**U.S. Department of Transportation**
Federal Aviation Administration

# Advisory Circular

**Subject:** Fatigue Risk Management Systems for Aviation Safety

**Date:** 5/6/13 **AC No:** 120-103A

**Initiated by:** AFS-220 **Change:**

**1. PURPOSE.**

**a. Contents.** This advisory circular (AC):

**(1)** Describes the basic concepts of Fatigue Risk Management Systems (FRMS), as prescribed in Title 14 of the Code of Federal Regulations (14 CFR) part 117, § 117.7, and how they relate to aviation industry employees safely performing their duties.

**(2)** Provides information on the components of an FRMS as applied to aviation, and on how to implement an FRMS within an aviation operation.

**(3)** Defines an FRMS as an operator-specific process; therefore, while all FRMSs will have common elements, the specifics will be tailored to a certificate holder's particular conditions.

**(4)** Provides (in Appendix 2, Fatigue Risk Management System Development) the certificate holder with the necessary detailed guidance to prepare for the FRMS approval process, develop the required documentation, develop and apply fatigue risk management (FRM) and Safety Assurance (SA) processes, collect and analyze data, develop flightcrew FRMS operations procedures and a step-by-step process required for Federal Aviation Administration (FAA) evaluation and validation of the proposed FRMS application.

**b. Parts of an FRMS.** This AC describes the essential processes and elements for an effective FRMS.

**c. Not Mandatory.** This AC is not mandatory and does not constitute a regulation. However, this AC provides an acceptable method for developing an FRMS application.

**2. CANCELLATION.** This AC cancels AC 120-103, Fatigue Risk Management Systems for Aviation Safety, dated August 3, 2010.

**3. INTRODUCTION TO FRMS.** An FRMS is an optional approach to prescriptive regulations. A certificate holder seeking to exceed a limitation in part 117 or in 14 CFR part 121 subparts Q, R, or S, would do so under an FAA authorization. An FRMS is largely developed as an alternative method of compliance (AMOC) to prescriptive limitations based upon objective performance standards. A certificate holder may be authorized to apply an FRMS to any part or all of its operation, provided that the certificate holder demonstrates an effective AMOC that

meets or exceeds the safety standards afforded by the prescriptive limitations. Unlike a Fatigue Risk Management Plan (FRMP) that is required for each certificate holder conducting operations under part 121, the FRMS is an AMOC to prescriptive limitations that the certificate holder may implement for fatigue management and mitigation.

**4. WHAT IS AN FRMS?** An FRMS is a management system for a certificate holder to use to mitigate the effects of fatigue in its particular operations. An FRMS is a data-driven system, based largely upon scientific principles and operational knowledge, that allows for continuous monitoring and management of safety risks associated with fatigue-related error. An FRMS is a fatigue mitigation tool that minimizes the acute and chronic sources of fatigue and manages the potential risks associated with fatigue. The FRMS is part of a repetitive performance improvement process that leads to continuous safety enhancements by identifying and addressing fatigue factors across time and changing physiological and operational circumstances. The objective of the FRMS is to manage, monitor, and mitigate the effects of fatigue to improve flightcrew member alertness and reduce performance errors.

**5. CREWMEMBER ALERTNESS AND PERFORMANCE.** A certificate holder's FRMS will be designed to demonstrate that flightcrew members are sufficiently alert so they can operate to a satisfactory level of performance. Additionally, the FRMS should be designed to achieve a realistic balance between safety and productivity. It should proactively identify opportunities to improve operational processes and reduce risk, as well as to identify deficiencies after adverse events or reports of excessive fatigue.

**6. DEFINITIONS.**

**a. Acute Fatigue.** Acute fatigue is closely related to recent sleep (i.e., sleep within the last 24 hours), time since last sleep, and current time of day. Less than 8 hours of sleep in the last 24 hours, being awake longer than 17 hours, and working between midnight and 0600 are associated with acute fatigue in the average person.

**b. Biomarkers.** Biomarkers are characteristic biological properties that can be detected and measured in the body, such as in the blood or tissue. Biomarkers may indicate either normal, abnormal, or diseased processes in the body. Currently, there are no easily obtainable biomarkers of fatigue. However, several biomarkers of the circadian rhythm exist, such as core body temperature and melatonin levels. In the absence of biomarkers to identify fatigue, we can measure fatigue effects directly, in performance variables, or indirectly, by using measures of sleep and time of day and by modeling the effects of these conditions on performance.

**c. Chronic Fatigue.** The average person needs about 8 hours of sleep per day. If the average person gets less than the required amount of sleep each day for multiple days, then a state of chronic fatigue can occur. With chronic fatigue, performance is degraded and recovery tends to be relatively slow. A person can hasten recovery by attempting to sleep longer than the normal amount for several days.

**d. Circadian Fatigue.** Circadian fatigue refers to the reduced performance during nighttime hours, particularly during an individual's Window of Circadian Low (WOCL) (typically between 0200 and 0600 hours).

**e. Circadian Rhythm.** In humans, the circadian rhythm is a daily alteration in a person's behavior and physiology. These behavioral and physiological alterations are controlled by an internal biological clock located in the brain (i.e., the circadian clock). Examples of circadian rhythms include body temperature, melatonin levels, cognitive performance, alertness levels, and sleep patterns.

**f. Cumulative Fatigue.** Cumulative fatigue is fatigue brought on by repeated mild sleep restriction or extended hours awake across a series of days.

**g. Fatigue.** Fatigue is a complex state characterized by a lack of alertness and reduced mental and physical performance, often accompanied by drowsiness. Fatigue is objectively observed as changes in many aspects of performance, including increased reaction time, lapses in attention (e.g., reaction times greater than 500 milliseconds), reduced speed of cognitive tasks, reduced situational awareness, and reduced motivation. A person's perceived fatigue levels are often lower than observed decrements in performance.

**h. Fatigue Risk Management System (FRMS).** A management system that certificate holders may use to mitigate the effects of fatigue in their operations where the FRMS is applied. Specifically, an FRMS is the method by which a certificate holder may exceed a flightcrew member flight, duty, or rest limitation, provided the FRMS demonstrates an AMOC and is approved by the FAA. Essentially, an FRMS is a nonprescriptive fatigue mitigation tool.

**i. Transient Fatigue.** Transient fatigue is acute fatigue brought on by extreme sleep restriction or extended hours awake within 1 or 2 days.

**j. Window of Circadian Low (WOCL).** Individuals living on a regular 24-hour routine with sleep at night have two periods of maximum sleepiness, also known as WOCLs. One WOCL occurs at night, roughly from 0200 to 0600, a time when physiological sleepiness is greatest and performance capabilities are lowest. The other WOCL is in the afternoon, roughly from 1500 to 1700, and is less severe than the nighttime WOCL.

## 7. RELATED READING MATERIAL (current editions).


- Proceedings of the "Aviation Fatigue Management Symposium: Partnerships for Solutions," June 17-19, 2008.
- AC 120-100, Basics of Aviation Fatigue.
- International Civil Aviation Organization (ICAO) Fatigue Risk Management Systems Implementation Guide for Operators.
- ICAO Document 9966, FRMS Manual for Regulators.
- Mahon, G. & Cross, T. The Fatigue Management Program: Alternatives to Prescription. Queensland Transport: Queensland, Australia, 1999.
- Mallis M.M., Banks S., & Dinges D.F. Aircrew fatigue, sleep need and circadian rhythmicity (Chapter). In Elsevier, E. Salas, T. Allard, & D. Maurino, (Eds), Human Factors in Aviation (2nd edition), in press; 2010.

## 8. BACKGROUND.

**a. Causes of Fatigue.** Generally speaking, the main causes of fatigue in aviation are:

- Amount, timing, and quality of sleep each day (sleep/wake schedule),
- Amount of time since last sleep period (continuous hours awake),
- Time of day (circadian rhythm),
- Operations through multiple time zones, and
- Workload and time on task.

**b. Fatigue Management.** The traditional ways to manage fatigue associated with aviation operations have been prescriptive flight and duty time limitations and rest requirements. Conventional regulations following this model reduce, but do not eliminate, the conditions that contribute to fatigue. They are primarily based on "time on task" theories and on the assumption that fatigue accumulates in a linear manner. Conventional regulations on fatigue management do not consider the interactions of sleep loss and circadian rhythms. Additionally, conventional regulations cannot address operational complexities on a case-by-case basis.

**9. THE FRMS CONCEPT.** An FRMS consists of organizational processes and procedures to control fatigue risk in aviation operations. 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. It is part of a repeating performance improvement process. This process leads to continuous safety enhancements, by identifying and addressing fatigue factors across time and changing physiological and operational circumstances. Structurally, an FRMS is composed of processes and procedures for measuring, modeling, managing, mitigating, and reassessing fatigue risk in a specific operational setting. An FRMS is an effective fatigue mitigation strategy when the organization bases it on valid scientific principles. An FRMS combines schedule assessment, operational data collection, continuous and systematic analysis, and both proactive and reactive fatigue mitigations, guided by information provided by scientific studies of fatigue. Overall, an FRMS offers a way to more safely conduct flights by offering flexibility not available within regulatory limits. An FRMS complements prescriptive flight time, duty time, and rest period requirements.

**a. Operational Demands.** An FRMS addresses the complexity of operational demands and the inherent fatigue-related challenges associated with aviation operations. The FRMS approach is to apply risk management (RM) techniques to identify and reduce the risk of fatigue relevant to specific operational circumstances. An FRMS aims to ensure high levels of alertness in personnel to maintain acceptable levels of performance and safety.

**b. Adaptability.** An FRMS provides an interactive and collaborative approach to operation performance and safety levels on a case-by-case basis. Therefore, an FRMS permits a certificate holder to adapt policies, procedures, and practices to the specific conditions that create fatigue in a particular aviation operation. Certificate holders may tailor their FRMSs to unique operational demands and focus on mitigations of fatigue that are practical within the specific operational environment.

**c. Assessment.** An FRMS relies on assessments to project and confirm the fatigue effects of an operation on crewmember sleep and alertness. This permits continuous assessment of fatigue levels associated with ever-changing operational conditions. The common tool for this assessment is a biomathematical model of fatigue and alertness levels.

**d. Risk Management Process (RMP).** The FRMS applies the RMP to identify fatigue risks through the use of data-driven systems. An FRMS includes documented processes for collecting and analyzing fatigue-related safety data and implementing corrective actions, always allowing for continuous improvement. A "just" or "safety" culture is integral to a successful FRMS, and it requires a shared responsibility among all levels of the organization, as well as the involvement of regulatory agencies.

**10. TOOLS FOR AN EFFECTIVE FRMS.** There are four basic tools for an FRMS to be effective. These basic tools are fatigue-related data, fatigue analysis methods, identification and management of fatigue drivers, and application of fatigue mitigation procedures.

**a. Fatigue-Related Data.** An effective FRMS is data-driven, meaning that it relies on the use of reports, studies, etc., rather than on speculation. An FRMS is based on scientific principles and involves continuous monitoring. Fatigue effects on performance and safety have been documented and are well recognized (Bonnet, 2000; Carskadon and Dement, 1987; Dinges, 1992; Dinges and Kribbs, 1991; Horne, 1993; Naitoh, 1975). It is difficult to detect fatigue in operational settings because there are no biomarkers for fatigue or simple tests of how an individual will respond to sleep loss. However, the environmental conditions that promote fatigue are well known and continue to contribute to performance deficits during operations. The challenge is that aviation operators cannot totally eliminate fatigue from 24/7 aviation operations, so certificate holders need to apply proactive and adaptive mitigation for fatigue. Managing fatigue risk depends on two types of operational evidence available to certificate holders:

**(1)** The duty schedule directly affects crewmembers' opportunities to obtain restorative recovery sleep. Monitoring work schedules provides indirect evidence of potential fatigue resulting from inadequate or poorly timed opportunities to obtain sleep.

**(2)** A nonpunitive reporting system permits crewmembers and other employees to report subjective fatigue and, from time to time, request relief from duties because of chronic fatigue. These reports contain valuable data, especially when coupled with information about the conditions that contributed to fatigue, such as the work schedule for the week prior to the report. Subjective reports of fatigue can underestimate the true extent of performance impairment, especially when an individual is already suffering from acute or chronic fatigue due to sleep loss or circadian disruption (Dinges, 1989; Horne, 1985; Rosekind et al., 1994; Wylie et al., 1996). Therefore, data on procedural errors and flight exceedances, Aviation Safety Action Program (ASAP) or Aviation Safety Reporting System (ASRS) reports, and flight operations quality assurance (FOQA) data may help a certificate holder to objectively document fatigue. Certificate holders may couple data sources with scheduling information or other event data reported by crewmembers that implicate the potential for fatigue (e.g., flight delays and irregular operations). A nonpunitive reporting system is essential to encouraging the reporting of fatigue-related events as part of the overall safety system.

**b. Fatigue Analysis Methods.** An FRMS should be part of the overall risk identification and management approach that employs both proactive and reactive processes to monitor, manage, and mitigate operational risk. Certificate holders can use commercially available computer models to assess average performance capability from sleep/wake history, placement within the circadian cycle, and duty schedule information (Hursh and Van Dongen, 2010). Certificate holders can embed models within the FRMS process to help themselves to understand the likely effects on individual performance of sleep obtained before and during trip patterns. Using these models (although it is not required) incorporates the latest scientific research on human circadian systems, sleep, and performance capability, and can be useful for rapidly estimating fatigue levels associated with proposed new routes or schedule changes. However, certain assumptions and limitations need to be taken into account. Models are not a substitute for a comprehensive FRMS; they are one useful component of an FRMS.

**(1) Retrospective (Reactive) Processes for Oversight of Schedules.** Certificate holders can use a science-based fatigue model to assess the estimated fatigue levels associated with current or past schedules and determine which schedules are more vulnerable to increased fatigue levels and reductions in performance. First, certificate holders identify those schedules (both trip sequences and monthly pilot schedules) that have been associated with the greatest levels of fatigue. Next, certificate holders can derive the fatigue factors present and examine the potential for schedule changes to reduce fatigue. Such changes might include additional layover days, additional recovery days, augmented crews to permit in-flight sleep opportunities, or rescheduled block times to avoid critical tasks at times during or near the WOCL.

**(2) Prospective (Proactive) Processes for Oversight of Schedules.** Certificate holders also can assess proposed schedules for potential fatigue impact by using the method described above. Trip sequences that have been identified as leading to acute and chronic fatigue can be removed or modified to prevent the accumulation of fatigue across a bid schedule. For scheduled operations, rules may be embedded into the schedule creation process to avoid those conditions that, according to the fatigue model, could lead to excessive fatigue risk.

**(3) Identification and Management of Aviation Fatigue Drivers.** Many operational drivers of fatigue occur in any aviation environment. Some of the common factors that certificate holders must manage to minimize fatigue risk in aviation operations are:

- Crew flight and duty periods, and rest breaks to reduce fatigue;
- Additional duties assigned to flightcrews that further reduce sleep opportunities;
- Schedule changes that extend duties beyond the published schedule;
- The duration and timing of layovers between successive flight segments;
- Recovery days, following a trip, that permit sufficient sleep to eliminate any accumulated sleep debt prior to scheduling or performing additional flight duties; and
- Optimal utilization of available rest opportunities.

**c. Application of Fatigue Mitigation Procedures.** An FRMS is part of a process that requires shared responsibility among management and flight/cabin crewmembers and builds on feedback and nonpunitive reporting within a “just culture.” Developing mitigation strategies and schedule adjustments should be part of a collaborative management process that includes all the

stakeholders, such as crew schedulers, marketing, safety, and employee representatives.
An FRMS should employ multiple layers of defense to prevent fatigue and fatigue-induced errors from progressing to a level that enables incidents or accidents. Based on an analysis of the factors that lead to fatigue and practical mitigation alternatives, one or more of these mitigations may be applied to reduce fatigue associated with specific schedules or situations. The primary levels of defense and mitigations are:

**(1)** Viewed together, the flight duty schedule, additional tasks assigned to crewmembers, and schedule change provide recovery sleep opportunities. It may be necessary to adjust scheduling rules to reduce the occurrence of identified fatigue drivers.

**(2)** Maximizing use of available sleep opportunities reduces cumulative fatigue. This level of defense is largely the responsibility of the crewmember. Comprehensive fatigue training, adequate crew rest facilities at non-domicile locations, and efficient transportation to rest facilities aid crewmembers in fulfilling their responsibility.

**(3)** Implementing error detection and corrective processes can prevent operational consequences of fatigue. Crew Resource Management (CRM) is a recognized and widely used process to encourage crewmembers to work together to detect and prevent operational errors.

**(4)** Conducting comprehensive and objective accident, incident, and error analyses can help in determining when fatigue has been a potential contributing factor, so that those conditions can be avoided in the future.

**11. COMPONENTS OF AN FRMS.** An FRMS is more than a collection of tools, it is a management process built on organizational policies and procedures that implement a systems approach to fatigue management. A “systems approach” means that FRMS is an integrated network of people and other resources performing activities designed to minimize fatigue in the operational environment. This network of people addressing potential fatigue uses the four basic tools described in paragraph 9. Below is a list of the six organizational components of the FRMS, as required under § 117.7. They will vary in complexity based on the size and diversity of the operational environment.

**a. FRMS Policy.** The first required component, as prescribed in § 117.7(b)(1), is an FRMS policy. The FRMS policy will be part of the overall fatigue management policy of the corporation. This policy defines the following:

**(1)** The organizational structure and composition of the FRMS in terms of people and job functions. This group may include individuals responsible for crew scheduling, operational safety, human resources, marketing, training, labor relations, and human factors research and analysis.

**(2)** At a minimum, scheduling policies assure that the organization adheres to all applicable FAA flight and duty time regulations. Beyond that minimum, the organization may develop additional scheduling constraints and rules that have proven to be useful in preventing fatigue under certain situations. Some of these limits and constraints may be formulated during collective bargaining agreements with labor organizations.

**(3)** Individuals are expected to report fit for duty. In the case of fatigue, employees are expected to report for duty sufficiently well rested to be able to safely perform the duties of the job. Likewise, it is the responsibility of the individual to alert the organization when her or she is not sufficiently rested to perform safely, and the organization must have a policy for replacing that person with someone who is well rested. The "absent for fatigue" policy must be designed to ensure that the individual reporting fatigued is not coerced into performing duties.

**(4)** Fatigue is a complex topic. All crewmembers should have adequate training to understand the causes of fatigue, how an individual can maximize the benefits of rest opportunities, the use of various countermeasures to minimize the effects of fatigue, and the overall responsibilities of the individual to report for duty fit to safely perform duties.

**(5)** Policies should define mechanisms for reporting errors and events related to fatigue, including policies that define a nonpunitive fatigue reporting system (refer to "Just Culture;" Reason, 1997).

**(6)** Depending on the size and complexity of the organization, this policy will define various methods utilized to collect objective data on fatigue and the effects of fatigue on performance.

**(7)** The overall FRMS is a Continual Improvement Process (CIP). This requires a set of policies that define how the data on fatigue are subsequently utilized to further improve the management of fatigue. In other words, these are procedures by which the system is self-corrective and adaptive to changing conditions that may cause fatigue.

