to Farmington, NN, back to DEN, then to Laramie, & then to Worland. (That is all this report says that could be directly related fatigue.) BUT, given number of days & segments flown, accident occurred precisely at NPRM's proposed limit of 11-hour duty day. Might have made a difference.	0.15	0	0
CAUSE: failure to discontinue approach when severe thunderstorms & associated hazards to flight operations had moved into airport area, & crew's failure to ensure that spoilers had extended after touchdown. Factors: flight crew's (1) impaired performance resulting from fatigue & situational stress associated with intent to land under the circumstances, (2) continuation of approach when company's max crosswind component was exceeded, & (3) use of reverse thrust greater than 1.3 engine pressure ratio after landing.	Flight 1420 was third & final leg of first day of 3-day sequence. Each pilot had been off several days & no unusual activity. PIC went to bed night before at 2200 & awoke at 0715. FO commuted day before from LAX & stayed in hotel. PIC checked in to ORD at 1038, & FO checked in at 1018. PIC T/O 1143, ORD-SLC & arrived SLC at 1458 CDT. FO T/O SLC at 1647 CDT & arrived 39 minutes late to DFW at 2010 due to airborne hold on approach in "adverse" wx. Flight 1420, from DFW to LIT scheduled to depart at 2028 & arrive at 2141. But departure delayed to 2100 for delayed in-bound A/C. FO advised gate agents that they had to T/O by 2316 for AAL's company duty time limit. FO then advised dispatch to another A/C or cancel flight. Dispatch did so. At gate, crew got AAL weather advisory for widely scattered thunderstorms along planned route & 2 NWS in-flight weather advisories for severe thunderstorms. T/O at 2240, 2:12 late. Only discussion of wx was about need to expedite approach. At 2326 (24 minutes before impact) FO said, "I don't like that…that's lightning" Between 2342:19 & 2342:24, PIC asked FO "do you have the airport? Is that it right there? I don't see a runway." FO asked PIC if he wanted "short approach" to "keep it in tight." PIC: "yeah, if you see the runway, cause I don't quite see it." FO: "right here, see it?" PIC: "you just point me in the right direction & I'll start slowing down here." At 2343, FO said "it's going right over the…field." Later PIC said "aw, we're going right into this." FO said "go around" but in very soft voice; unclear if PIC heard it as he was "intent on flying." FO was 5 months into 1-year probation & paired with Chief Pilot. But FO later testified of good working relationship with PIC & said rank of Chief Pilot was no barrier. Accident occurred 14 hours into duty day & nearly 17 hours after awakening. Long day & disrupted flight into & from DFW. FO showed signs on CVR of recognizing that landing was not a good idea, but PIC focused on landing. Was this fatigue or task fixation? Would more rest have made recently hired FO more willing to speak up to PIC-Chief Pilot? Call-outs were made & SOPs indicate they were engaged. Perhaps a less worn-out PIC would have considered diverting (or not), or may at least have responded to implied warnings from tower.Would have exceeded NPRM duty day by 12 minutes at impact; may have changed sequence before T/O (had to be released by 2316 - - 2304 might have made a difference).	0.15	1.65	6.75