**(8)** Policies should define manager and employee responsibilities relative to managing fatigue, both on the job and between assignments, including policies providing adequate rest opportunities between assignments and requiring individuals to report fit for duty (i.e., well rested).

**b. Education and Awareness Training Program (§ 117.7(b)(2)).** Comprehensive education and awareness training programs applicable to the certificate holder's FRMS are essential in providing a foundation and understanding for managing and mitigating fatigue associated with operations where the FRMS authorization is applied. The certificate holder should develop their education and training program to focus on the specifics of the FRMS authorization and applicable flightcrew FRMS operation procedures. Each FRMS authorization will be different; therefore, the education and awareness training program for that FRMS will be specific to that FRMS authorization. If the certificate holder is issued multiple FRMS authorizations, the certificate holder should identify the training items associated with that authorization. For specific guidance in developing an education and awareness training program refer to Appendix 2, Section 3.

**c. Fatigue Analysis and Reporting System (§ 117.7(b)(3)).**

**(1)** This component defines the processes needed to detect, report, and investigate cases of fatigue risk from internal and external sources. It includes objective operational data and methods that enable the certificate holder to develop and evaluate reactive and proactive methods to reduce and manage fatigue risk, including:

- Trip scheduling,
- Crew scheduling (rostering), and
- Rest periods.

**(2)** There are analysis methods, such as biomathematical models of fatigue, which can be used to evaluate the fatigue implications of specific city pairs or trips and monthly pilot schedules. This system includes two components: an analysis of the risk of fatigue associated with the trip/schedule and an analysis of the potential consequences of that fatigue risk. Based on this risk and consequence analysis, proactive corrective action can be taken to mitigate the risk. In addition, the fatigue reporting system may suggest that certain schedules are causing fatigue, and corrective steps can be taken to analyze the source of the fatigue and prevent a similar set of circumstances in the future.

**d. Monitoring Fatigue in Flight and Cabin Crew (§ 117.7(b)(4)).** Conceptually, this is similar to the fatigue analysis and reporting system component, but this component focuses on individual crewmember reports of fatigue. These reports provide feedback to the certificate holder about conditions perceived to contribute to fatigue.

**(1)** To maximize the utility of such reports, procedures must be arranged to capture all relevant information, such as the schedule leading up to the fatigue report, the actions of the employee to obtain rest, subjective and objective evidence of fatigue, environmental conditions that may have exaggerated or contributed to fatigue, relevant health or medical conditions, specific actions (commissions and/or omissions) related to the incident, and communications prior to and during the event. Corporate policy must provide protection of privacy and methods to protect the employee from adverse actions that would discourage reports of fatigue.

**(2)** Technologies developed to monitor sleep and performance in crewmembers can be used to supplement self-reports of fatigue. While it may not be practical to apply these technologies continuously, periodic studies of actual sleep (using actigraphs or logbooks) and fatigue (using performance measures and subjective ratings) can be highly valuable for objectively measuring the extent of fatigue across different kinds of operations and isolating key fatigue drivers (Hursh and Van Dongen, 2010). The certificate holder can use the results of these assessments to inform the analysis and forecasting functions of the FRMS to better assess potential fatigue in future operations (e.g., in a proposed new schedule).

**e. Incident Reporting Process (§ 117.7(b)(5)).** Reports of adverse events that may be attributable wholly or in part to fatigue are similar to crew reports, and can serve as a mechanism for obtaining all relevant information regarding fatigue contributions to the incident. Ideally, corporate policy would define how an adverse event is evaluated for potential fatigue involvement and also define a methodology for conducting a detailed Root Cause Analysis (RCA). Details of RCAs are available elsewhere (refer to the current edition of AC 120-59, Air Carrier Internal Evaluation Programs) but at a minimum, the incident investigation and reporting process must obtain all the necessary information to trace the root cause of the incident, especially the potential level of fatigue and the conditions that contributed to the fatigue-related event. The FRMS policy must provide for protection of privacy and methods to protect the employee from adverse actions that would discourage reporting events and conditions surrounding the events.

**f. Performance Evaluation (§ 117.7(b)(6)).** An FRMS is a self-correcting process that includes evaluating the results of prior monitoring, analysis, training, and mitigation. Policies and procedures, based on the evaluation of results and the effectiveness of the FRMS in reducing fatigue, provide feedback to the system for continuous performance improvement.

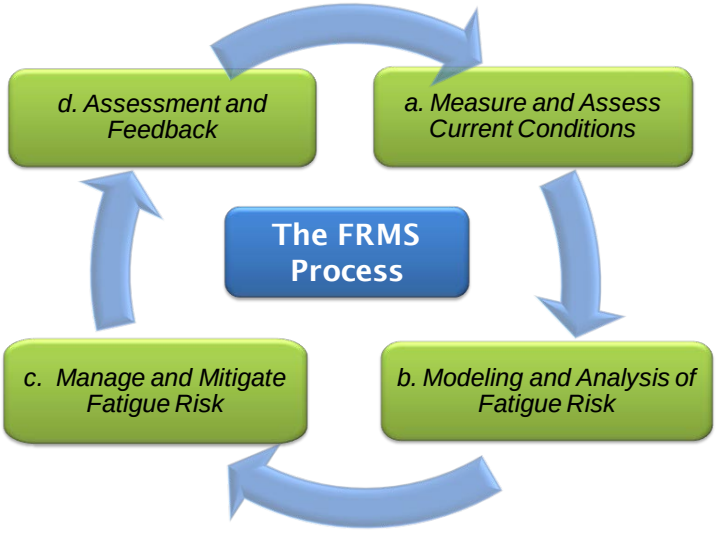
**(1)** The CIP includes the following:

- A system for evaluating and reporting the effectiveness of the FRMS, including reporting that is available to the regulator.
- A process whereby the results of evaluations provide guidance to the FRMS program for self-correction and improvement.
- A system for periodic independent review of the FRMS for its effectiveness in managing fatigue-related risk.

**(2)** While not required, it may be desirable to have a process for capturing economic benefits and costs of the program.

**12. THE CONTINUOUS FRMS PROCESS.** This paragraph reviews four steps that comprise a typical continuous FRMS process (refer to Figure 1, Fatigue Risk Management System Process). Calling an FRMS a "process" means that it consists of a series of actions that build on corporate policies, organizations, and procedures. An FRMS is not just a written set of rules, but a living system that envisions certificate holders detecting and adapting to fatigue impact on their operation and employees carrying out specific actions that implement the policies and procedures within an established organization. The specific actions that comprise the FRMS process break down into four general steps that repeat, leading to continuous performance improvement and reductions in fatigue-related risk. Each step in the process relies on one or more of the fatigue management tools.

**FIGURE 1. THE FATIGUE RISK MANAGEMENT SYSTEM PROCESS**




**a. Measurement and Assessment of Current Conditions.** The first step is to measure and assess the level of fatigue risk associated with current schedules and operations by collecting

information on crewmember reports of fatigue or fatigue-related errors and incidents, and information on the schedules that led up to these reported fatigue-related errors and incidents. Understanding the current conditions within the organization is critical for the development of a valid mitigation plan.

**b. Modeling and Analysis.** This second step helps to determine the root cause of fatigue by modeling the work schedules and analyzing fatigue risk associated with them. This step is crucial to the process because it uses scientific principles about fatigue, perhaps aided by computer modeling, to find the specific operational and crewmember factors that could contribute to significant performance changes due to fatigue (Hursh and Van Dongen, 2010). Managing and mitigating fatigue depends on this step because fatigue risk needs to be measured and connected to the conditions (fatigue drivers) that contribute to the risk. Analysis of the fatigue risk can be broken down into two components: likelihood of occurrence of a particular level of fatigue and the severity of the consequence of fatigue, should it occur (Van Dongen and Hursh, 2010). For example, flight time that occurs between midnight and 0600 will inevitably include the period identified as the WOCL. This low point in performance should be evaluated in relation to the duties to be performed at that time; an expected raised level of fatigue is of greater concern if it coincides with critical flight maneuvers.

**c. Management and Mitigation of the Fatigue Risk.** This third step is based on the measurement and analysis of the fatigue-causing conditions. It requires explicit and regular management activity to consider the information from the first two steps and engage all the stakeholders in a collaborative process to develop solutions to address the fatigue-causing factors.

**d. Assessment and Feedback.** The fourth step in the process is collection of evidence of success in the form of improved schedules, additional sleep opportunities, enhanced training, and revised policies combined with objective data that demonstrate that these changes have effectively reduced fatigue. Evidence of reduced fatigue includes fewer reports of fatigue and/or errors due to fatigue, evidence of increased sleep, or modeling of schedules that predicts improved performance and reductions in fatigue related risk. This step is important and essential for continuous process improvement. Some measures may not prove to be as effective in reducing fatigue as anticipated, leading to a need for further adjustments. Additionally, changes in schedules, turnover in the workforce, added demands for service, and the addition of new routes can lead to emerging pressures that contribute to increased fatigue risk. This step allows for further adjustments to improve current operations and correct for changes in future operations.

**13. ROLES AND RESPONSIBILITIES.** This paragraph describes the general roles and responsibilities of the three primary stakeholders in the FRMS process: the certificate holder, the employees, and the FAA. The stakeholders should regard the roles and responsibilities described here as a starting point. These general roles and responsibilities are not an exhaustive description of the various actions to be taken by each group during the development and execution of the FRMS. Many of the details left to be defined depend on the specifics of each operation.

**a. Certificate Holder.** For the certificate holder, there are five general responsibilities:

**(1) Initial Commitment.** The certificate holder is responsible for taking the initiative to develop, document, and implement the scientifically based FRMS. First, the organization must understand what developing an FRMS entails and must garner the commitment of its leadership to support the process. Second, the organization must be willing to commit the resources of time and money to assign individuals in the organization to develop and sustain the FRMS.

**(2) Assign FRMS Team.** Once the certificate holder identifies a team to develop the FRMS, the certificate holder is responsible for tasking the team to develop policies, training, data acquisition processes, analysis methods, and management procedures to implement, audit, and guide the FRMS process.

**(3) Commitment of Resources.** An FRMS is not a one-time activity; an FRMS is a living system that requires a continuing commitment of resources to support the effectiveness and progressive improvement of the process. The size of the resource commitment will depend on the size and complexity of the operation, but it does not end once the certificate holder establishes the FRMS.

**(4) Collaboration.** An effective FRMS is a collaborative process that involves all the stakeholders in discussion and joint action to be successful. It is the certificate holder's responsibility to provide the mechanisms for collaboration/consultation among managers, employees, and the regulator. The certificate holder is responsible for creating a "just culture" where managers and employees can share information about fatigue without threat of reprisal or disciplinary action. In keeping with the responsibility of each crewmember to only accept duty when he or she is adequately rested to safely perform his or her duties, it is the responsibility of the organization to develop a nonpunitive policy for responding to legitimate reports of fatigue and providing reserves to replace fatigue-impaired crewmembers.

**(5) Customization.** The certificate holder can tailor an FRMS to the size of the organization. For a large organization with an entire department dedicated to each primary function, it will be necessary to have a Fatigue Safety Action Group (FSAG) to coordinate the fatigue-related initiatives across departmental boundaries. Within a smaller organization, it may only require that a single person be assigned the responsibilities to oversee the program. Likewise, within a large organization, there may be multiple sources available to support the data requirements of the FRMS, while, in a small organization, data may be limited to reports of fatigue from pilots and occasional reports of procedural errors.

**b. Employees/Crew.** For the employees/crew there are three main responsibilities:

**(1) Get Enough Sleep.** The only remedy for sleep deprivation is sleep and it is the employee's responsibility to use the facilities and sleep opportunities to obtain rest, sleep, and meals. Each person has a unique requirement for sleep and only the individual can decide how much sleep is adequate to maintain alertness and performance. As a general guide, the average person is thought to require about 8 hours of sleep per day, although individual differences exist in sleep need, ranging from 7-9 hours. In general, it is the employee's responsibility to get as much sleep as they need and to take additional sleep when they feel fatigued or unfit for duty.

**(2) Plan Sleep Ahead of Time.** Getting adequate sleep requires planning with future duty times in mind. For example, if duty will require an early morning awakening, then the employee should plan to go to bed early the night before so as to be fully rested for the next duty. If the next duty will commence in the evening, the employee is responsible for taking an afternoon or evening nap so that her or she does not start work with eight or more hours of continuous wakefulness before the start of duty.

**(3) Report Fatigue.** If circumstances preclude sufficient sleep for the employee to be adequately alert and rested and to perform duty, whether they are the result of the schedule, delays, illness, life events, or personal actions, it is the employee's responsibility to report his or her state of fatigue to the certificate holder. The employee should not accept the responsibilities of duty when fatigued or feeling unfit to perform assigned duties to the extent that the safety of the flight may be jeopardized.

**c. Regulator.** A regulator needs to be able to see that a certificate holder has a well defined FRMS plan that provides for at least an AMOC to that provided by the applicable prescriptive flight, duty, and rest regulations. Beyond evaluation of the plan, the regulator has the responsibility to monitor the application of the FRMS plan and evaluate measures of outcomes to ensure that an AMOC is, in fact, provided by the FRMS. Both of these steps are critical to the success and public acceptance of an FRMS. The assessment requires evaluation of both the FRMS plan and the FRMS process and outcomes. The following are the regulator's responsibilities for guiding and assessing a certificate holder's FRMS:

**(1)** The regulator has the responsibility to provide descriptions of the essential components and guidance for the steps required to implement an acceptable FRMS. Given the complexity of the aviation industry, such guidance will necessarily be general in nature to allow for adaptation to the size of the organization. This AC provides useful guidance for the regulator and certificate holder.

**(2)** For each certificate holder, the regulator reviews the components of the system (structures, policies, and process) and assesses whether those components are implemented on an ongoing basis.

**(3)** Prior to implementation, the regulator evaluates whether the FRMS, as planned, would be expected to establish an AMOC (forecasting function) to that provided by compliance with established flight time/duty time regulations.

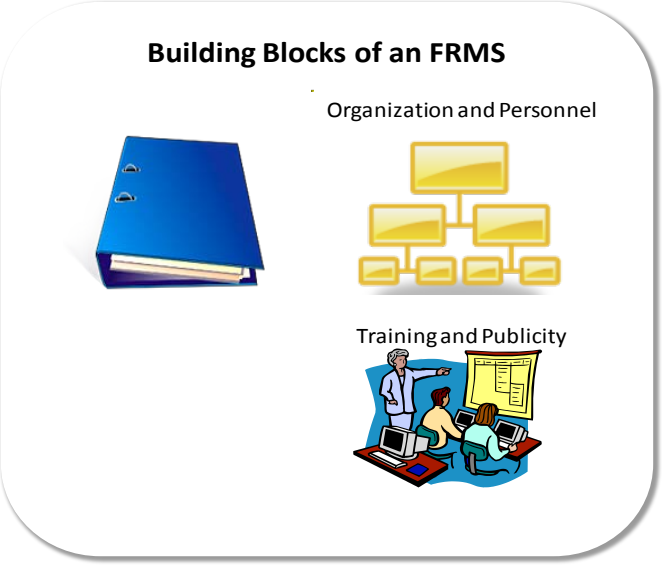
**(4)** Once implemented, the regulator periodically evaluates if the FRMS, in practice, is meeting safety goals (auditing function).

**(5)** The regulator must evaluate if the FRMS process itself is responsive to feedback for continuous improvement (tracking progress).

**14. IMPLEMENTATION.** Details of implementation will depend greatly on the complexity of the organization and the demands of the operational conditions confronted by flightcrew. This AC does not provide a step-by-step implementation guide, but rather details the general progression of the implementation process and several potential implementation pitfalls.

**a. Resources.** In order to implement an effective FRMS, the organization must commit resources to acquire and develop the four basic building blocks (refer to Figure 2, Building Blocks of a Fatigue Risk Management System):

**FIGURE 2. BUILDING BLOCKS OF A FATIGUE RISK MANAGEMENT SYSTEM**




**(1) Policies and Procedures.** The foundation of the FRMS is documentation that defines the policies and procedures that guide FRM, representing the commitment of the organization to the process and clear statements defining how the system will function. The basic elements of that documentation have been outlined in this AC, but the detail and complexity of the system will depend on the size and diversity of the organization and its operation.

**(2) Organization and Personnel.** An FRMS is more than documentation; it is an active process that is implemented by members of the organization who regularly meet to review data on fatigue indicators, analyze contributing factors to fatigue, take reactive and proactive actions to mitigate fatigue, audit the effectiveness of the system, and take corrective action to continuously improve the system. Most organizations can form a defined FSAG to implement the system. The committee should include representatives of all departments and groups that have a role in reporting, managing, and mitigating fatigue.

**(3) Tools and Methods.** A variety of tools and methods are instrumental in aiding the activities of the FRMS organization, such as fatigue modeling, statistical analysis software, performance and sleep measurement systems, and reporting forms and databases. The tools do not constitute the FRMS, but they are essential for the system to function effectively. The organization must be willing to commit resources to procure the necessary supporting tools if the FRMS is to be effective.

**(4) Training and Publicity.** Training operational personnel and managers about the physiological and behavioral foundations of fatigue, the operational and environmental drivers of fatigue, and effective fatigue mitigations is essential to managing fatigue risk. Furthermore, all personnel must know the corporate policies that are the foundation of the corporate FRMS

process, including policies and procedures that govern fatigue reporting, fitness for duty, absence for fatigue, incident reporting, employee privacy, and prevention of coercion to perform duties while fatigued. Finally, an effective FRMS includes feedback and publicity about the system to all affected employees to encourage cooperative participation in the corporate FRM strategy.

**b. Extending Processes.** The building blocks of the FRMS will be an extension of existing processes to manage overall operational safety. For example, incident report forms may already exist and need only be expanded to collect information relevant to a fatigue analysis. An organizational structure may already exist to implement safety management, and the addition of an FSAG might be the only change in the organization.

**c. Developing an FRMS.** The initial development of an FRMS will start with a certificate holder assembling the building blocks described above, starting with developing the policies and procedures and establishing the FRMS organization. The organization will then acquire the necessary tools and methods, and develop supporting training and publicity programs. There are several pitfalls to avoid in this complex process.

**(1)** The FRMS organization, such as the FSAG, should include representatives of all the key departments and groups that have a role in identifying, managing and mitigating fatigue in operations. FRM is a collaborative process and will require the commitment of key leaders of the organization and the cooperative participation of relevant groups. An example would be the marketing department, which plays a key role in defining trips and schedules. While their primary responsibility is to advance the business interests of the corporation and provide service to customers, marketing also has a key role in defining the requirements of schedules that may be causing excessive fatigue. Its participation in finding acceptable alternatives that reduce fatigue is essential to a successful FRMS. At the same time, employee groups (e.g., union representatives) should also participate in the process because managing and mitigating fatigue is a shared responsibility between the organization and the employees. Ensuring that employees understand and embrace their responsibilities to report for duty well rested is just as important as arranging schedules that provide sufficient rest opportunities.

**(2)** There is a danger that the FSAG may adopt a reactive approach to fatigue management, taking constructive action only in response to reports of fatigue or fatigue-related adverse events. The more effective approach is to minimize fatigue by using available tools to forecast potential fatigue well in advance of actual operations, and taking corrective action to proactively eliminate potentially fatiguing schedules or conditions prior to their occurrence. An indicator of a highly effective FRMS is the frequency of such proactive corrective actions.

**(3)** The FRMS should include a methodology for evaluating the success of the program and make changes in the program for process improvement. Two equally important parts of the evaluation and validation process are necessary. The first is self-evaluation using established metrics that reflect the degree of fatigue in the organization. The FSAG should monitor those metrics regularly, looking for trends over time that suggest the need for change or validate the effectiveness of actions already taken. The second is an occasional independent audit of the program by an outside agency or consultant.

**(4)** An outside observer familiar with FRMS principles and cognizance of best practices developed by other organizations can be an invaluable aid to improving the effectiveness and efficiency of the FRMS process.

**15. FRMS APPLICATION PROCESS.** For a full description of the FRMS approval process, see Appendix 2, Section 7. The FRMS approval process consists of five steps that must be satisfactorily completed in succession. Each step is referred to as a phase. Within each phase are specific tasks that must be completed before the certificate holder may move to the next phase. These tasks are compiled into number gates. Each gate must be completed in succession before that phase is considered completed. Appendix 2, Figure 2-6, Fatigue Risk Management System Approval Process, provides a graphic depiction of the FRMS approval process. The five phases of the approval process are:

- Phase 1: Preapplication, Planning, and Assessment (4 Gates).
- Phase 2: Formal Application (2 Gates).
- Phase 3: Documentation and Data Collection Plan (1 Gate).
- Phase 4: Demonstration and Validation (1 Gate).
- Phase 5: Authorization, Implementation, and Monitoring (1 Gate).

**NOTE: Appendix 2 of this AC provides a complete, step-by-step process for applying for an FRMS authorization.**

/s/ for

John M. Allen,
Director, Flight Standards Service

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# APPENDIX 2: FATIGUE RISK MANAGEMENT SYSTEM DEVELOPMENT

## SECTION 1. INTRODUCTION

**1. PRACTICAL APPLICATION OF A FATIGUE RISK MANAGEMENT SYSTEM (FRMS).** An FRMS is as an alternative regulatory approach to providing a means of managing, monitoring, and mitigating fatigue to improve flightcrew member alertness and reduce performance errors. Under an FRMS, a certificate holder develops processes that manage and mitigate fatigue that serve as an alternate method of compliance (AMOC) to the prescriptive rule. Essentially, a certificate holder may apply an FRMS, which is an approved AMOC, to a specific limitations imposed by Title 14 of the Code of Federal Regulations (14 CFR) part 117. However, before the certificate holder may conduct operations under a Federal Aviation Administration (FAA)-approved FRMS, the certificate holder must satisfactorily demonstrate to the FAA that their proposed FRMS satisfactorily demonstrates that the AMOC provides an equivalent level of safety to the safety standards set forth in part 117. At a minimum, the certificate holder's proposed FRMS must include the following elements listed in part 117, § 117.7:

- A Fatigue Risk Management (FRM) policy,
- An education and awareness training program,
- A fatigue reporting system,
- A system for monitoring flightcrew fatigue,
- An incident reporting process, and
- A performance evaluation.

**2. FRMS STRUCTURE.** An FRMS structure employs multilayered defensive strategies to manage fatigue-related risks, regardless of their source. It includes data-driven, ongoing adaptive processes that can identify fatigue hazards and then develop, implement, and evaluate controls and mitigation strategies. These include both organizational and personal mitigation strategies. However, the cost and complexity of an FRMS may not be justified for operations that remain inside the flight and duty time limits and where fatigue-related risk is low. Some certificate holders, therefore, may choose to place only certain parts of their operations under an FRMS, or not to implement an FRMS at all. Nonetheless, where an FRMS is not implemented, it remains the certificate holder's responsibility to manage fatigue-related risks through their existing safety management processes, the Fatigue Risk Management Plan (FRMP), and the prescriptive flight, duty, and rest limitations.

**3. FRM AND SAFETY ASSURANCE (SA).** FRM and SA are the core components of the FRMS. These core activities are governed by an FRMS policy and supported by FRMS promotion processes, and the system must be documented. The FRMS relies on the concept of an effective safety reporting culture, in which personnel have been trained and are constantly encouraged to report hazards whenever they observed them in the operating environment. To encourage the reporting of fatigue hazards by all personnel involved in an FRMS, a certificate holder must clearly distinguish between unintentional human errors, which are accepted as a normal part of human behavior and are recognized and managed within the FRMS, and deliberate violations of rules, policies, and established procedures. The certificate holder should have processes independent of the FRMS to deal with intentional noncompliance. Table 2-1,

Components of Fatigue Risk Management Systems, describes the basic components of an FRMS.

**TABLE 2-1. COMPONENTS OF FATIGUE RISK MANAGEMENT SYSTEMS.**

| Components | Elements |
|---|---|
| Fatigue Risk Management System (FRMS) policy and documentation | |
| Fatigue Risk Management (FRM) processes | • Identification of hazards<br>• Risk assessment<br>• Risk mitigation |
| Safety Assurance (SA) processes | • FRMS performance monitoring<br>• Management of operational and organizational change<br>• Continuous FRMS improvement |
| FRMS promotion processes | • Training programs<br>• FRMS communication plan |

**4. THE ADVANTAGE OF FRMS.** Since an FAA-approved FRMS is applied to exceed a specific limitation, the potential exposure to a fatigue-related event must be mitigated, managed, and monitored. Typically, accidents and incidents result from interactions between organizational processes (i.e. workplace conditions that lead crewmembers to commit active failures) and latent conditions that can penetrate current defenses and have adverse effects on safety. The FRMS approach is designed to apply fatigue science and safety management. It is intended to provide an equivalent, or enhanced, level of safety, while also offering greater operational flexibility to that provided by the prescriptive limitation(s).

**5. PERFORMANCE-BASED APPROACH.** Essentially, an FRMS represents a performance-based regulatory approach. This means that the FRMS defines the requirements and processes required for certificate holders to measure, manage, mitigate, and monitor potential fatigue risk associated with the operation for which the FRMS is applied. Data collection and analysis are vital in determining the flightcrew members' level of performance during that operation proposed by the certificate holder. The FRMS requirements and processes are derived from the data collection and analysis output. Applying the FRM and SA components, the FRMS requirements and processes are measured, managed, and monitored for continuous improvement of the FRMS.

**6. FRMS LIMITATIONS AND CONDITIONS.** The certificate holder's FAA-approved FRMS authorization will be based on analyzed and validated data applicable to the specific limitation to be exceeded under the FRMS. Therefore, the FAA will impose specific limitations and conditions applicable to the FRMS authorization. While conducting operations under an FRMS authorization, the certificate holder must comply with these limitations and conditions along with their FAA-approved FRMS processes and procedures.

**7. FRMS COMPLEXITY.** The complexity of the FRMS structure will vary according to:

- The size of the organization,
- The scope of the FRMS,
- The type of operations where the FRMS will be applied,
- The type and complexity of the operations being managed,
- The relative maturity of the FRMS; and
- The relative importance of the fatigue hazards governed by the FRMS.

## SECTION 2. FRMS POLICY AND DOCUMENTATION

**1. OVERVIEW OF FRMS POLICY AND DOCUMENTATION.** The FRMS policy and documentation are instrumental in defining the organizational measures to support the core operational activities of the FRMS. While FRMS policy specifies the certificate holder's commitment and approach to the management of fatigue risk, it should be noted that the certificate holder must clearly define all elements of their FRMS policy. The certificate holder's FRMS policy must be distinguishable from the general safety policy to allow for a separate review. FRMS documentation describes the components and elements of the entire FRMS. Additionally, the use of FRMS documentation makes it possible to audit the effectiveness of the FRMS (internally and externally) to verify that it is meeting the safety objectives defined in the FRMS policy.

**2. FRMS DOCUMENTATION.** The FRMS documentation describes all the elements of the FRMS and provides a record of FRMS activities and any changes to the FRMS. The documentation can be centralized in an FRMS manual. However, it needs to be accessible to all personnel who may need to refer to it and to the FAA for auditing purposes. The current edition of ICAO Annex 6, Part I, Appendix 8 requires that the certificate holder shall develop and keep current FRMS documentation that describes and records:

- FRMS policy and objectives;
- FRMS processes and procedures;
- Accountabilities, responsibilities and authorities for these processes and procedures;
- Mechanisms for ongoing involvement of management, flight and cabin crewmembers, and all other involved personnel;
- FRMS training programs, training requirements, and attendance records;
- Scheduled and actual flight times, duty periods, and rest periods with significant deviations and reasons for deviations noted; and
- FRMS outputs including findings from collected data, recommendations, and actions taken.

**3. FATIGUE SAFETY ACTION GROUP (FSAG).** As a way of meeting the ICAO requirements described in paragraph 2, it is expected that a certificate holder establish a functional group that is responsible for coordinating the fatigue management activities within the organization.

**a. FSAG Role.** This task should be the responsibility of the FSAG. The FSAG is a group comprised of representatives of all stakeholder groups (e.g., management, scheduling, and crewmembers) together with specialist scientific, data analysis, and medical expertise, as required), that is responsible for coordinating all fatigue management activities in the organization. The principle functions of the FSAG are to:

**(1)** Develop and maintain the FRMS documentation;

**(2)** Manage the FRM processes;

**(3)** Contribute to the FRMS SA processes;

**(4)** Be responsible for the FRMS promotion processes; and

**(5)** Maintain the required documentation.

**b. FSAG Composition.** The composition of the FSAG should reflect the shared responsibility of individuals and management by including representatives of all stakeholder groups (management, scheduling staff, and crewmembers and/or their representatives) and other individuals as needed to ensure that it has appropriate access to scientific and medical expertise.

**c. FSAG Scalability.** The size and composition of the FSAG will vary for different certificate holders, but should be related to the size and complexity of the operations covered by the FRMS, and to the level of fatigue risk in those operations. Figure 2-1, Midsize and Large Air Carriers, illustrates midsize and large air carrier operations and Figure 2-2, Small Air Carriers, depicts operations for a small air carrier. In small certificate holders, a single individual may represent more than one stakeholder group; for example, the chief pilot may also be the primary scheduler. In very small operations, there may not even be a designated FSAG, but simply extra items on the safety meetings agenda, as long as long as all FRM activities are documented. Larger airlines will have specialized departments that interact with the FSAG. While the FAA may wish to observe FSAG meetings as part of its oversight activities, the FAA is not a required part of this group. However, the FAA may also wish to review the minutes and outputs of such meetings as part of their continuous oversight activities.

**4. FRMS SCOPE.** Within the FRMS manual, the certificate holder must identify the scope of the FRMS operations for which the FRMS is applied to their operations. Otherwise, all operations not covered by the FRMS must operate under the applicable prescriptive flight time, duty time, and rest limits. A certificate holder may choose to apply the FRMS to all its operations, or only to specific types of its operations (e.g., a particular fleet, a particular route, or only ultra long-range (ULR) operations). Because the policy statement is typically short, it does not have to detail the scope of the operations to which the FRMS applies; however, the policy statement must identify where the scope of FRMS operations is detailed. As a certificate holder's familiarity and experience with the FRMS builds, they may wish to expand the scope of the FRMS.

**5. FRMS POLICY.** The FRMS policy provides the umbrella under which the FRMS operates. Within the FRMS policy, the certificate holder shall clearly define all elements of the FRMS. The FRMS policy shall also require that the scope of the certificate holder's FRMS operations be clearly defined in their FRMS manual.

**a. Minimum Requirements.** The FRMS policy must identify and address the minimum requirements of the FRMS, which are essentially the prerequisites of an FRMS. As with prescriptive flight and duty limitations, the management of fatigue-related risks associated with the FRMS is a joint responsibility between the certificate holder and individual crewmembers due to the particular nature of fatigue. The FRMS policy specifies the certificate holder's commitment and approach to the management of fatigue risk. It is the responsibility of the certificate holder to clearly define all elements of the FRMS in its policy. Additionally, the certificate holder's FRMS policy must be able to be distinguished from the general safety and operational policy to allow separate review. Minimum requirements for the FRMS policy shall:

**(1)** Reflect the joint responsibility among the certificate holder's management, flight and cabin crews, and other involved personnel;

**(2)** Clearly state the safety objectives of the FRMS;

**(3)** Be signed by the accountable executive of the organization;

**(4)** Be communicated, with visible endorsement, to all the relevant areas and levels of the organization;

**(5)** Declare management's commitment to effective safety reporting;

**(6)** Declare management's commitment to providing adequate resources for the FRMS;

**(7)** Declare management's commitment to continuous improvement of the FRMS;

**(8)** Require that clear lines of accountability for management, flight and cabin crews, and all other involved personnel are identified; and

**(9)** Require periodic reviews of the FRMS policy to ensure that it remains applicable and appropriate.

**b. Responsibility of Crewmembers.** Fatigue is affected by all waking activities, not only work demands, sometimes described as "day-to-day life issues." For example, crewmembers have personal responsibility because they can choose the amount of time they spend trying to sleep during available rest breaks, and choose when to use personal fatigue mitigation strategies. They have a responsibility to use rest periods effectively to be properly rested and fit for duty. Ultimately, as required in § 117.5(d), it is the responsibility of the flightcrew member to affirmatively state on the dispatch or flight release, prior to commencing a flight segment, that he or she is fit for duty. To that point, it is imperative that the flightcrew member obtain the proper amount of rest to safely perform their assigned duties during that flight. In addition, their cooperation is vital for voluntary reporting of fatigue hazards, and when fatigue levels need to be measured for FRM processes and FRMS SA processes. Crewmembers' willingness to cooperate will depend on their confidence that the certificate holder is committed to promoting a "just" culture an effective safety reporting culture.

**c. Responsibility of Management.** Management is primarily responsible for the management and mitigation of fatigue risk because it schedules the work activities of personnel and the distribution of resources in the organization. The FRMS is an organizational system that enables management to meet that responsibility. The accountable executive, when signing the FRMS policy, accepts accountability for the FRMS, either directly or through supervision and management of others, including those to whom the accountable executive has delegated this responsibility. The safety objectives in the FRMS policy must specify what the certificate holder wants the FRMS to achieve. To track whether the FRMS is meeting these objectives, its performance needs to be monitored. The FRMS policy needs to be reviewed periodically by the certificate holder to ensure that it is adequate to meet changing operational demands. In addition, it will be subject to periodic review by the FAA.

**FIGURE 2-1. MIDSIZE AND LARGE AIR CARRIERS**

**NOTE: The FSAG should consist of members from management, flight operations, and dispatch or flight following, as applicable. Advisors are assigned to provide the FSAG with input on their area of responsibility to shape the overall FRMS. Additionally, the FSAG will communicate specifics regarding the FRMS to the advisors, as it relates to the advisor's area of responsibility.**

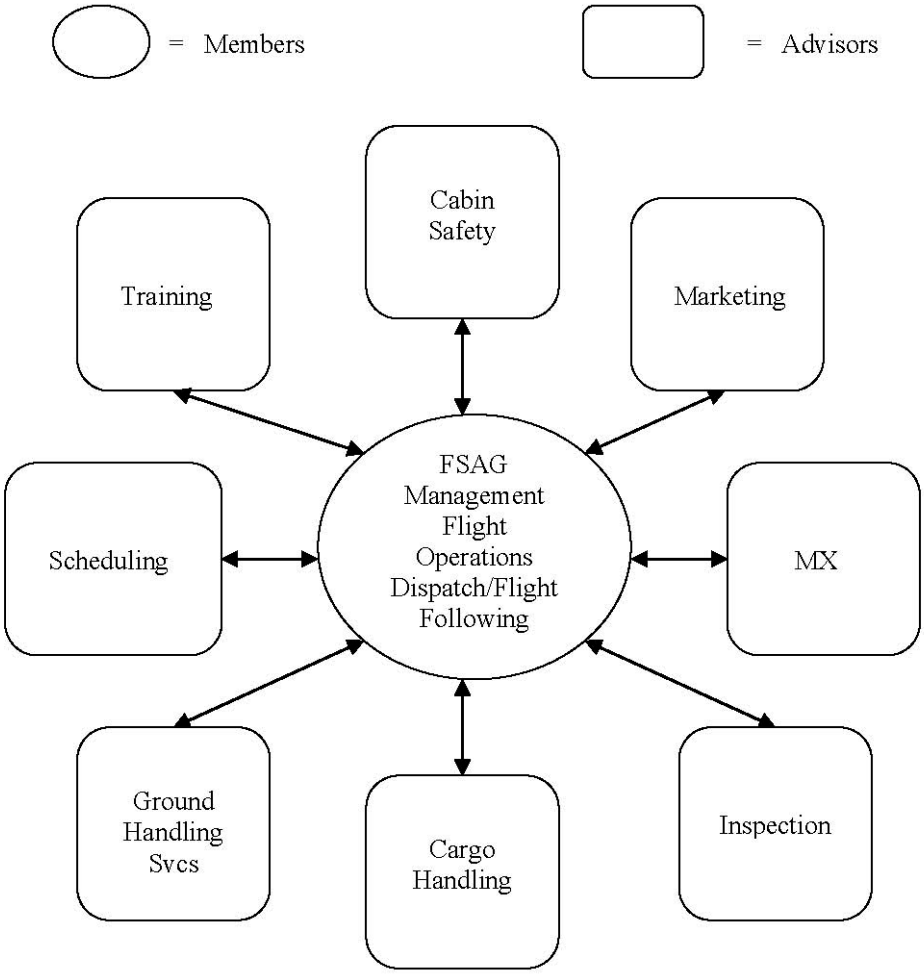

**FIGURE 2-2. SMALL AIR CARRIERS.**

## SECTION 3. FATIGUE RISK MANAGEMENT SYSTEM PROMOTION PROCESSES

**1. INTRODUCTION TO FRMS PROMOTION PROCESSES.** This section outlines the FRMS promotion processes, which includes training programs, a communication plan, and the links between the FRMS promotion processes and other FRMS components. Along with the FRMS policy and documentation, the FRMS promotion processes support the core operational activities of the FRMS.

**a. Training.** An Education and Awareness Training program, as prescribed in part 117, § 117.7(b)(2), is a required element of the certificate holder's FRMS. The objective of the certificate holder's FRMS Education and Awareness Training program is to ensure that all involved personnel are trained and competent to undertake their responsibilities relevant to the certificate holder's FRMS. In addition to the FRMS training program, the training completion standards for both initial and recurrent training should be specified in the FRMS documentation. The certificate holder must maintain FRMS training records in accordance with 14 CFR part 121, § 121.683. The FRMS training program should emphasize the key principles of fatigue science, management of sleep, and understanding the effects of the circadian body clock to illustrate the relevancy not only to individual's roles in the FRMS but also to their lives outside of work. Thus, FRMS training covers issues that everyone can identify with personally and promotes the concept of shared responsibility in an FRMS.