CAUSE: PIC's improper placement of power levers in BETA position while inflight. Factors: fog & dusk conditions.	Accident report summarizes only Captain's flight day, not his preceding 72 hours. Clearly had a long day & difficulty getting into HYA did not help. But hard to make a strong case for fatigue. Arguably, better rested PIC might have handled flare better, but others have pulled throttle & props into beta. Add IMC over coastal airport, & capacity of more rest to have led to different outcome gets more limited.	0.15	0	0
CAUSE: crew's failure to complete published checklist & to adequately cross-check actions of each other, which resulted in failure to detect that leading edge slats had not extended & led to A/C's tail contacting runway during computer-driven, auto-land flare. Factors: Lockheed's inadequate inspection procedures for slat drive system; & operator's inadequate checklist, which did not include having FE monitor double needle slat gauge.	Trip sequence began with evening flight on 8/23 from JFK to LAS. NTSB report is unclear about when crew arrived in LAS, but appear to have reached hotel around 2200L (0100 EDT) to start 24-hour rest period. Itinerary resumed at 2130 (PDT) next night when they were picked up at hotel, so crew would have been awake at least since about 2000 (2300 EDT). Though crew ostensibly had adequate rest period, they had arrived at hotel late on preceding night & resumed itinerary on back side of clock for 5-hour red-eye to JFK. Crew reported for duty & departed LAS 54 minutes late at 1154 PDT (0254 EDT); wheels up at 0310. On arrival in JFK area, wx was ¼-mile in fog, scattered at 200, & temp/dew of 66/66F. Crew expected 4R, but before reaching FAF, 4R went below minimum & ATC offered 4L (still above minimum). Crew then failed to reset altimeter bug for new runway (100 feet higher than 4R). PIC (PNF) also missed several required call-outs on approach & no charts for 4L were on board. When FO (PF) asked for charts, PIC said "just fly the approach." A/C was slow & unstable throughout approach & when altimeter read 50 feet, A/C began its flare. FO recognized they were high (by 100 feet) & pushed nose over to land. On landing, A/C had tail strike & substantial damage. Failure to reset altimeter & absence of charts were fundamental in this accident. Had crew been better rested, they may not have missed altimeter reset, may have recognized or acted upon unstable approach, or may have gone around, as required by company procedures when not stabilized at 500 feet. NPRM's treatment of night operations may have affected this operation. Conversely, crews have made similar errors when well rested & flying at mid-day. But reasonable argument can be made that fatigue contributed to crew's failures on approach.	0.35	0	0

CAUSE: decision to continue approach into severe convective activity conducive to microburst; 2) failure to recognize windshear in timely manner; 3) failure to establish & maintain proper A/C attitude & thrust setting necessary to escape windshear; & 4) lack of real-time adverse weather & windshear hazard information from ATC, all of which led to encounter with & failure to escape from microburst-induced windshear in rapidly developing thunderstorm at approach end of 18R. Factors: 1) lack of ATC procedures to require controller to display & issue ASR-9 weather information to pilots; 2) tower supervisor's failure to properly advise & ensure that all controllers were aware of & reporting reduction in visibility & RVR, & low level windshear alerts that had occurred in multiple quadrants; 3) inadequate remedial actions by US Air to ensure adherence to SOPs; & 4) inadequate software logic in A/C's windshear warning system that did not provide alert upon entry into windshear	Fatigue could have affected FO's performance (PF). PIC, who was off-duty preceding 3 days, was much less vulnerable to fatigue, but he too had already had a long day. Accident occurred 14 hours into PIC's day. He awoke at 0455, drove to Dayton from home, then flew to PIT to begin duty day. Accident occurred at 1843, at end of third of 4 scheduled legs. His long day may have contributed to his failure to make 2 standard call-outs on approach at 1000 AGL & 100 AGL. As NTSB notes, failure to make these call-outs contributed to PIC's loss of situational awareness, his directing FO to go around "to the right" instead of following runway heading as directed, & directing FO to "push down" after FO had initiated 15-degree nose-up & right banking turn. FO was more vulnerable to fatigue. His duty day ended June 30 at 2230 at Blountsville, TN. NTSB does not say when that duty day began, nor when FO awoke that day. At Blountville, he went to bed at 0130 & awoke at 0900. His next duty day ended at STL at 2040 EDT. He went to bed at 2230 & awoke at 0615 on accident day. He then flew to PIT & began pairing with accident PIC. Like PIC, FO was nearly 14 hours into his day when accident occurred. He was PF on PIT-LGA leg & on accident leg from CAE. Fatigue could have contributed to incomplete pre-flight brief, failure to maintain sterile cockpit below 10,000 feet, approach briefing in which he omitted field elevation, FAF altitude, DH, & MAP altitudes, all of which NTSB noted had contributed to lack of situational awareness by both pilots. Finally, all this contributed to crew's choice to initiate non-standard go-around. Other factors were important, including ATC performance, A/C's inadequate windshear algorithm, & abnormally severe windshear. In short, hard to justify a high score indicating that more rest would have had a high change of changing the outcome, but equally hard to argue that fatigue was irrelevant. Bottom line: fatigue may have been a minimal factor.	0.15	5.55	2.4