**b. Communication.** An FRMS relies on effective communication throughout the certificate holder's organization. On the one hand, there needs to be regular communication about the activities and safety performance of the FRMS to all stakeholders. Depending on the structure of the organization, this may come from the FSAG or an accountable executive responsible for the FRMS communication plan. On the other hand, crewmembers and other stakeholders need to communicate promptly and clearly about fatigue hazards to the FSAG or other relevant management.

**2. FRMS PROMOTION PROCESSES.** FRMS promotion processes support the ongoing development of the FRMS and the continuous improvement of its overall performance for maintaining optimum safety levels. The following shall be established and implemented by the certificate holder as part of its FRMS:

**a. Training Programs.** Training programs to ensure competency commensurate with the roles and responsibilities of management, flight and cabin crew, and all other involved personnel under the planned FRMS; and

**b. Communication Plan.** An effective FRMS communication plan that:

**(1)** Explains FRMS policies, procedures, and responsibilities to all relevant stakeholders; and

**(2)** Describes communication channels used to gather and disseminate FRMS-related information.

**3. FRMS EDUCATION AND AWARENESS TRAINING PROGRAMS.** In addition to the above requirements, the current edition of ICAO Annex 6, Part I, Appendix 8 requires that a

certificate holder maintain documentation that describes and records FRMS training programs, training requirements, and attendance records. It further recommends that regulators have competency requirements for FRMS training instructors, who may be part of a certificate holder's internal training department or external contractors.

**4. WHO NEEDS TO BE TRAINED?** For an FRMS to be effective, all personnel who contribute to FRMS safety performance need to have appropriate training. The FRMS training audience should include the executive accountable for the FRMS, crewmembers, crew schedulers, dispatchers, persons holding operational control, individuals responsible for management oversight of these areas, all members of the FSAG, and personnel involved in overall operational risk assessment and resource allocation.

**5. FRMS TRAINING PROGRAM.** The content of training programs should be adapted according to the knowledge and skills required for each group to play their part effectively in the FRMS. All groups require basic education about the dynamics of sleep loss and recovery, the effects of the daily cycle of the circadian body clock, the influence of workload, and the ways in which these factors interact with operational demands to produce fatigue. In addition, it is useful for all groups to have information on how to manage their personal fatigue and sleep issues. Schedulers and dispatchers should have a comprehensive understanding in the use and limitations of any scheduling tools and biomathematical models or other algorithms that may be used to predict the levels of crewmember fatigue across schedules and rosters.

**a. Curriculum.** The FRMS training curriculum should provide a full understanding of all FRMS components and elements: policy and documentation; processes for hazard identification, risk assessment, mitigation, and monitoring; SA processes for monitoring FRMS performance, managing change, and continuously improving the FRMS; and FRMS promotion processes, including training and communication. The training should provide a robust understanding of how scheduling affects sleep opportunities and interacts with the circadian biological clock cycle, the fatigue risk that this creates, and how it can be mitigated through scheduling. The training should provide an in-depth understanding of the certificate holder's flightcrew member FRMS operating procedures. Lastly, the training program should highlight the processes and procedures for implementing scheduling changes recommended by the FSAG.

**b. Outline.** The following is an outline of subjects that may be incorporated into the FRMS training curriculum:

**(1) Overview of the FRMS Concept.**

**(a)** Definition.

**(b)** Purpose.

**(c)** An overview of the FRMS structure and how it works in the certificate holder's organization, including the concepts of shared responsibility and an effective reporting culture.

**(d)** FRMS SA metrics used by the organization.

**(e)** FRMS regulatory requirements.

**(f)** FRMS structural components.

**(g)** The role of the FSAG.

**(h)** The current edition of Advisory Circular (AC) 120-100, Basics of Aviation Fatigue.

**(2) Fatigue Mitigation and Managing Rest.**

**(a)** An overall understanding of crewmember fatigue and the safety risk that it represents to the organization.

**(b)** Basic environmental factors that lead to fatigue.

**(c)** General strategies to maintain alertness and recover from sleep loss.

**(d)** Causes and consequences of fatigue in the operation(s).

**(e)** Signs of fatigue.

**(f)** The importance of accurate fatigue data (both subjective and objective).

**(g)** Personal strategies that they can use to improve their sleep at home and to minimize their own fatigue risk while on duty.

**(h)** Basic information on sleep disorders and their treatment.

**(3) Tools for an Effective FRMS.**

**(a)** Fatigue assessment and analysis methods.

**(b)** Identification and management of aviation fatigue drivers.

**(c)** Fatigue mitigation approaches.

**(d)** Positive safety culture.

**(4) Components of an FRMS.**

**(a)** FRM policies.

**(b)** Education and awareness training.

**(c)** Fatigue analysis and reporting system.

**(d)** Fatigue monitoring methods.

**(e)** Fatigue-related incident reporting process.

**(f)** FRMS performance evaluation.

**(g)** Continuous improvement process.

**(5) FRMS Roles and Responsibilities.**

**(a)** Certificate holder.

**(b)** Crewmember/employee.

**(c)** Schedulers/dispatchers.

**(d)** Operational control personnel.

**(e)** Management personnel.

**(f)** FSAG.

**(g)** Other stakeholders.

**(h)** FAA responsibilities.

**(6) FRMS Implementation.**

**(a)** Policies and procedures.

**(b)** Organization and personnel.

*1.* FSAG.

*2.* Relationships to other safety personnel.

**(c)** Tools and methods.

**(d)** Training and awareness.

**(7) Safe Scheduling Policies and Procedures.**

**(a)** Proactive and adaptive fatigue mitigation.

**(b)** Work schedule oversight and monitoring.

**(c)** Crew augmentation.

**(d)** Circumstances beyond the control of the certificate holder.

**(8) Records and Reports.**

**(a)** Schedule accuracy.

**(b)** Reports of fatigue by flightcrew members.

**(c)** Fatigue-related events.

**(d)** How reports of fatigue and other related data are processed.

**(e)** Records of the activities of the FSAG and resulting interventions.

**(9) FRMS Implementation Policies and Procedures.**

**(a)** Organizational policies and procedures that establish the FRMS.

**(b)** Flightcrew member operating procedures related to FRMS.

**(10) Continuous Performance Improvement Process.**

**(a)** FRMS performance evaluation.

**(b)** Work schedule modeling and fatigue risk analysis.

**(c)** Management and mitigation of fatigue risk.

**(d)** Assessment, feedback and corrective action.

**(e)** Reporting intervals.

**6. DELIVERY OF FRMS TRAINING.** There is a variety of ways in which FRMS training can be delivered, each of which has strengths and limitations. Live training sessions with a trained instructor have the advantage that crewmembers can ask questions about their specific issues or concerns and can learn from each other's experiences. Face-to-face contact with different stakeholders in the FRMS can facilitate building the safety culture. However, live training requires coordinating a time and place that groups of participants can attend, and involves time getting to and from the venue, in addition to the time required for the actual training session.

**a. Alternative Methods.** Web-based learning and distributed training (for example, using DVDs) allow greater flexibility in the time and place that training occurs. Individualized training allows participants to proceed at their own pace through the training materials. In Web-based learning, sessions can be networked so that multiple participants can join in with a tutor online. Material can also be made interactive (a task has to be completed, e.g., a short quiz must be answered, before the participant can move on to the next part of the training).

**b. Alternative Materials.** Providing different materials and formats for recurrent training can help to maintain interest. For example, recent fatigue reports or FSAG interventions can be used as case studies to illustrate and revise concepts covered in the initial training material. Recurrent training can also cover changes to the operations or the FRMS and scientific and regulatory updates. The frequency and nature of recurrent training needs to be decided by the

FSAG, in consultation with professional trainers (internal or external to the certificate holder) as needed.

**7. TRAINING FREQUENCY.** The FRMS training program must contain an initial and recurrent curriculum. The frequency of the recurrent FRMS training is every 12 calendar-months.

**8. FRMS TRAINING EVALUATION.** The effectiveness of FRMS training and education programs should be periodically evaluated. Examples of evaluation tools can include the following.

**a. Quizzes.** To evaluate immediate knowledge transfer from a training session, participants can be given a short quiz assessing fatigue knowledge, to be completed before and after the training session.

**b. Surveys.** To evaluate the amount of knowledge retained, crewmembers' use of suggested countermeasure strategies, and perceived usefulness of training, a survey can be conducted at a fixed time (e.g., 6 months) after training.

**c. Feedback and Improvement.** Findings from the quizzes and surveys can be used to:

**(1)** Revise the content of the training package, to improve the training on topics that a significant proportion of crewmembers have not fully understood;

**(2)** Provide feedback to trainers on areas where they may need to change or improve their teaching approaches; and

**(3)** Identify areas that need to be reviewed or added in recurrent training.

**9. FRMS TRAINING DOCUMENTATION.** The current edition of ICAO Annex 6, Part I, Appendix 8 requires that a certificate holder keep documentation that describes and records FRMS training programs, training requirements, and attendance records.

**10. FRMS COMMUNICATIONS PLAN.** The current edition of ICAO Annex 6, Part I, Appendix 8 requires a certificate holder to have an FRMS communication plan that explains FRMS policies, procedures and responsibilities to all stakeholders; and describes communication channels used to gather and disseminate FRMS-related information.

**a. Communication.** The FRMS training programs are clearly an important part of the communication plan. Since training intervals are annual, ongoing communication to stakeholders is required. Various media channels may be used to report the activities and safety performance of the FRMS, to sustain interest in fatigue-related matters, and to encourage the continuing commitment of all stakeholders to the FRMS processes. A variety of types of communication can be used, including electronic media (Web sites, online forums, email), newsletters, bulletins, seminars, periodic poster campaigns in strategic locations, and the like.

**b. Content.** Communications about the activities and safety performance of the FRMS (from the FSAG or other designated management) need to be clear, timely and credible

(i.e., consistent with the facts and with previous statements). The information provided also needs to be tailored to the needs and roles of different stakeholder groups, so that people are provided information that is relevant, practical, and concise.

**c. Crewmember Feedback.** Communications from crewmembers are vital for fatigue hazard identification, for feedback on the effectiveness of controls and mitigations, and in providing information for FRMS safety performance indicators (e.g., by participating in surveys and fatigue-monitoring studies). For these communications to be open and honest, all FRMS stakeholders need to have a clear understanding of the policies governing data confidentiality and the ethical use of information provided by crewmembers. There also must be clarity about the thresholds that separate nonculpable fatigue-related safety events from deliberate violations that could result in penalties. Timely feedback to crewmembers who submit fatigue reports is vital. Feedback does not require completion of a full investigation. Every crewmember should receive a timely response to their report with some indication of the planned follow-up activity, such as: "This report has been forwarded to the Fatigue Safety Action Group, which is currently investigating an adverse trend in fatigue reports associated with this trip and is evaluating a number of potential mitigation strategies."

**d. Documentation and Assessment.** The communication plan needs to be described in the FRMS documentation and assessed periodically as part of FRMS SA processes. The communications plan explains FRMS policies, procedures and responsibilities to all stakeholders, and providing timely information on FRMS-related activities, trends, corrective actions, pairing and scheduling policy changes, and fatigue management tips for crewmembers.

## SECTION 4. DATA COLLECTION

**1. DATA COLLECTION SOURCES.** Data collection is a fundamental element for determining the effectiveness of an FRMS. Data collection and analysis is not a task undertaken once in the life cycle of an FRMS; rather, it is one of the certificate holder's day-to-day functions. Data collection provides the certificate holder with an understanding of the suspected areas that contribute to fatigue. It is essential for the certificate holder to gather enough data and information to be confident that they can identify the likely fatigue hazards in their operations. It is instrumental in achieving the objective that the certificate holder must have a good understanding of the operational factors that are likely to cause crewmember fatigue.

**a. Prioritization.** Because fatigue-related impairment affects many skills and has multiple causes, there is no single measurement that gives a total picture of a crewmember's current fatigue level or the factors that might cause fatigue. To decide which types of data to collect, the most important thing to consider is the expected level of fatigue risk. It is not a good use of limited resources to undertake intensive data collection with multiple measures on a route where the fatigue-related risk is expected to be minimal. Therefore, resources should be targeted towards operations where the risk is expected to be highest.

**b. Efficiency.** A balance needs to be maintained between gathering enough data for the certificate holder to be confident about its decisions and actions and the additional demands and cost of the data collection and analysis. Data analysis should provide the certificate holder with an idea of the appropriate mitigations and controls necessary for managing the risk. All measures require resources (financial and personnel) for data collection and analysis. Limited resources need to be used effectively to identify fatigue hazards where controls and mitigations are most needed.

**c. Sample Sources.** A sampling of the following data collection sources might be useful and should be considered by the certificate holder:

**(1) Crew Reporting.**

- Reports of sickness.
- Crews calling in fatigued.
- Crews filing fatigue reports.

**(2) The Company.**

- Flat or peaking flying program on monthly and seasonal basis.
- Category of airfields or seasonality of airfield use.
- Single- or multi-flightcrew member operations.
- Market sector.
- Aircraft operated.

**(3) Scheduling.**

- Schedule stability (especially changes of plus or minus 2 hours, unplanned night stops, time between schedule change, and new/revised duty).
- Scheduling buffers.
- Use of reserves flightcrew members.
- Block hours.
- Duty hours.
- Extensions of flight duty periods (FDP).
- Extension of flight times.

**(4) Days Off.**

- Number of days off.
- Days off spread through the schedule.
- Frequency of single day off usage.
- Leave (how many days taken and how long since last leave period).

**(5) The Duties.**

- Duty transitions.
- Working the Window of Circadian Low (WOCL) (early, late, night duties, scheduled and actual).
- Rest between duties.
- Number of segments per day (scheduled and actual).
- Long/extended duty days (including extended duties due to positioning or 14 CFR part 91 operations).
- Length of FDPs.
- Number of consecutive duty days.
- Augmented and unaugmented flightcrew operations.
- Time zone crossings: frequency and direction.
- Augmented crew routes.
- Length of layovers.
- Rest facilities on the aircraft: class of rest facility.
- Travel time between airport and hotel and the return trip.
- Waiting time for transport (hotel pickups).

**(6) Contingency Plans.**

- Delayed report usage.
- Reserve assignments.
- Time between reserve call and show time.
- Working on days off.
- Delays during the FDP.

**(7) Scheduled vs. Actual.**

- Task analysis of the duty days.
- Operational issues.

**(8) Reportable/Measurable Data.**

- Fatigue incident reports.
- Aviation Safety Reporting Systems (ASRS).
- Aviation Safety Action Program (ASAP) reports.
- Biomathematical computer modeling: fatigue modeling.
- Modeling of pairings, assignments, and actual FDPs and flight times.

**(9) Internal Actions.**

- FSAG meeting minutes.
- Fatigue survey.
- Fatigue report data.
- Internal incident/accident reports.
- External reports, studies, reviews, and accident/incident reports.

**(10) Planned Data Collections.**

- Sleep data.
- Cognitive performance data.
- Flight performance data.
- Scheduling data.

**(11) Other Data Sources.**

- Hazard reporting and investigations.
- Operational data related to fatigue.
- Audits and surveys.
- Reviews and fatigue studies.

**2. FATIGUE REPORT.** A fatigue reporting system is an integral component of the FRMS, as it supports the evaluation of the air carrier's FRMS and provides data points from fatigue-related occurrences. However, to be effective, the fatigue reporting policy must be based upon open communications encouraging employees to report fatigue-related occurrences without fear of reprisal. Voluntary disclosure has proven to be an excellent vehicle for conveying safety information to those individuals having the authority to effect and change policy. The air carrier's fatigue reporting system should support this concept. In return, the air carrier is afforded the opportunity to collect valuable safety information and effect changes in policies, as appropriate, and continue to build upon their safety culture. Figure 2-3, Sample Fatigue Report, is a sample fatigue report providing multiple data points. This sample report may be incorporated as one of the certificate holder's data collection sources.

## FIGURE 2-3. SAMPLE FATIGUE REPORT

| SAMPLE FATIGUE REPORT | | Answer |
|---|---|---|
| **A** | **Fatigue Occurrence** | |
| 1 | In the previous 12 calendar-months, how many times have you experienced fatigue and reported the occurrence? | |
| 2 | When the fatigue event occurred, how many consecutive days had you been on duty? | |
| 3 | In the days leading up to this fatigue occurrence, how many segments had you flown during each duty day within the previous 72-hour period? | |
| 4 | Were you rescheduled for duty during the previous 72-hour period? (Yes or No) | |
| 5 | Prior to this notification, how long has it been since you were on duty or operating as a flightcrew member? | |
| 6 | In the days leading up to this fatigue occurrence, how many hours had you flown during each duty day within the previous 72-hour period? | |
| 7 | In the days leading up to this fatigue occurrence, how many duty hours had you worked during each duty day within the previous 72-hour period? | |
| 8 | Were you performing any other duties for the air carrier on any day within the previous 72-hour period? (Yes or No.) If Yes, answer the following question. | |
| 9 | If you were performing other duties, what was the total time worked each day performing those duties? | |
| **B** | **Commuter** | |
| 1 | Are you a commuter? (Yes or No.) If No, indicate so and move to the next section. | |
| 2 | What form of transportation was used for your commute? | |
| 3 | How long is your commute? | |
| 4 | What was that total time from the time you left your home to start your commute until the time you reported for duty? | |
| 5 | How much time elapsed between the time you arrived at your domicile and your report time? | |
| 6 | Did you receive any additional rest at your domicile prior to reporting for duty? If so, how much? | |

| C | Reserve Pilot Assignment | |
|---|---|---|
| 1 | During the previous 72-hour period, were you assigned as a reserve pilot? (Yes or No.) If No, indicate so and move to the next section. | |
| 2 | Do you regularly hold a reserve line? (Yes or No) | |
| 3 | How many hours had your flown during the previous 24-hour period? | |
| 4 | How many hours had you been on duty during the previous 24-hour period? | |
| 5 | How many hours had your flown during the previous 72-hour period? | |
| 6 | How many hours had you been on duty during the previous 72-hour period? | |
| 7 | How many days had you been on duty during the previous 30 days? | |
| 8 | How many hours had your flown in the previous 30 days? | |
| 9 | When was the last period that you had been assigned at least 24 hours free from all duty? | |
| **D** | **Operational Issues** | |
| 1 | Did you experience any operational or maintenance delays within the previous 72-hour period? If so, please provide details. | |
| 2 | How many rest periods did you have in the previous 72-hour period leading up to the fatigue occurrence? | |
| 3 | Did you have the opportunity to get additional rest between flights? If so, what was the quality of that rest? | |
| 4 | During the previous 72-hour period, did your duty period involve consecutive night duty or continuous duty overnights? (Yes or No) | |
| 5 | If you answered “Yes” to question D4, how many consecutive nights of duty did you perform consecutively? | |
| 6 | If you answered “Yes” to question D4, how many continuous duty overnights did you perform consecutively leading up to the fatigue occurrence? | |
| **E** | **Augmented Crew** | |
| 1 | During the 72-hour period leading up to the fatigue occurrence, did you serve as an operating crewmember in an augmented crew? (Yes or No.) If you answered No, move to the next section. | |
| 2 | Within the previous 24 hours, how many hours did you operate as an augmented crew? | |

| | | |
|---|---|---|
| 3 | Within the previous 72 hours, how many hours did you operate as an augmented crew? | |
| 4 | What classification of onboard rest facility did you use for in-flight rest? (Class 1, 2, or 3) | |
| 5 | What would you estimate was the quality of rest you received during the previous 24-hour period? (Good, Fair, or Poor) | |
| 6 | What would you estimate was the quality of rest you received during the previous 72-hour period? (Good, Fair, or Poor) | |
| 7 | What was the length of your duty period within the previous 24-hour period? | |
| 8 | How many hours had you spent on flight duty periods (FDP) during the previous 72-hour period? | |
| 9 | Did you perform as an operating crewmember during the landing phase? If so, were you the flying pilot or the monitoring pilot? | |
| 10 | During the previous 72-hour period, had you served in a two-pilot crew? (Yes or No.) If Yes, please provide details regarding the length of FDP, number of segments flown in a two-pilot configuration, and the timeframe in which this occurred during the previous 72-hour period. | |
| **F** | **Hotel/Suitable Accommodation** | |
| 1 | Within the previous 72-hour period, what type of suitable accommodation did you use? (Hotel or at Home) | |
| 2 | If you rested at home, were there conditions that interrupted your sleep? (Yes or No.) If Yes, how many interruptions? | |
| 3 | Were the hotels you stayed in regular hotels used by your carrier? (Yes or No) | |
| 4 | Were your hotel rooms located close to the elevator, ice machine, or high traffic area? | |
| 5 | Did you experience environmental issues interrupting your ability to sleep such as social events occurring in the hotel, vehicular traffic, or air traffic? (Yes or No.) If Yes, please explain. | |
| 6 | Did you experience noise from hotel construction or remodeling that interrupted your ability to sleep during your rest period? (Yes or No) | |
| **G** | **Rest (During the 72-hour period leading up to the fatigue occurrence)** | |
| 1 | What was the difference (in time) between your scheduled rest periods and your actual rest periods? | |

| | | |
|---|---|---|
| 2 | How long (in time) was your sleep opportunity during your scheduled rest periods? | |
| **H** | **Sleep Opportunities** | |
| 1 | Within the 24-hour period leading up to the fatigue occurrence, how many hours did you sleep? | |
| 2 | Within the 48-hour period leading up to the fatigue occurrence, how many hours did you sleep? | |
| 3 | Within the 72-hour period leading up to the fatigue occurrence, how many hours did you sleep? | |
| **I** | **Circadian Issues** | |
| 1 | Within the previous 72-hour period, did any part of your duty period fall within the window of circadian low (WOCL)? (Yes or No.) If Yes, please elaborate. | |
| 2 | How many time zones had you flown through within the previous 24-hour period? | |
| 3 | How many time zones had you crossed within the previous 72-hour period? | |
| 4 | Within the previous 72-hour period, had you operated through the nighttime hours (Between 0200 and 0559)? (Yes or No.) If Yes, please explain. | |
| **J** | **Nutrition and Hydration** | |
| 1 | During the 24-hour period leading up to the fatigue occurrence, what was the quality of your meals? (Good, Fair, or Poor) | |
| 2 | During the 72-hour period leading up to the fatigue occurrence, did you have the opportunity to eat properly? (Yes or No) | |
| 3 | During the 24-hour period leading up to the fatigue occurrence, have you experience dehydration? (Yes or No) | |
| 4 | During the 72-hour period leading up to the fatigue occurrence, did you have the opportunity to properly hydrate yourself? (Yes or No) | |
| **K** | **Personal Factors** | |
| 1 | Are you currently experiencing any personal issues that may have contributed to your fatigue occurrence? (Yes or No) | |

| L | Pre-Duty Activities | |
|---|---|---|
| 1 | Within the 24-hour period leading up to the fatigue occurrence, were you engaged in any pre-duty activities? (Yes or No.) If Yes, please explain. | |
| 2 | Within the 72-hour period leading up to the fatigue occurrence, were you engaged in any pre-duty activities? (Yes or No.) If Yes, please explain. | |

**Remarks Section**

| Question # | Comments |
|---|---|
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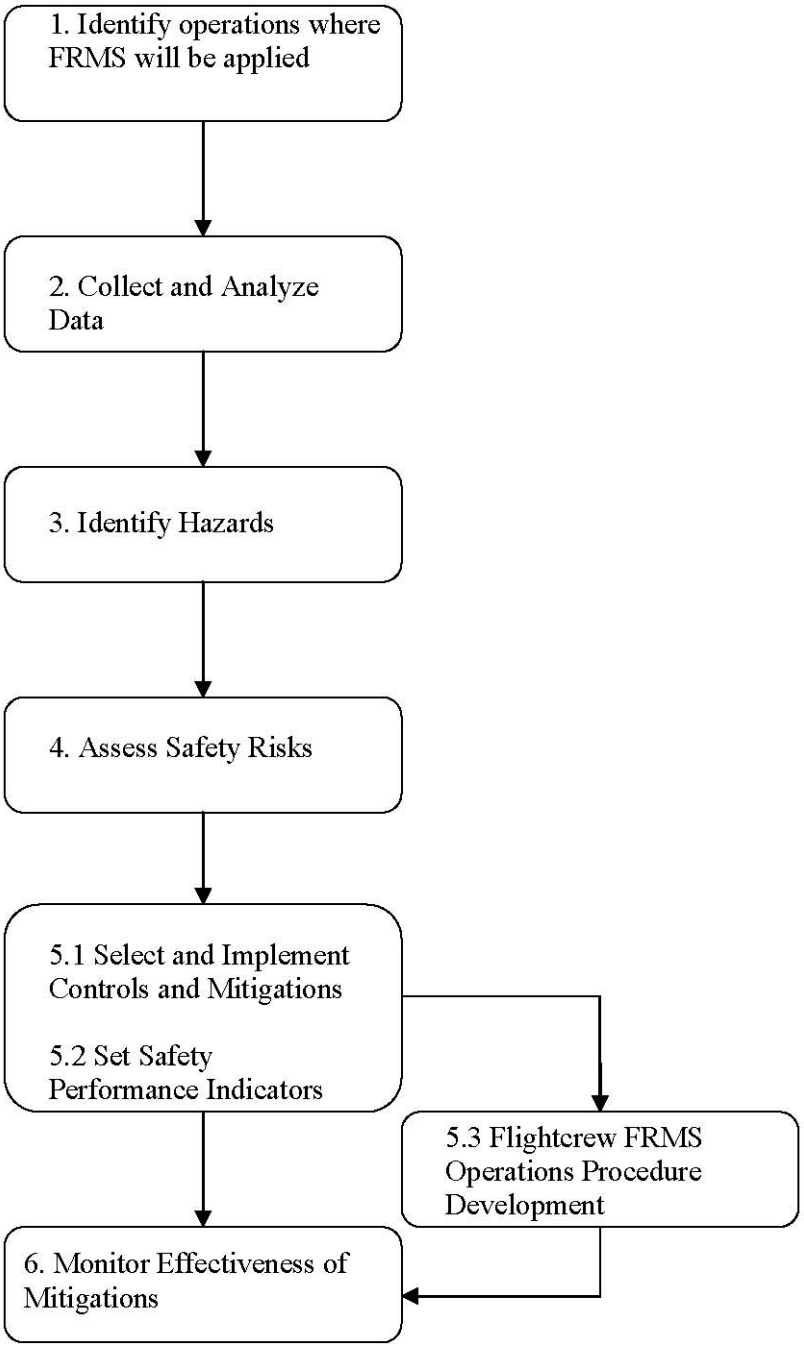
## SECTION 5. FATIGUE RISK MANAGEMENT PROCESSES

**1. SETTING UP FRM PROCESSES.** This section describes the basic steps for setting up and applying FRM processes. FRM processes within an FRMS are specifically designed to manage the risks related to crewmember fatigue. Figure 2-4, Fatigue Risk Management Processes, illustrates these processes.

**FIGURE 2-4. FATIGUE RISK MANAGEMENT PROCESSES**



**a. Processes.** FRM processes are one part of the day-to-day operations of the FRMS. They are designed to enable the certificate holder to achieve the safety objectives defined in its FRMS policy, and are managed by the FSAG. The basic FRM processes are:

**(1)** Identify where fatigue is a hazard;

**(2)** Assess the level of risk that a given fatigue hazard represents; and

**(3)** If necessary, put in place controls and mitigation strategies, and monitor them to make sure that they manage the risk to an acceptable level.

**b. Data Analysis.** To be effective at managing risks, FRM processes require data input from a number of sources, including measurements of the crewmembers' fatigue levels and measurement of operational performance. The key is choosing the right combination of measurements applicable to each operation covered by the FRMS. However, just collecting data is not enough. The data must be analyzed for data output that will be used by the FSAG and others accountable for FRM processes so that informed decisions can be made relative to the FRMS safety performance.

**2. FRM PROCESSES OUTLINE.** The following outlines the FRM processes:

**a. Process 1.0: Identify Operation(s) to which FRMS Processes will be Applied.** It is important that the certificate holder clearly identify the operations where the FRMS will be applied. Different types of flight operations can involve different causes of crewmember fatigue and may require different controls and strategies to mitigate the associated risks. Within its FRMS, a certificate holder may need to develop multiple sets of different FRM processes for different operations. These should be clearly identifiable.

**b. Process 2.0: Collect and Analyze Data.** The FRMS must provide an AMOC and demonstrate that it meets or exceeds the limitations (safety standards) prescribed in part 117. To demonstrate an AMOC of the FRMS, the certificate holder must, prior to FAA approval, define measurements of fatigue that will serve as performance safety standards for the evaluation of the effectiveness of the FRMS.

**(1) Measurements Summary.** An AMOC demonstration of effectiveness of the FRMS will require a combination of measurements.

- Subjective fatigue and sleepiness ratings,
- Objective performance measurements,
- Sleep monitoring and measurement, and
- Circadian rhythm measurements.

**(2) Required Measurements.** The suite of measurements should include the following:

**(a) Performance Measurement.** A range of objective performance tests are used in scientific research. Things to consider when choosing a performance test for measuring crewmember fatigue include the following:

*1.* How long does the test last? Can it be completed at multiple time points (e.g., in the operations room during preflight preparations, near top of climb, near top of descent, and post-flight before disembarking from the aircraft) without compromising a crewmember's ability to meet duty requirements?

*2.* Has it been validated? For example, has it been shown to be sensitive to the effects of sleep loss and the circadian body clock cycle under controlled experimental conditions?

*3.* Is the test predictive of more complex tasks (e.g., crew performance in a flight simulator)?

*4.* Has it been used in other aviation operations, and are the data available to compare fatigue levels between operations?

**(b) Measurement Methodology.** The certificate holder must provide a measurement methodology that will be sufficient to demonstrate that operations under the FRMS do not induce additional fatigue relative to operations under the prevailing prescriptive rules. The data collection and analysis methodology must specify the following components:

*1.* A description of the study population and the operations under which measurements will be collected. The methodology must provide for an unbiased and voluntary selection of participants.

*2.* A definition of what metrics will be derived from each measurement. For example, a reaction time test can provide multiple metrics, such as mean reaction time, long reaction times (lapses), and mean speed.

*3.* A definition of what level of each metric will serve as the safety standard, based on data collected during operations under the prevailing prescriptive rules. The safety standard serves as the baseline against which operations under the FRMS will be evaluated.

*4.* The duration of the study and a schedule of measurements. The data collection schedule must include measurements under the alternative operating procedures, as well as measurements during any subsequent trip by the same individuals.

*5.* A statistical analysis plan that will define how measurements under the FRMS will be evaluated against the safety standard to demonstrate an adequate level of compliance.

*6.* A description of methods used to assure the accuracy and integrity of all data collected to support the proposed FRMS.

**(c) Fatigue Modeling.** The analysis of empirical data may be supplemented by the use of a biomathematical model to estimate the level of fatigue or performance. For example, measurement of sleep could be used as input to a biomathematical model to derive estimates of fatigue or performance. If modeling is used, a justification of the choice of model must be provided, all modeling assumptions, parameters, and initial conditions must be defined, and a

modeling safety standard must be defined, based on the prevailing prescriptive rules, that serves as the baseline for evaluation of fatigue or performance estimates under the FRMS operation.

**(3)** The collection and analysis of data are a prerequisite for the approval of the FRMS and issuance of Operations Specification (OpSpec) A318, Authorization to Conduct Operations under an FRMS. Once the FRMS is approved, similar measurements will be obtained periodically as part of the SA process to confirm the continued effectiveness of the FRMS relative to the established safety standards.

**c. Process 3.0: Identify Hazards.** Identify the specific nature of the fatigue hazard(s) associated with the proposed operations where FRMS will be applied that may need to be managed. The current edition of ICAO Annex 6, Part I, Appendix 8 requires that a certificate holder develop, maintain, and document three types of processes for fatigue hazard identification. These are referred to as predictive, proactive, and reactive processes. A certificate holder shall develop and maintain the following three fundamental and documented processes for fatigue hazard identification as part of the approved FRMS:

**(1) Predictive.** The predictive process shall identify fatigue hazards by examining crew scheduling and taking into account factors known to affect sleep and fatigue and their effects on performance. Methods of examination may include but are not limited to:

- Certificate holder or industry operational experience and data collected on similar types of operations;
- Evidence-based scheduling practices; and
- Biomathematical models.

**(2) Proactive.** The proactive process shall identify fatigue hazards within current flight operations.

**(a) Methods.** Methods of examination may include but are not limited to:

- Self-reporting of fatigue risks;
- Crew fatigue surveys;
- Relevant flight and cabin crew performance data;
- Relevant flight and cabin crew sleep data;
- Available safety databases and scientific studies; and
- Analysis of planned versus actual time worked.

**(b) Crewmember Fatigue Reports.** Reports citing high fatigue levels or fatigue-related performance issues are vital to keep the FSAG informed about fatigue hazards in day-to-day FRMS operations. A series of fatigue reports on a particular route can be a trigger for further investigation by the FSAG. An effective fatigue reporting system requires an effective reporting culture. It needs to:

*1.* Use forms that are easy to access, complete, and submit;

*2.* Have clearly understandable rules about confidentiality of reported information;

*3.* Have clearly understandable voluntary reporting protection limits;

*4.* Include regular analysis of the reports; and

*5.* Provide regular feedback to crewmembers about decisions or actions taken based on the reports and lessons learned.

**(c) Crew Fatigue Surveys.** Crew fatigue surveys fall into two basic types:

*1.* Retrospective surveys that ask crewmembers about their sleep and fatigue in the past. These can be relatively long and are usually completed only once, or at long time intervals (e.g., once a year); and

*2.* Prospective surveys that ask crewmembers about their sleep and fatigue right now. These are typically short and are often completed multiple times to monitor fatigue across a duty period, trip, or schedule. They usually include measures such as sleepiness, fatigue, and mood ratings.

**(d) Performance Measurements.** Performance measurements provide objective data that can be used to supplement the subjective data collected in fatigue reports and survey responses. Currently, there are three main approaches to monitoring crewmember performance:

*1.* Simple tests, developed in the laboratory, which measure aspects of an individual's performance (e.g., reaction time, vigilance, and short-term memory). These performance measurements used to monitor the effectiveness of the FRMS may be the same as those utilized to obtain FAA approval of the FRMS;

*2.* Flight data analysis (FDA), which examines the relationship between identified elements of aircraft performance and pilot performance; and

*3.* Having trained flight deck observers rating the performance of crewmembers on the flight deck (e.g., Line-Oriented Safety Audit).

**(e) Sleep Measurements.** Sleep measurements provide objective data that verify that the sleep assumptions that were the foundation of the FRMS approval remain valid during the implementation of the FRMS. Sleep measurement technology used for ongoing hazard identification may be similar to those used for the FRMS approval.

**(3) Reactive.** The reactive process shall identify the contribution of fatigue hazards to reports and events associated with potential negative safety consequences in order to determine how the impact of fatigue could have been minimized. At a minimum, the process may be triggered by any of the following:

- Fatigue reports,
- Confidential reports,

- Audit reports,
- Incidents, and
- Flight data analysis events.

**d. Process 4.0: Assess Safety Risk.** Conduct a safety risk assessment for each identified hazard. Decide which risks require mitigation. A certificate holder shall develop and implement risk assessment procedures that determine the probability and potential severity of fatigue-related events and identify when the associated risks require mitigation. The risk assessment procedures shall review identified hazards and link them to:

- Operational processes,
- Their probability,
- Possible consequences, and
- The effectiveness and controls of existing safety barriers and controls.

**e. Process 5.1: Select and Implement Controls and Mitigations (Risk Management (RM)).** Implement appropriate mitigation strategies and communicate them to all relevant personnel. When it is decided that a particular fatigue hazard requires action, then controls and mitigations must be identified and implemented. The specific expertise of the FSAG should be used in the selection of these controls and mitigations.

**(1)** All involved personnel should clearly understand the hazard and the controls and mitigations designed to reduce the associated risk. The certificate holder shall develop and implement risk mitigation procedures that:

**(a)** Select the appropriate mitigation strategies,

**(b)** Implement the mitigation strategies, and

**(c)** Monitor the strategies' implementation and effectiveness.

**(2)** If the controls and mitigations perform to an established safety standard, they become part of normal operations and are monitored by the FRMS SA processes. If, however, the controls and mitigations do not perform to an acceptable standard, then it will be necessary to reenter the FRM processes at the Process 2.0, Collect and Analyze Data. This will require gathering additional information and data; and/or re-evaluation of the fatigue hazard and the associated risks; and/or identification, implementation, and evaluation of new or revised controls and mitigations.

**f. Process 5.2: Set Safety Performance Indicators.** Set safety performance indicator(s) to be able to assess whether the mitigation strategies are delivering the required level of risk reduction. Data collected during the first 4 months of the FRMS operation will be compared to the respective model predictions and the performance safety standards from the FRMS validation (Process 2.0) to establish whether crewmember performance and fatigue are in the acceptable range. By the fourth month of the FRMS operation, the fatigue reporting rate (reports per flight segment) and average fatigue report risk level should be comparable to operations under the prevailing prescriptive rules. No "intolerable" fatigue reports should be received.

**g. Process 5.3: Develop Flightcrew FRMS Operations Procedures.** Flightcrew FRMS operations procedures, are developed by the certificate holder and approved by the FAA to provide operational guidance for flightcrew members, dispatchers, schedulers, persons holding operational control, and individuals with oversight management of these areas for operations where an FAA-approved FRMS is applied. Therefore, flightcrew FRMS operations procedures serve as the foundation for disseminating safety-related guidance and procedural information for operations where an FRMS is proposed. FRMS operations procedures should be designed with supporting validated data collected and analyzed from various sources associated with the FRMS operation. Such data sources includes, but not limited to, actigraphy, performance tests, biomathematical modeling, and fatigue monitoring and reporting. Whenever FRMS is applied to any operation flightcrew members, dispatchers, schedulers, persons holding operational control, and individuals with oversight management of these areas for operations, all must comply with the FRMS operations procedures for that operation.