CAUSE: PIC's failure to use proper directional control techniques to maintain A/C on runway." note:: damage described as "substantial." Photo shows badly beaten up A/C; $35 million in damage (about $55 million in 2010 $; not repaired.)	Accident occurred just 46 hours into crew's duty tour, but at end of crew's second day of disrupted circadian rhythms. Crew likely had awoken no later than 0600 CDT to reach DFW & report for duty in advance of 0900 DFW-HNL flight. After 10-hour duty day, crew arrived at HNL at 1900 CDT (1400 HAST) & began rest period about 2200 HAST, awakening around 0700 HAST, with added naps of various lengths from 1600 to 2100 Local. Crew then reported for duty & flew more than 8 hours through the night to DFW. Accident occurred at 0700 CDT. FO told investigators he felt tired twice during flight & briefly used oxygen to "perk-up." PIC & FE said they did not feel tired during flight, but sleep literature finds that people often fail to recognize when their performance deteriorates due to fatigue and disrupted circadian rhythms. Crew landed in thunderstorms, lightning, & strong crosswinds, for which crew had accurate wx info before T/O at HNL. Crew also had multiple in-flight updates from ATC & dispatch, including company SIGMEC one hour before landing to advise of "worsening conditions." When FE communicated this information to FO & Captain, he omitted parts of it, such as "thunderstorms in all quadrants." NTSB also found no indication of approach briefing or briefing about possible go-around procedures. Crew never explicitly discussed DFW wx in pre-flight brief nor en route, nor did they brief or discuss go-around procedures. On descent, crew had 2 possible lightning strikes, made 2 requests to ATC Approach for vectors around wx cells, & had requested from ARTCC & Approach to land to north, which were denied. Then, at 50 AGL, FO (PF) said he was initiating go-around. PIC said "No, no, no I, got it," & took control at 40 feet AGL. This left him virtually no time to communicate with crew & no altitude for responding. His decision committed him to landing long on wet runway with cross wind. On touchdown in 15-knot crosswind, A/C weather-vaned & drifted right. PIC responded "with minimal rudder commands, inappropriate tiller nosewheel steering commands, & lack of forward pressure on control column." At impact, crew had been awake 36 of preceding 46 hours & had just flown 8-plus hours through the night. NTSB did not cite fatigue as factor & instead cited PIC's failure to control A/C after landing but fatigue may have contributed to entire crew's performance. Yet, role of fatigue would be limited to back-of-the-clock & circadian factors over a rather short duty tour that included day off & reasonable rest. Consequently, we probably can not defend a high score, yet the fact that all 3 crew performed poorly & never mentally integrated winds & cells is hard to explain any other way. But rest period & duty day were within NPRM limits. Bottom line: likely fatigued but unclear how strong NPRM details would have addressed the issue.	0.15	0	0.3

CAUSE: crew failure to recognize or recover from unusual attitude due to PIC's apparent spatial disorientation, resulting from physiological factors and/or failed attitude director indicator.	All 3 crew had week off until reporting to duty on 2/13 in TOL at 0300. Flew to PDX via SEA; released from duty at 1145 EST (0845L) at PDX. Returned to duty on 2/15 at 1945 (1645L; 32 hours off). Length of days & past 30 days were hardly brutal but NTSB noted it 'was unable to determine conclusively that they were 'well rested' in traditional sense" for first duty day due to circadian rythym for 0300 start. That "placed them in abnormal, reversed sleep-awake cycles." Accident also occurred on second day of this disrupted sleep cycle during early morning hours, time of day associated with a diminished capacity." Though CVR indicated "no obvious symptoms of fatigue" crew said they were well rested, but research shows that "fatigued persons usually cannot accurately judge that they are, in fact, fatigued." Several events suggested possible fatigue: PIC became irritated with FO on first 2 ILS approaches & FO was slow to react to excessive bank angle on accident approach; several obvious "misspeaks" by both pilots (drift vs. crab, & 25 degrees flaps vs. 23); missed call-outs & "less than rigorous adherence to SOPs." NTSB found "evidence is not sufficient to [conclude] that fatigue adversely affected performance [but] NTSB cannot rule out that possibility." In sum, crew clearly displayed some symptoms of fatigue but "no obvious" indications, so score must be imited to minimal.	0.15	0.6	0
CAUSES & Factors: (TSB Canada) "1. crew planned & executed landing on runway that did not permit required landing distance. 2. crew likely did not reference performance chart to determine that landing A/C on 4000-foot, snow-covered runway with flaps-15 was inappropriate. 3. After landing long on snow-covered runway & applying full reverse thrust, PIC tried to go-around but remained in ground effect at low speed until striking perimeter fence, rising terrain, & line of large cedar trees. 4. crew conducted flap-15 approach, based on company advice per All Operator Message (AOM) issued by A/C manufacturer to not use flap-30. This AOM was superseded on 10/20/04 by AOM No. SD006/04, which cancelled any potential flap-setting prohibition."	Canadian TSB report does not implicate fatigue or rest periods.	0	0	0