**(1)** As mitigations and controls are identified and validated to reduce fatigue risks associated with a specific FRMS operation, the certificate holder will be responsible for developing operating procedures that support those mitigations and controls. Specific limitations and conditions outlined in the certificate holder's OpSpec A318, Authorization to Conduct Operations under an FRMS, must also be reflected in the FRMS operating procedures. The certificate holder should use FRM and SA to validate and update their FRMS operation procedures. This process adds an additional layer of safety with regard to demonstrating the certificate holder's FRMS operation procedures support their AMOC.

**(2)** As part of the FRMS continuous monitoring and improvement process, the certificate holder will be responsible for evaluating the effectiveness of the FRMS and updating these procedures to support the data results. This data shall be submitted with the certificate holder's reporting interval data. The certificate holder must make available to each flightcrew member, dispatcher, scheduler, person holding operational control, and individual with oversight management of these areas for operations a current copy of the flightcrew FRMS operations procedures. When an FRMS is being applied to any part of the certificate holder's operation, each person involved with the FRMS shall comply with the flightcrew FRMS operations procedures.

**h. Process 6.0: Set Up Processes for Monitoring the Effectiveness of Controls and Mitigations.** If mitigation strategies perform to an acceptable standard, they become part of normal operations and are monitored by the FRMS SA processes. If mitigation strategies do not perform to an acceptable standard, then reenter the FRM processes at the appropriate step.

**(1)** There is a defined validation period for the first 4 months of the operation that involves more intensive monitoring. The FSAG will have regular oversight of all data and fatigue reports coming in and will act in a timely manner when issues arise. Copies of all data collected and associated monitoring data, along with actions taken by the certificate holder to mitigate fatigue events and occurrences, shall be submitted to the FAA during regular scheduled reporting intervals. A report will be compiled and routine processes will be defined for fatigue risk monitoring and management. This report will be available to all interested parties, including the FAA. If the performance indicators are acceptable, the operation will revert to routine monitoring.

**(2)** If the controls and mitigations perform to an acceptable standard, they become part of normal operations and are monitored by the FRMS SA processes. If the controls and mitigations do not perform to an acceptable standard, then it will be necessary to reenter the FRM processes at the appropriate step. This could require:

- Gathering additional information and data;
- Reevaluation of the fatigue hazard and the associated risks; and/or
- Identification, implementation, and evaluation of new or revised controls and mitigations.

## SECTION 6. FATIGUE RISK MANAGEMENT SYSTEM SAFETY ASSURANCE PROCESSES

**1. INTRODUCTION TO FRMS SA PROCESSES.** The FRMS processes is the part of the day-to-day FRMS operations focusing on identifying fatigue hazards, assessing safety risks, putting in place controls and mitigation strategies, and monitoring their effectiveness. This section works through the basic steps in FRMS SA processes, which form another layer in a certificate holder's defenses against fatigue-related risk.

**a. SA Processes.** Figure 2-5, Fatigue Risk Management and Safety Assurance Processes, illustrates the combined elements of the FRM and FRMS SA processes. FRMS SA processes are also part of the routine operation of the FRMS, and they monitor how well the entire FRMS is functioning. The FRMS SA processes:

**(1)** Check that the FRMS is functioning as intended;

**(2)** Check that it is meeting the safety objectives defined in the FRMS policy;

**(3)** Check that it is meeting regulatory requirements;

**(4)** Identify where changes in the operating environment have the potential to increase fatigue risk; and

**(5)** Identify areas for improvement in the management of fatigue risk (continuous improvement of the FRMS).

**b. Continuous Monitoring.** The certificate holder shall develop and maintain FRMS SA processes to provide for continuous FRMS performance monitoring, analysis of trends, and measurement to validate the effectiveness of the fatigue safety risk controls. The sources of data may include, but are not limited to:

**(1)** Hazard reporting and investigations,

**(2)** Operational data related to fatigue,

**(3)** Audits and surveys, and

**(4)** Reviews and fatigue studies.

**c. Management Process.** The certificate holder shall provide a formal process for the management of changes which shall include, but is not limited to:

**(1)** Identification of changes in the operational environment that may affect the FRMS;

**(2)** Identification of changes within the organization that may affect the FRMS; and

**(3)** Consideration of available tools that could be used to maintain or improve FRMS performance prior to implementing changes.

**d. Continuous Improvement.** The FRMS SA process must provide for the continuous improvement of the FRMS. This shall include, but is not limited to:

**(1)** The elimination and/or modification of risk controls that have had unintended consequences or that are no longer needed due to changes in the operational or organizational environment;

**(2)** Routine evaluations of facilities, equipment, documentation, and procedures;

**(3)** Trending of safety performance indicators to determine if there is a need to introduce new processes and procedures to mitigate emerging fatigue-related risks; and

**(4)** As an option, retrospective and prospective biomathematical modeling of schedules to assess potential schedule-related fatigue risk.

**e. Safety Performance Indicators.** The FRMS SA processes use a variety of data and information as safety performance indicators that can be measured and monitored over time. Having a variety of safety performance indicators, plus a safety target for each, is expected to give better insight into the overall performance of the FRMS than having a single measure. Safety performance targets must fall in the tolerable region defined in the risk assessment process and they may need to be revised as operational circumstances change. The information, data, and safety performance indicators from the FRMS processes provide a source of information for the FRMS SA processes. In addition, the FRMS SA processes:

**(1)** Use information and expertise from other sources, both from within the certificate holder's organization and external to it, to evaluate the functioning of the FRMS;

**(2)** Evaluate trends in safety performance indicators to identify emerging or changed hazards and refer these back to the FRM processes;

**(3)** Identify changes in the operating environment that could affect fatigue risk and refer these back to the FRM processes; and

**(4)** Provide input for improving the operation of the FRMS.

**2. FRMS SA FIVE-STEP PROCESS.** The FRMS SA processes consist of a five-step process that focuses on identifying fatigue hazards, assessing safety risks, putting in place controls and mitigation strategies, and monitoring their effectiveness. The objectives of each individual step are outlined below.

**a. Step 1: Collect and Review Information.**

**(1) Safety Performance Indicators.** This process involves collecting and reviewing information gained through the FRMS processes to examine the overall performance of the FRMS. Performance of the FRMS should be examined through indentifying a variety of safety performance indicators. This should include information specific to the FRMS as well as safety performance indicators.

**(2) Examples.** Examples of safety performance indicators specific to an FRMS will include measures obtained through the FRMS processes, such as:

- The number of exceeded maximum duty days in operations covered by the FRMS,
- The number of voluntary fatigue reports per month,
- The average "fatigue call" rate by flightcrews on a specific pairing (trip),
- The ratio of fatigue reports from operations covered by the FRMS to fatigue reports from operations covered by the prescriptive flight and duty time regulations,
- Attendance at FRMS training sessions,
- Results on FRMS training assessments,
- The level of crewmember participation in fatigue-related data collection; and
- The number of times fatigue is identified as an organizational factor contributing to an event.

**(3) Sources of Data.** The sources of data for monitoring the safety performance of the FRMS may include (but are not limited to):

- Hazard reporting and investigations,
- Audits and surveys, and
- Reviews and fatigue studies.

**(4) Hazard Reporting and Investigations.** Trends in voluntary fatigue reports by crewmembers and others can provide valuable insights into the effectiveness of the FRMS. Safety events in which crewmember fatigue has been identified as a contributing factor should be less common than fatigue reports. However, regular review of these events may also highlight areas where functioning of the FRMS could be improved. The value of both these sources of information depends on appropriate methods to identify the role of fatigue.

**(5) Audits and Surveys.** Audits and surveys can provide measures of the effectiveness of the FRMS without having to rely on fatigue levels being high enough to trigger fatigue reports or fatigue-related safety events (both of which are relatively rare events).

**(a)** Audits focus on the integrity of, and adherence to, the FRMS processes. These audits should answer questions such as:

- Are all departments implementing the recommendations of the FSAG?
- Are crewmembers using mitigation strategies as recommended by the FSAG?
- Is the FSAG maintaining the required documentation of its activities?

**(b)** Audits can also periodically assess the effectiveness of the FRMS (e.g., by looking at the status of FRMS safety performance indicators and targets). Audits are external to the FSAG, but may still be internal to the certificate holder (i.e., conducted by other groups within the organization). In addition, feedback from regulatory audits can provide useful information for FRMS safety performance monitoring. Another type of audit that can be used in this context is a review by an independent scientific review panel that periodically reviews the

activities of the FSAG and the scientific integrity of their decisions. A scientific review panel can also provide the FSAG with periodic updates on new scientific developments relevant to the FRMS.

**(c)** Surveys can provide information on the effectiveness of the FRMS. For example, they can document how schedules and assignments are affecting crewmembers, either by asking about their recent experiences (retrospective) or tracking them across time (prospective). Surveys for this purpose should include validated measures, such as standard rating scales for fatigue and sleepiness and standard measures of sleep timing and quality. Remember that a high response rate (ideally, more than 70%) is needed for survey results to be considered representative of the entire group, and response rates tend to decline when people are surveyed too frequently (participant fatigue).

**(6) Reviews and Fatigue Studies.** In general, safety reviews are used to ensure that safety performance is adequate during times of change (e.g., during the introduction of a new type of operation or a significant change to an existing operation covered by the FRMS).

**(a)** A review would start by identifying the change (e.g., moving a trip to a crew base in a different time zone, changes in on-board crew rest facilities, significant changes in the total trip, or a change of equipment being used for the trip). It would then evaluate the appropriateness and effectiveness of the FRMS activities relative to the change (for example, proposed methods for fatigue hazard identification, the risk assessment process, proposed controls and mitigations to address the fatigue hazard(s), and measures of their effectiveness to be used during the implementation of the change).

**(b)** Fatigue studies, as part of FRMS SA processes, are undertaken when a certificate holder is concerned about a broad fatigue-related issue for which it is appropriate to look at external sources of information. These could include the experience of other certificate holders, industry-wide or nation-wide studies, and scientific studies. External sources of information are particularly helpful when an internal consensus for a course of action cannot be reached or to supplement the limited experience and knowledge within that certificate holder’s organization. Fatigue studies in this context are mainly used for gathering information about large-scale issues related to the FRMS, rather than for identifying specific fatigue hazards.

**(7) FRMS Safety Performance Indicators.** Trends in FRMS safety performance indicators are also an important source of information about the effectiveness of the FRMS. This may include indicators identified by the FSAG as part of the FRMS processes. They may also include indicators that capture more global aspects of the safety performance of the FRMS.

**b. Step 2: Evaluate FRMS Performance.**

**(1)** This process is intended to validate the effectiveness of the fatigue controls and mitigations by analyzing the data collected and reviewed in Step 1 of the FRMS SA processes to determine whether:

**(a)** All specified FRMS safety performance targets are being met;

**(b)** All specified FRMS safety performance indicators remain in the tolerable region defined in the risk assessment process;

**(c)** The FRMS is meeting the safety objectives defined in the FRMS policy; and

**(d)** The FRMS is meeting all regulatory requirements.

**(2)** The following are examples of safety performance targets and indicators that could be used in FRMS SA processes and that correspond with the safety performance indicators identified above:

**(a)** The length of the maximum duty days in operations covered by the FRMS does not exceed the limits defined in the FRMS policy. This is reviewed monthly by a computer algorithm and trends across time are evaluated every 3 months.

**(b)** By the fourth month after the introduction of a new operation, there must be a stable, low number of voluntary fatigue reports per month or a clear downward trend in the number per month (allowing time for crewmembers and other affected personnel to adjust to the new operation).

**(3)** The FSAG is responsible for providing a written report on the validation phase of the new operation, including analysis of all fatigue-related events and voluntary fatigue reports, and documentation of the corresponding adjustments made in fatigue controls and mitigations. Additionally, the following information that should be included in the report:

**(a)** The rate of fatigue calls under the FRMS operation in comparison to the rate under non-FRMS operations.

**(b)** Actions taken when the rate of fatigue reports for operations conducted under the FRMS exceed the rate of fatigue reports for non-FRMS operations. The actions by the certificate holder taken must be reported to the FAA.

**(c)** Evidence that, in the last quarter, designated management has provided adequate resourcing for the FRMS, as specified in the FRMS policy.

**(d)** Evidence that, in the last quarter, the FSAG has met as often as is required in the FRMS policy and has maintained all the documentation of its activities required for internal and regulatory auditing.

**(e)** Evidence that all personnel responsible for schedule design and assignments have met annual FRMS training requirements as specified in the FRMS promotion processes.

**(f)** Measures of the effectiveness of FRM training and education programs.

**(g)** Evidence that quarterly levels of absenteeism are below the target specified for each operation covered by the FRMS.

**(4)** When FRMS safety performance targets are not met or when safety performance indicators are not at an acceptable level, the controls and mitigations in use may need to be modified by reentering the FRMS processes at Step 2 or beyond. It may also be appropriate to seek additional information from outside the organization (e.g., by looking at fatigue studies). It may be necessary to undertake a review of compliance of crewmembers and other departments with the recommendations of the FSAG. It may also sometimes be necessary to review the functioning of the FSAG itself to find out why the FRMS is not working as intended.

**c. Step 3: Identify Emerging Hazards.**

**(1)** Analysis of trends in safety performance indicators may indicate the emergence of fatigue hazards that have not previously been recognized through the FRMS processes. For example, changes in one part of the organization may increase workload and fatigue risk in another part of the organization. Identifying emerging fatigue-related risks is an important function of FRMS safety performance processes, which take a broader system perspective than FRMS processes.

**(2)** Any newly identified fatigue risk, or combination of existing risks for which current controls are ineffective, should be referred back to the FSAG for evaluation and management using FRMS processes (risk assessment and design and implementation of effective controls and mitigations).

**d. Step 4: Identify Changes Affecting the FRMS.**

**(1)** In our dynamic aviation environment, changes are a normal part of flight operations. They may be driven by external factors (e.g., new regulatory requirements, changing security requirements, or changes to air traffic control) or by internal factors (e.g., management changes or new routes, aircraft, equipment, or procedures). Changes can introduce new fatigue hazards into an operation, which need to be managed. Changes may also reduce the effectiveness of controls and mitigations that have been implemented to manage existing fatigue hazards.

**(2)** During Step 4, the objective of FRMS SA processes is to identify new hazards that may be a result of change. The current edition of ICAO Annex 6, Part I, Appendix 8 requires that a certificate holder has FRMS SA processes that provide a formal methodology for the management of change. These must include (but are not limited to):

**(a)** Identification of changes in the operational environment that may affect the FRMS;

**(b)** Identification of changes within the organization that may affect the FRMS; and

**(c)** Consideration of available tools that could be used to maintain or improve FRMS performance prior to implementing changes.

**(3)** A change management process is a documented strategy to proactively identify and manage the safety risks that can accompany significant change. When a change is planned, the following steps can be followed.

**(a)** Use the FRM processes to identify fatigue hazards, assess the associated risk, and propose controls and mitigations; and

**(b)** Obtain appropriate management and/or regulatory signoff that the level of residual risk is acceptable.

**(4)** During the period of implementation of the change, use the FRMS SA processes to provide periodic feedback to line managers that the FRMS is functioning as intended in the new conditions. Documentation of the change management strategy in relation to fatigue management is also the responsibility of the FSAG. Changes in the operational environment may also necessitate changes in the FRMS itself. Examples include bringing new operations under the scope of the FRMS, collecting different types of data, and adjusting training programs. The FSAG should propose such changes and obtain approval for them from the FAA for implementation.

**e. Step 5: Improve Effectiveness of the FRMS.**

**(1) Ongoing Evaluations.** Ongoing evaluation by the FRMS SA processes not only enables the FRMS to be adapted to meet changing operational needs: it also allows the FRMS to continuously improve the management of fatigue risk. In doing so, risk controls that have unintended consequences or that are no longer needed due to changes in the operational or organizational environment can be identified and then modified or eliminated through the FRMS processes. Examples include:

**(a)** Routine evaluations of facilities, equipment, documentation, and procedures; and

**(b)** The determination of the need to introduce new processes and procedures to mitigate emerging fatigue-related risks.

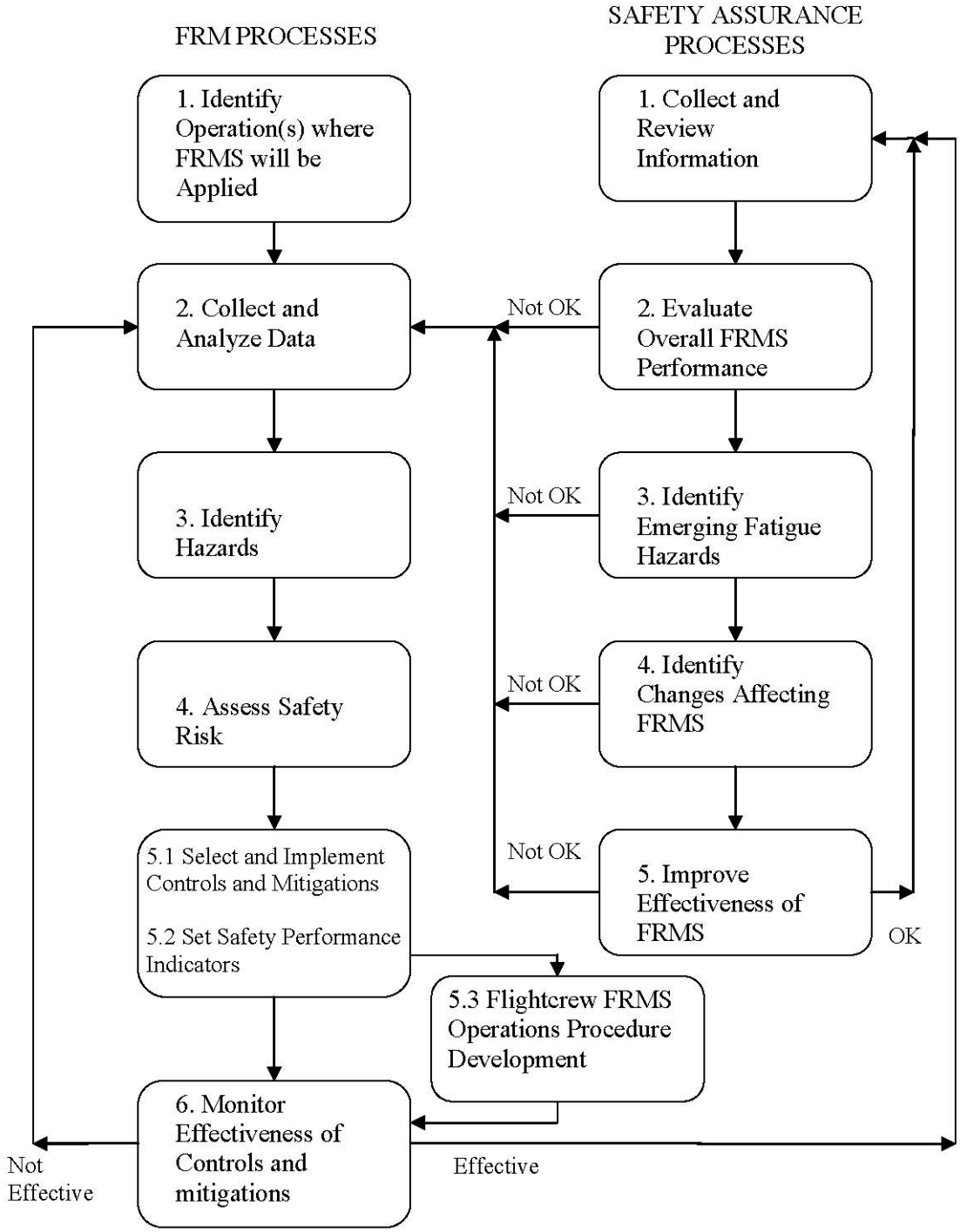
**(2) Documentation.** It is important that changes made to the FRMS are documented by the FSAG so that they are available for internal and regulatory audits.

**(3) Assigning Responsibility for FRMS SA Processes.**

**(a)** To deliver effective oversight of the functioning of the FRMS, the FRMS SA processes need to operate in close communication with the FSAG, but with a degree of independence. The objective is to avoid the FSAG from reviewing its own performance.

**(b)** Primary responsibility for the FRMS SA processes is assigned to a quality assurance (QA) person or team (as appropriate) that is accountable to the executive management team. In smaller operations, responsibility for the FRMS SA processes might reside with an individual rather than a team. This individual may also have a variety of other QA responsibilities.

**FIGURE 2-5. FATIGUE RISK MANAGEMENT AND SAFETY ASSURANCE PROCESSES**



## SECTION 7. FRMS AUTHORIZATION PROCESS

**1. HOW AN FRMS IS APPLIED.** An FRMS is a data-driven system based upon scientific principles that must be evaluated and validated by the FAA for safety and effectiveness. Typically, a certificate holder will utilize an FRMS authorization as a means to apply an AMOC to a prescriptive rule. Therefore, the certificate holder's AMOC must be evaluated and validated for safety and effectiveness. The certificate holder must also develop flightcrew member FRMS operations procedures that are supported by the validated data and evaluated and approved by the FAA as demonstrating compliance with the FRMS authorization.

**2. DEFINITION OF TERMS.** The following terms are applied to FRMS and the approval process:

**a. Actigraph.** A wristwatch-like device containing an accelerometer to detect movement. Activity counts are recorded every minute. The patterns of movement can be analyzed using purpose-built software to estimate when the wearer of the actigraph is asleep, and to provide some indication of how restless a sleep period is (i.e., to measure sleep quality). Actigraphs are designed to record continuously for several weeks, so they are valuable tools for monitoring sleep patterns before, during, and after a trip.

**b. Biomathematical Model.** A computer program (a fatigue model) designed to predict crewmember fatigue levels, based on scientific understanding of the factors contributing to fatigue. All biomathematical models have limitations that need to be understood for their appropriate use in an FRMS and the determination of predicted fatigue levels.

**c. Controls.** System-level defensive strategies designed to minimize fatigue risk on an ongoing basis.

**d. Data.** Routine or planned collection of sleep, performance, and alertness measurements. Other sources of data include flightcrew member reports of fatigue, reports of fatigue-related events, actions taken by the certificate holder to mitigate future fatigue events, and continuous monitoring of performance indicators to determine the overall effectiveness of the FRMS.

**e. Data Collection.** Application of a scientific methodology during flight operations designed to acquire the information (data) necessary for comparisons between groups or conditions or across time to assess the relative levels of fatigue experienced by flightcrew members both before FRMS operations and after FRMS operations combined with mitigating strategies.

**f. Data Package.** A description of data collection methods, a compilation of collected data, the results of the analysis of the data with comparisons between groups or conditions or across time, and the FRMS operations procedures that are constructed to support the results of data analysis for FRMS approvals and continuous monitoring.

**g. Fatigue Risk Management (FRM).** The management of fatigue in a manner appropriate to the level of risk exposure and the nature of the operation in order to minimize the adverse effects of fatigue on the safety of operations.

**h. Fatigue Risk Management (FRM) Processes.** FRM processes are one part of the day-to-day operations of the FRMS. They are designed to enable the certificate holder to achieve the safety objectives defined in its FRMS policy, and are managed by the FSAG.

**i. Fatigue Safety Action Group (FSAG).** A group comprised of representatives from all stakeholder groups that are responsible for coordinating all fatigue management activities in the organization.

**j. Flightcrew Member FRMS Operations Procedures.** Flightcrew member operations policy and procedures demonstrating compliance during operations where FRMS is applied.

**k. Mitigations.** System-level interventions designed to reduce a specific identified fatigue risk.

**l. Reporting Intervals.** Specific timeframes for when the certificate holder is required to provide reports to the FAA regarding data collection, analysis, and the demonstration of the effectiveness of their overall FRMS.

**m. Safety Assurance (SA) Processes.** SA processes monitor the entire FRMS to check that it is functioning as intended and meeting the safety objectives in the FRMS policy and regulatory requirements. SA processes also identify operational and organizational changes that could potentially affect the FRMS, and identify areas where the safety performance of the FRMS could be improved (continuous improvement).

**n. Safety Performance.** The level of safety achieved in a risk-controlled environment, measured against a safety level deemed as low as reasonably practicable.

**o. Study Design.** The definition of the goals or aims of the study, the description of the data collection methods, the groups or conditions that will be studied and compared, the measurements to be taken, the frequency and timing of those measurements, the crewmembers to be studied, the timeframe of the data collection, the methods of analysis, the criteria to be applied to evaluate the findings relative to the goals or aims of the study, and the proposed approach to establish that an FRMS provides an effective AMOC.

**3. FRMS APPROVAL PROCESS OVERVIEW.** The FRMS authorization process is a systematic and progressive approach to obtain approval of a certificate holder's proposed FRMS. This process provides a means for the certificate holder to demonstrate their proposed FRMS provides an AMOC for managing and mitigating fatigue along with a continuous monitoring output.

**a. Meet with the FAA.** Prior to development of the FRMS application package, the certificate holder should contact the Air Transportation Division (AFS-200) to schedule time to discuss their plans for operating under an FRMS. This meeting may be conducted as either an in-person meeting or a teleconference. During this meeting, the FAA will review the approval process with the certificate holder and outline all of the items required for the process. Additionally, this meeting will serve as an opportunity for the certificate holder to ask the FAA any questions relative to any part of the approval process.

**b. Approval Process.** The FRMS approval process consists of five phases and nine gates, all of which must be satisfactorily completed in succession. See Figure 2-6, Fatigue Risk Management System Approval Process, for a graphic representation of the FRMS approval process.

**(1)** The five phases of the approval process are:

- Phase 1: Preapplication, Planning, and Assessment.
- Phase 2: Formal Application.
- Phase 3: Documentation and Data Collection Plan.
- Phase 4: Demonstration and Validation.
- Phase 5: Authorization, Implementation, and Monitoring.

**(2)** Phase 1 has four gates, Phase 2 has two gates, and Phases 3 through 5 have one gate per phase. Each gate must be satisfactorily completed in succession before the certificate holder may move to the next phase.

**(3)** The certificate holder is responsible for developing the requirements outlined in each gate and satisfactorily demonstrating the effectiveness of those items. The FAA is responsible for reviewing, evaluating and validating the effectiveness of each phase completed by the certificate holder.

**c. Submit Application.** Each part 121 certificate holder must develop their draft FRMS application package in a manner acceptable to the FAA for review. When the draft FRMS application package is ready for FAA submission, the certificate holder will electronically submit it to AFS-200 via email at 9-AWA-AVS-AFS-200-Air-Transportation-Division@faa.gov and provide its principal operations inspector (POI) with a copy. Upon receipt of the package, AFS-200 will acknowledge to the sender receipt of the package via email reply, copying the respective POI and Regional Office (RO).

**d. Primary Objectives.** Upon satisfactory conclusion, this process will yield four primary objectives relative to the certificate holder's proposed FRMS, including:

- Validation,
- Authorization,
- Phased implementation, and
- Continuous improvement monitoring.

**e. Basic Steps for the Approval of an FRMS Application Package.**

**(1)** The certificate holder develops their plan for an AMOC to a prescriptive rule.

**(2)** The certificate holder presents their fatigue modeling results or another form of data acceptable to the FAA that supports their proposed AMOC.

**(3)** The certificate holder presents their study design to verify the AMOC.

**(4)** The FAA reviews and validates the certificate holder's proposed AMOC, study design, flightcrew FRMS operations procedures, and data package. If the FAA determines that the certificate holder has satisfactorily demonstrated that they can safely conduct the data collection operations outlined in the proposed application, the FAA may authorize the operation.

**(5)** The certificate holder conducts data collection and analysis (in real time) and submits results to the FAA.

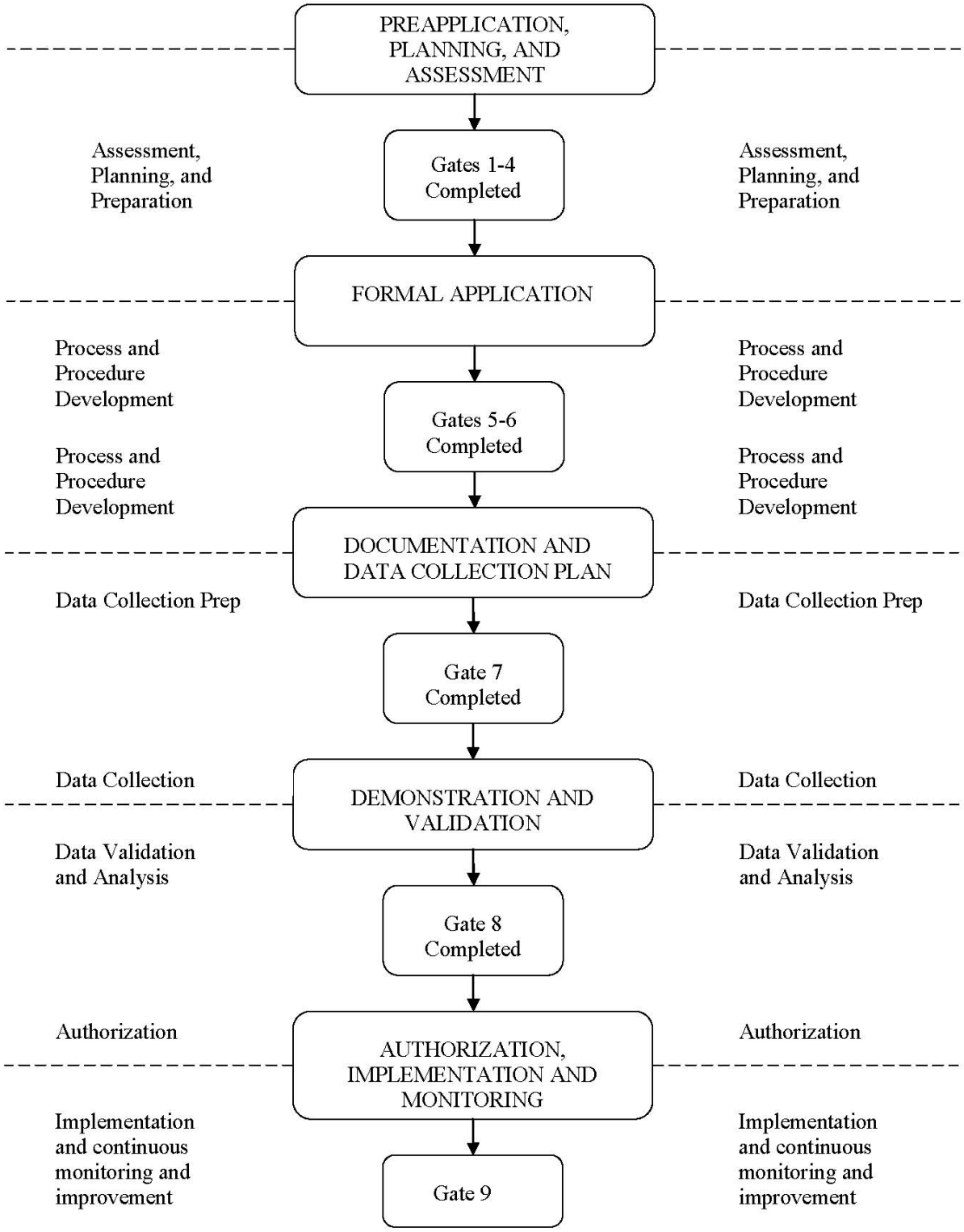
**(6)** The FAA validates the certificate holder's data collected and the associated analysis.

**(7)** The certificate holder submits flightcrew member FRMS operations procedures supported by the validated data that demonstrates compliance.

**(8)** The FAA approves the certificate holder's FRMS operations procedures and methods for continuous performance improvement.

**(9)** The certificate holder inserts statements in their operations manual that each flightcrew member, scheduler, dispatcher, person holding operational control, and any person having management oversight of these areas must comply with the FAA-approved FRMS operations procedures where the FRMS is being applied to that flight operation or flight segment.

**FIGURE 2-6. FATIGUE RISK MANAGEMENT SYSTEM APPROVAL PROCESS**



**4. PHASE ONE: PREAPPLICATION, PLANNING, AND ASSESSMENT.** The certificate holder develops plans for a proposed AMOC to the prescriptive rule(s). The plan should be based upon fatigue modeling data or some other form of data acceptable to the FAA that supports the proposed AMOC. The certificate holder will develop appropriate FRM and SA processes to identify and document risks and to apply appropriate mitigations to reduce the likelihood and severity of those risks. The certificate holder will utilize the FRM and SA processes in the development of flightcrew member FRMS operations procedures throughout the FRMS approval process, which will be driven by data and appropriate fatigue analysis methods.

**a. Certificate Holder Responsibilities.** The certificate holder will develop a data package to serve as a repository for all collected and analyzed data. Additionally, the certificate holder will maintain a collection of all amendments to their draft flightcrew member FRMS operations procedures to illustrate policy and procedural changes, driven by the results of the data analysis and the FRM and SA processes.

**b. Objectives.** This phase is designed as the platform from which the certificate holder will present their ideas, assessment, and plans for applying for a proposed FRMS authorization. Phase 1 also serves as the initial meeting between the certificate holder and FAA to discuss the milestones and provide their proposed FRMS planning and assessment. The FAA will review the certificate holder's proposed FRMS plans, identify the necessary guidance resource documents, and outline the phased authorization process for their proposed FRMS. The four gates in this phase are designed to give the certificate holder the necessary tools to develop the framework for their proposed FRMS. The objective of this phase is to prepare the certificate holder for data collection and ultimately to develop their proposed FRMS. The certificate holder should expect to accomplish modifications to some of their submissions required in Gates 1-4.

**(1) Gate 1.** The certificate holder will:

**(a)** Perform a needs analysis that defines the specific operational conditions for which a proposed FRMS will be applied to justify a deviation from prescriptive rules and why such an operation must or should be conducted under alternative duty and rest conditions.

**(b)** Define how proposed operational procedures will require an AMOC to the prescribed flight time, duty time, and rest requirements, citing the specific regulatory section and the applicable justification.

**(c)** Describe how proposed operational procedures will provide sufficient fatigue mitigations to provide an AMOC to that provided by current prescriptive rules.

**(d)** Perform a gap analysis to:

*1.* Identify elements of the proposed FRMS that are already available in existing systems and process.

*2.* Identify existing systems and process that could be modified to meet the needs of proposed FRMS (to minimize "reinventing the wheel").

*3.* Identify where new systems and processes need to be developed for the proposed FRMS.

**(e)** Prepare an FRMS policy statement signed by the accountable executive. Expect to revise the policy statement between phases and as the proposed FRMS becomes operational. The policy statement shall:

*1.* Reflect the shared responsibility of management, flight and cabin crews, and other involved personnel.

*2.* Clearly state the safety objectives of the proposed FRMS.

*3.* Be signed by the accountable executive of the organization.

*4.* Be communicated, with visible endorsement, to all the relevant areas and levels of the organization.

*5.* Declare management's commitment to effective safety reporting.

*6.* Declare management's commitment to the provision of adequate resources for the proposed FRMS.

*7.* Declare management's commitment to continuous improvement of the proposed FRMS.

*8.* Require that clear lines of accountability for management, flight and cabin crews, and all other involved personnel are identified.

*9.* Require periodic reviews to ensure that it remains relevant and appropriate.

**(f)** Develop the FRMS documentation plan. The certificate holder shall develop and keep current FRMS documentation that describes and records:

*1.* FRMS policy and objectives.

*2.* FRMS processes and procedures.

*3.* Accountabilities, responsibilities and authorities for these processes and procedures.

*4.* Mechanisms for ongoing involvement of management, flight and cabin crewmembers, and all other involved personnel.

*5.* FRMS training programs, training requirements and attendance records.

*6.* Scheduled and actual flight times, duty periods and rest periods with significant deviations and reasons for deviations noted.

*7.* FRMS outputs including findings from collected data, recommendations, and actions taken.

**NOTE: Expect to revise this document between phases and as the FRMS becomes operational.**

**(g)** Identify and allocate financial and human resources. The FRMS accountable executive needs to have the authority and control to ensure that this happens.

**(h)** Establish an FSAG, or its equivalent. Define the mission of the FSAG and outline the roles and responsibilities of each member, along with company resources. The stage at which the FSAG is established will vary according to the size and complexity of the organization and the FRMS and whether there are suitably qualified people in other parts of the organization who are available to begin these activities.

**(i)** Develop the FRMS communication plan. The current edition of ICAO Annex 6, Part I, Appendix 8 requires the certificate holder to have an FRMS communication plan that:

*1.* Explains FRMS policies, procedures, and responsibilities to all stakeholders.

*2.* Describes communication channels used to gather and disseminate FRMS-related information.

**(j)** There needs to be ongoing communication to stakeholders about the activities and safety performance of the FRMS and initiatives to ensure the commitment of all stakeholders. Communications about the activities and safety performance of the FRMS (normally from the FSAG) need to be clear, timely, and credible. The information provided also needs to be tailored to the needs and roles of different stakeholder groups, with a minimum of unnecessary or irrelevant information. The certificate holder should choose from a variety of types of communication such as electronic media (Web sites, online forums, and email), newsletters, bulletins, seminars, periodic poster campaigns in strategic locations, and the like.

**(k)** Communications from crewmembers are vital for fatigue hazard identification in obtaining feedback on the effectiveness of controls and mitigations and in providing information for FRMS safety performance indicators. For these communications to be open and honest, all FRMS stakeholders need to have a clear understanding of the policies governing data confidentiality and the ethical use of information provided by crewmembers. Expect to revise this document between phases and as the FRMS becomes operational.