CAUSE: fuel starvation resulting from PIC's decision not to follow approved fuel crossfeed procedures. Factors: PIC's inadequate preflight planning, subsequent distraction in flight, late initiation of in-range checklist, & crew's failure to monitor fuel gauges & to recognize A/C's changing handling characteristics were caused by fuel imbalance.	PIC had stayed 3 days at carrier's crew house in MEM; well rested. Typically slept until noon after returning from flights at about 0500. On accident day, he watched TV from 1600 to 2100, & checked in at MEM for accident flight. PIC said he felt fine but was "preoccupied" with & "stressed" about calculating A/C's weight & balance. FO was experienced on MEM-CVG route & with accident A/C. On accident day, FO got home at 0700, slept until 1530, went to his son's football practice, & ate dinner before checking in for flight. Co-workers said both crew seemed fine, alert, etc. The only plausible argument here for fatigue would rest on a back-of-the-clock rationale, but that seems a stretch in this case and difficult to defend.	0	0	0
CAUSE: PIC's over-control during landing & failure to go around from destabilized flare. Factor: PIC's concern with touching down early to ensure adequate stopping distance.	Accident occurred on flight from ANC-EWR. PIC arrived at ANC night before accident flight from his home in Nevada after 7 days off. He slept until 0830 ADT (1230 EDT). NTSB then notes that accident occurred 14 hours later (0132 EDT - -13 hours later?). FO lived in Minnesota but was based at ANC. He was off duty in ANC for 2 days before accident flight & had more than 8 hours of sleep before accident flight, after being awake briefly between 0630 & 0830 local. Both pilots ate meals en route. FO reported not feeling tired on flight, but PIC said he was tired by end of flight. A/C had strong tailwinds en route & took 5 hours, 52 minutes, or 47 minutes less than planned. Except for failure to select last-second go-around, this accident was all about MD-11's tendency to pitch up after ground spoilers deploy, crew tendencies to over-control in response by pushing nose over, & particularly rigid gear design on MD-11 & its transfer of loads directly to wing spar. Despite PIC's comment about having been tired, this was not a particularly demanding day for crew. Accident occurred 13 hours after PIC awoke, after 7 days off, & FO also appeared well rested. Accident occurred at 0130 Eastern, but body clocks still very much on ANC time (2130). Fatigue likely scores zero in this accident.	0	0	0

CAUSE: crew's failure to maintain required MDA until visual contact with runway environment. Factors: failure of BDL approach controller to provide crew with current altimeter setting & crew's failure to ask for more current setting.	(1) First duty day was long day. Report at 1700; what time did their day begin? Got to bed perhaps 0400. Still, decent lay-over of 13+ hours. Left hotel at 1700. Weather delay & accident at 0100 in intense rain & winds. Had wx information but other flights were getting in. Backside of clock. More rested crew MIGHT have recognized altimeter confusion. However, except possibly for circadian issues, hard to argue that rule would have influenced crew performance, & hard to argue argue dramatic fatigue or that new rule would have influenced their schedule (had 13-hour period after 1 day of duty; accident on end of 2nd day).	0	0	0

TAB 8

All Benefit Accidents Used in Pilot Rest and Duty
[Note this total of 250 minus included 43 accident < 235 because there were duplicates]
(NTSB descriptors)

ANC01FA011
ANC01LA081
ANC01LA146
ANC02FA023A
ANC02LA008
ANC02LA015
ANC03LA024
ANC03LA043
ANC05LA025
ANC90FA047
ANC92FA006
ANC92LA010
ANC92LA041
ANC95FA008
ANC95LA084
ANC96FA072
ANC96FA102
ANC96LA026B
ANC96LA066
ANC98LA085
ANC98LA122
ATL00LA072
ATL02LA111
ATL07LA016
ATL90FA095A
ATL91LA091
ATL92MA118
ATL93LA159
ATL97FA113A
ATL97LA064
BFO93FA049
CHI00FA071
CHI00LA047
CHI00LA269
CHI01FA084
CHI01FA104
CHI01FA270