**(2) Gate 2.** The certificate holder will:

**(a)** Develop the FRMS implementation plan. The results of the gap analysis are used as the basis for the development of the certificate holder's FRMS implementation plan. Essentially, this provides a roadmap describing how the development of each of the FRMS processes will proceed. Expect to revise this document between phases and as the FRMS becomes operational.

**(b)** Develop a fatigue reporting system. A fatigue report is a method for a flightcrew member to communicate to management personnel (and the FSAG) when they encounter a nonadverse fatigue event. There should be a clear process outlining how the fatigue report will be handled to include a Root Cause Analysis (RCA) and fatigue data collection and retention. The FRMS policy must provide for protection of privacy and methods to protect the employee from adverse actions that would discourage reporting events and conditions surrounding the events. The process should outline the length of time the data will be retained and a path to mitigation or management of the fatigue occurrence. Expect to revise this document between phases and as the FRMS becomes operational.

**(c)** Develop a fatigue incident reporting system. A fatigue incident is defined as an adverse event, in which fatigue is suspected to have been a causal or contributing factor, that results in an accident, incident, pilot deviation or noncompliance with FRMS policies or procedures. The fatigue incident reporting system is a method by which a flightcrew member communicates an adverse fatigue event to management personnel (and the FSAG). Reports of adverse events that may be attributable wholly or in part to fatigue are similar to crew reports, and can serve as a mechanism for obtaining all relevant information regarding fatigue contributions to the incident. FRMS policy would define how an adverse event is evaluated for potential fatigue involvement, as well as define a methodology for conducting a detailed RCA. At a minimum, the incident investigation and reporting process must obtain all the necessary information to trace the root cause of the incident, especially the potential level of fatigue and the conditions that contributed to the fatigue-related event. The fatigue reporting policy must protect the privacy of employees and minimize adverse actions that would discourage reporting events and circumstances surrounding the events. Expect to revise this document between phases and as the FRMS becomes operational.

**(d)** Develop a system for monitoring flight crewmember fatigue as part of an overall FRMS. The data collected provides feedback to the certificate holder regarding conditions perceived to contribute to fatigue. To maximize the utility of such reports, procedures must be developed to capture all relevant information, such as the schedule leading up to the fatigue report, the actions of the employee to obtain rest, subjective and objective evidence of fatigue, environmental conditions that may have exaggerated or contributed to fatigue, relevant health or medical conditions, specific actions related to the incident, and communications prior to and during the event. Expect to revise this document between phases and as the FRMS becomes operational.

**(e)** Develop a FRM process and a SA process to identify fatigue risks and apply effective safety mitigations throughout the data collection process.

**(f)** Develop a training plan specific to the FRMS. The list below identifies general FRMS training subjects for the training plan. In addition to the general subjects, the certificate holder’s training plan should also include specific subjects relative to their proposed FRMS. Expect to revise this document between phases and as the FRMS becomes operational. Figure 2-7, Fatigue Risk Management System Training Outline, outlines a sample FRMS training curriculum.

**FIGURE 2-7. FATIGUE RISK MANAGEMENT SYSTEM TRAINING OUTLINE**

1) Overview of the Fatigue Risk Management System (FRMS) concept
    i. Definition
    ii. Purpose
    iii. Structural components
    iv. Overview of the certificate holder's FRMS
    v. Relationship between FRMS and Fatigue Risk Management Plan (FRMP)
    vi. AC 120-100 Basics of Aviation Fatigue
    vii. AC 120-103 Fatigue Risk Management Systems for Aviation Safety
2) Tools for an effective FRMS
    i. Fatigue analysis methods
    ii. Identification and management of aviation fatigue drivers
    iii. Fatigue mitigation approaches
    iv. Positive safety culture
3) Components of an FRMS
    i. Fatigue Risk Management (FRM) policy
    ii. Education and awareness training
    iii. Fatigue analysis and reporting system
    iv. Fatigue monitoring methods
    v. Fatigue related incident reporting process
    vi. FRMS performance evaluation
    vii. Continuous improvement process
4) Roles and responsibilities
    i. Certificate holder responsibilities
    ii. Fatigue Safety Action Group (FSAG)
    iii. Crewmember/employee responsibilities
    iv. Federal Aviation Administration (FAA) responsibilities
5) FRMS Implementation
    i. Policies and procedures
    ii. Organization and personnel
        a) FSAG
        b) Other supporting departments and personnel
        c) Roles and responsibilities
    iii. Tools and methods
    iv. Training and awareness
6) Safe scheduling policies and procedures
    i. Proactive and adaptive fatigue mitigation
    ii. Work schedule oversight and monitoring
    iii. Crew augmentation
    iv. Unforeseen operational circumstances
7) Records and reports
    i. Schedule accuracy
    ii. Reports of fatigue by flightcrew members
    iii. Fatigue-related events
    iv. Records of actions of the FSAG
8) Continuous performance improvement process
    i. FRMS performance evaluation
    ii. Work schedule modeling and fatigue risk analysis
    iii. Management and mitigation of fatigue risk
    iv. Assessment, feedback, and corrective action

**(3) Gate 3.** The certificate holder will:

**(a)** Develop a data collection plan following the guidelines described in the FRM process. Expect to revise this document between phases.

*1.* Develop an initial data collection plan.

*2.* Define how the data collection plan will establish the effectiveness of the FRMS.

*3.* Identify the necessary resources and tools (Actigraph, Psychomotor Vigilance Testing (PVT), modeling, etc.) (FAA review).

*4.* Specify study design, timeline for data collection, and context of the study (FAA review).

*5.* FAA evaluates the data collection plan for feasibility, completeness, and credibility.

*6.* Adjust the plan accordingly (FAA review).

**(b)** Develop a data analysis plan following the guidelines described in the FRM process. Expect to revise this document between phases.

*1.* Describe the initial data analysis plan (FAA review).

*2.* Based on the proposed sleep and performance measures, define safety standards that will be used to evaluate the effectiveness of the proposed operation under alternative duty and rest conditions.

*3.* Describe how the data analysis plan will support the effectiveness of the FRMS based on those safety standards.

*4.* Describe how these data will be used to establish an AMOC.

*5.* Identify the necessary resources and data analysis tools (FAA review).

*6.* Specify study design, timeline for data analysis plan, and context of the data output.

*7.* Justify the proposed safety standards for establishing effectiveness of the FRMS and the validity of the data collection and analysis plan to establish that the proposed FRMS meets those standards (FAA review).

*8.* Adjust the plan accordingly (FAA review).

**(c)** Design and develop plans for proposed data collection flights in accordance with the proposed FRMS policy statement that will be used for data collection.

*1.* The data collection plan information shall outline the following operational parameters and indicate to what extent they will exceed prescriptive flight time and duty limitations:

- Pre- and post-rest duty requirements,
- Start time (acclimated) of the FDP,
- Start time (unacclimated) of the FDP,
- Flightcrew complement (number of pilots) and unbiased method to select voluntary study participants,
- Predominant direction of flight (north, south, east, or west),
- Duration of the proposed FDP,
- Length of total flight time,
- Maximum proposed flight deck duty period for each flightcrew member during that FDP,
- Number of planned theater crossings,
- The number of flight segments and the timing of the takeoffs and landings for acclimated and unacclimated flightcrew members,
- Provisions for layover rest, and
- Number and class of installed onboard rest facilities.

*2.* Consider and compensate for the length of typical delays.

*3.* If required, propose a petition for exemption for the data collection operation based upon the data collection plan. If an exemption is required, the FAA will impose applicable safety limitations and conditions associated with the proposed exemption.

*4.* If required, the certificate holder will file a petition for exemption. If granted, the exemption will be limited in duration to collect the data.

**(4) Gate 4.** The certificate holder will:

**(a)** Define the scope of the data collection requirement utilizing the guidelines described in Section 4. In addition, the certificate holder shall satisfactorily demonstrate that all data collection flights can be safely conducted utilizing the processes outlined in the FRM and the FRMS SA sections of this appendix The plan shall, as a minimum, accomplish the following:

*1.* Develop flightcrew member operational procedures based upon FRM processes and SA processes for operations where FRMS will be applied.

*2.* Develop an in-flight rest scheme for flightcrew members operations on the data collection flights. Define target sleep patterns for in-flight rest.

*3.* Develop pre- and post-FDP rest schemes for the data collection flights. Define target sleep patterns for pre- and post-duty rest periods.

*4.* Develop any special procedures specifically applicable to the planned data collection flights.

*5.* Provide a list of aircraft that will be authorized for data collection by make, model, and series (M/M/S), to include a description (class) of the installed onboard rest facility.

*6.* Develop procedures for situations when an operating flightcrew member becomes fatigued in-flight and mitigations to reduce the flightcrew member's level of fatigue.

**(b)** Develop FRMS processes based on reactive hazard identification, including risk assessment and the development, implementation, and monitoring of appropriate controls and mitigations based upon the planned data collection flights.

*1.* Identify hazards, risk assessment, risk mitigation, SA process, and promotion process based upon the planned data collection flights.

*2.* Verify that FRMS documentation processes are established to support the current version of the FRMS.

*3.* Verify FRMS training program activities are established to support the current version of the FRMS. (Stakeholders need training to ensure that they are competent to undertake their responsibilities in the FRMS as the implementation plan rolls out.)

*4.* Develop a method for exclusively retaining all FRMS training records and implement that process.

*5.* Verify FRMS communication processes are established to support the current version of the proposed FRMS.

**5. PHASE TWO: FORMAL APPLICATION.** Upon satisfactory completion of Gates 1–4, the certificate holder may proceed to Phase Two. This phase involves the certificate holder submitting all their formal documentation (as required in Gates 1–4) to the FAA as outlined in Gates 5 and 6. The FAA will evaluate and validate the certificate holder's documentation. Upon satisfactory completion of Gates 5 and 6, the certificate holder may proceed to Phase Three. Based upon the certificate holder's proposed AMOC, the certificate holder will develop and submit a proposed data collection plan and a data analysis plan for review, evaluation, and validation. The data collection plan will outline the resources and methods for collecting all measurements. The data analysis plan will describe the method(s) for analyzing the data and how the results will be applied to evaluate the effectiveness of the FRMS. At this stage, the primary focus for the FAA will be to determine that the data collection operation can be safely conducted. Secondly, the FAA will evaluate the effectiveness of the data collection plan and the data analysis plan. The certificate holder will revise, as necessary, their operational procedures for data collection, which will be reviewed and evaluated by the FAA prior to authorizing the certificate holder to collect data. The certificate holder will also revise the operating manual to direct flightcrew members, schedulers, dispatchers, personnel holding operational control and persons having direct management oversight of these areas to comply with the FRMS operation procedures whenever the FRMS is applied to a flight or series of flights.

**a. Gate 5.** The certificate holder will provide documented evidence of the following items, which will be reviewed, evaluated and validated by the FAA:

- Formal FRMS policy statement.
- Formal documentation plan.
- Formal communications plan.
- Formal training plan.
- Formal implementation plan.
- Formal description of flightcrew member fatigue monitoring process.
- Formal reporting process to include fatigue reporting and fatigue incident reporting, which will include RCA.
- A performance evaluation process to support continuous improvement of the FRMS.
- Formal documentation of the data collection and analysis plan to support the policy statement.
- That roles and responsibilities for ensuring the safety performance of the FRMS are developed, to include the roles and responsibilities of the FSAG.
- That the necessary communication channels are active.
- That FRMS processes based on reactive, proactive, and predictive hazard identification are operational, including risk assessment and the development, implementation, and monitoring of appropriate controls and mitigations.
- That FRMS documentation processes have been established to support the current version of the proposed FRMS.
- That FRMS training activities have been established to support the current version of the proposed FRMS.
- That FRMS communication processes have been established to support the current version of the proposed FRMS.

**b. Gate 6.** The FAA will review, evaluate, and validate the following:

- FRMS safety performance indicators have been developed and agreed on.
- Formal statement of how the FRMS will demonstrate an effective AMOC.
- The procedures and processes for periodic evaluation of the safety performance indicators have been established.
- Appropriate feedback has been established between the FRMS processes and the FRMS SA processes.
- FRMS documentation processes are fully implemented.
- FRMS training processes are fully implemented.
- FRMS communication processes are fully implemented.
- Processes for monitoring the effectiveness of controls and mitigations are fully implemented.

**6. PHASE THREE: DOCUMENTATION AND DATA COLLECTION PLAN.** Upon satisfactory completion of Gates 5–6, the certificate holder may proceed to Phase Three. The certificate holder will provide the FAA with their planned data collection flight information.

**a. Overview.** During this phase, the FAA will evaluate the certificate holder's data collection plan and all their documentation outlining their policies and procedures to support all flight operations during data collection. Upon satisfactory completion of Gate 7, if required, the certificate holder will be authorized by exemption to collect data for their proposed FRMS.

**b. Gate 7.** The FAA will:

**(1)** Assess and model the proposed data collection flight plan information to determine the anticipated levels of fatigue.

**(2)** Evaluate the certificate holder's documentation outlining their policies and procedures to support all flight operations during data collection.

**(3)** Determine whether the certificate holder's proposed FRMS can demonstrate an effective AMOC.

**(4)** Assess any fatigue modeling analysis of the proposed AMOC if any part of the justification is based on modeling. The FAA will review justification of the modeling choice and all modeling assumptions, parameters, and initial conditions, including the modeling safety standard that serves as the baseline for evaluation of fatigue or performance estimates under the FRMS operation.

**(5)** Validate and authorize data collection and that the data collection and analysis method will be sufficient to demonstrate an effective AMOC. The FAA will evaluate the data collection and analysis plan based on the guidelines described in the FRM process. Collect and analyze data.

**(6)** Evaluate policy, documentation, procedures, and processes.

**(7)** Evaluate safety performance indicators and provide input.

**(8)** Evaluate proposed FRMS policy and documentation, along with processes and procedures.

**(9)** Evaluate the FRM process and SA, based on the guidelines provided in the SA process.

**(10)** Upon satisfactory evaluation and validation, approve the proposed data collection flight operation information.

**(11)** Issue applicable exemption with specific limitations and conditions for the data collection flight operation.

**(12)** With the certificate holder, establish, agree upon, and document reporting intervals.

**(13)** The certificate holder is then ready for data collection.

**(14)** If required, the FAA authorizes the certificate holder through an exemption to collect data for a specific duration.

**7. PHASE FOUR: DEMONSTRATION AND VALIDATION.** The certificate holder will collect and analyze the data. The data collected and analyzed will be compiled into a data package. Throughout this process, the certificate holder will also collect and analyze other data,

such as fatigue reports, and will compile these data with the data package. Once all the data have been collected, analyzed and compiled in the data package, the certificate holder will submit the data package to the FAA for review and validation.

**a. FRMS Procedure Revisions.** Additionally, the certificate holder will revise their FRMS operational procedures, as necessary, in support of the data analysis outcomes. Upon successful validation of the data, the FAA will review and evaluate the certificate holder's FRMS operation procedures to ensure that these procedures support the validated data analysis. If required, the certificate holder may be required to revise their FRMS operation procedures to support the validated results.

**b. Data Package Submission.** Upon completion of Gate 8, the certificate holder will submit the data package to the FAA for evaluation and validation. The FAA will validate the data and evaluate the certificate holder's policies, procedures, and processes to ensure that the certificate holder's proposed FRMS meets an AMOC. Upon satisfactory completion of Gate 8, the FAA will prepare the appropriate OpSpec A318 for use of that FRMS flight operation with specific limitations and conditions based upon the certificate holder's policies, procedures, and processes.

**c. Gate 8.**

**(1)** The certificate holder will prepare a complete review and analysis of the results of the data collection with specific emphasis on how the data confirm that the alternative operation outside the prescriptive rules provides an effective AMOC with safety standards. The collection and analysis of data should follow the guidelines described in the FRM process. Collect and analyze data.

**(a)** Describe the aggregate findings from each of the measures specified in the proposed data collection plan.

**(b)** Provide specific information on how the results relate to the defined safety standards established in the data collection plan.

**(c)** Show how the results establish the effectiveness of the proposed FRMS relative to operations conducted under the prescriptive rules.

**(d)** Identify any evidence of excessive fatigue discovered in association with the proposed operation and how this fatigue is mitigated so that the proposed FRMS will demonstrate effectiveness and compliance.

**(e)** Adjust the data collection plan accordingly and provide the FAA with evidence of the effectiveness of any proposed mitigations (FAA approval of amended mitigations to the proposed FRMS).

**(f)** Amend the proposed FRMS polices, procedures and processes, as required, to support their revised FRMS.

**(2)** The FAA will evaluate the validity of the data analysis results and determine if the results demonstrate the effectiveness of the proposed FRMS operation as an AMOC. The FAA will determine if the data provided are adequate for demonstrating the effectiveness of the proposed FRMS and will request additional details, as necessary.

**(3)** The FAA will evaluate changes to the certificate holder's amended policies, procedures and processes to determine if the amended policies, procedures, and processes will support an AMOC.

**(4)** The FAA will do one of the following:

**(a)** Approve the proposed FRMS operation and issue an OpSpec A318; or

**(b)** Disapprove the proposed FRMS and recommend changes for a revised FRMS application package.

## 8. PHASE FIVE: AUTHORIZATION, IMPLEMENTATION AND MONITORING.

**a. FAA Authorization.** Upon satisfactory completion of this process, the FAA may grant authorization to operate in accordance with the FRMS flight operation by issuance of OpSpec A318.

**b. FRMS Operations Manual.** Lastly, the certificate holder will amend their FRMS operations manual to direct flightcrew members, schedulers, dispatchers, personnel holding operational control, and persons having direct management oversight of these areas to comply with the FRMS operation procedures whenever the FRMS is applied to a flight or series of flights.

**c. Gate 9.**

**(1)** The FAA issues OpSpec A318.

**(2)** The FAA approves a phased implementation of the proposed FRMS operation.

**(3)** The FAA approves an ongoing SA process to monitor the continued success of the FRMS operation (refer to the guidelines outlined Section 6). This process will specify courses of action that will be taken if reports of fatigue occur under the FRMS operation, including a process for informing the FAA and a process to ensure safe operations while effective fatigue mitigations and associated policies are implemented for the FRMS operation.

**(4)** The FAA determines the duration of OpSpec A318.

**(5)** The FAA establishes a regular audit schedule (at a minimum, quarterly for the first 24 months of operations) to ensure that fatigue reports and other safety indicators support the effectiveness of the FRMS operation.

**(6)** The certificate holder provides the FAA with all monitoring data at the specified intervals for evaluation.

**(7)** The FAA approves the certificate holder's FRMS implementation plan.

**(8)** The certificate holder develops a method to declare those flights operating under an FAA-authorized FRMS.

**(9)** Unless otherwise specified, for the purpose of continuous monitoring, the certificate holder will comply with the following reporting intervals:

- First year: quarterly.
- Second year: quarterly.
- Third year: semi-annually.
- Fourth year and beyond: annually.

**NOTE: Under extraordinary conditions, based on the frequency of the proposed FRMS operations, alternative reporting intervals may be required.**