CHI01FA292
CHI01LA331
CHI02LA111
CHI02LA170
CHI03LA113
CHI04LA086
CHI04LA126
CHI04LA148
CHI05FA077
CHI05LA238
CHI05MA111A
CHI05MA111B
CHI06LA038
CHI06LA099
CHI07FA020B
CHI07FA184B
CHI07LA093
CHI08FA050
CHI90FA278
CHI91LA087
CHI91LA103
CHI91LA301
CHI91MA260
CHI92LA206
CHI93LA043
CHI93LA160
CHI93LA192
CHI93MA061
CHI94FA039
CHI95LA031
CHI95LA094
CHI95LA170
CHI95MA044A
CHI97FA083
CHI99LA055
CHI99LA184
DCA00RA002
DCA00WA007
DCA01MA031
DCA01WA028
DCA02MA039

DCA02MA054
DCA04MA011
DCA04MA045
DCA04MA068
DCA04MA082
DCA04WA043
DCA05MA004
DCA05MA071
DCA05MA095
DCA05MA099
DCA05WA019
DCA06FA068
DCA06MA009
DCA06MA064
DCA06RA042
DCA07FA037
DCA07MA072
DCA07MA310
DCA08CA041B
DCA08FA018
DCA08RA077
DCA08WA071
DCA09RA041
DCA91MA010A
DCA91MA010B
DCA91MA019
DCA91MA042
DCA92MA016
DCA92MA044
DCA94MA027
DCA94MA033
DCA97MA009A
DCA97MA049
DCA97MA059
DCA97WA047B
DCA98MA015
DCA98MA045
DCA99MA007
DCA99WA042
DCA99WA064
DEN00FA085

DEN03FA070
DEN03LA096
DEN07LA098
DEN08LA151
DEN90FA042
DEN90LA046
DEN93FA049
DEN93LA098
DFW08CA215
FTW00FA101
FTW00LA244
FTW00RA126
FTW02LA198
FTW02LA199
FTW04LA225
FTW91LA137B
FTW92LA001
FTW92LA005
FTW93LA020
FTW93MA143
FTW95FA004
FTW95LA055
FTW95LA167
FTW95LA170
FTW96LA111
FTW97LA081
FTW98FA001
FTW98FA273
FTW98FA380
FTW98LA243
FTW98LA351
FTW98LA353
FTW98RA401
FTW99LA207
IAD01FA021
IAD05LA044
IAD05LA118A
IAD05LA118B
IAD97FA052
LAX00FA041
LAX00FA229

LAX00LA072
LAX00LA192
LAX01LA136
LAX01LA240
LAX01LA307
LAX02FA266
LAX04LA007A
LAX04LA050
LAX04LA318
LAX05LA218
LAX06LA009B
LAX07LA064B
LAX07LA127
LAX90FA148
LAX90LA116
LAX90LA122
LAX95LA255
LAX97FA164
LAX97FA276
LAX98FA013
LAX98FA169
LAX99FA207
LAX99LA322
MIA00LA206
MIA01FA029
MIA01LA030
MIA01LA131
MIA01LA224
MIA03FA130
MIA03LA155
MIA04LA134
MIA07LA068
MIA90FA105
MIA90LA058
MIA91LA005
MIA92MA131
MIA93FA073
MIA93LA044
MIA93LA110
MIA94LA166
MIA95RA121

MIA95WA143
MIA96FA059
MIA96LA107
MIA98FA089
MIA98WA251
MIA99FA012
NYC01LA023A
NYC01LA077
NYC01LA094B
NYC02LA013
NYC02LA110
NYC02LA187
NYC03FA035
NYC03LA114A
NYC03LA177
NYC03LA208
NYC04LA174
NYC05FA054
NYC05FA094
NYC05LA013
NYC06LA002
NYC06LA033
NYC06LA191
NYC06LA222B
NYC07LA105
NYC90LA132B
NYC91FA086
NYC92FA009A
NYC92FA009B
NYC92LA002
NYC92LA128
NYC93FA137B
NYC94LA062
NYC94LA111
NYC96LA058
NYC96LA148
NYC98LA177
NYC99LA177
SEA03WA033
SEA05LA184B
SEA08LA050

SEA91FA216
SEA91LA040
SEA92LA025
SEA97LA077
SEA97LA085
SEA98LA016
SEA99LA014
DCA02MA029