Reactive processes

The operator has systems in place for analysing the contribution of fatigue to safety reports and events, and for determining how to reduce the likelihood of similar events occurring in future. Special attention will be paid to ensuring that any fatigue reports or incidents from the A-B-A operation are analysed quickly and appropriate action taken.

4.7.4 Step 4 – Assess safety risk

The biomathematical model used to predict crew member alertness on the A-B-A route has previously been used to predict alertness on a range of two-person and three-person long-haul routes. These predictions indicate that minimum alertness levels on the A-B-A route are likely to be higher than on some existing long-haul routes, notably three-person westward return night flights with duty periods of about 14 hours, and long overnight flights with two-person crews.

Two sets of operational experience support the prediction that the A-B-A route does not pose excessive fatigue hazards: 1) the safety record of the C-D-C operation which has flown daily for four years; and 2) the A-B-A operator's experience with similar long-haul routes using the same aircraft and crew complement, but remaining under the 16-hour flight time limit.

4.7.5 Step 5 – Select and implement controls and mitigations

In this example, the following controls and mitigation strategies are proposed for the A-B-A operation.

- The aircraft chosen for the route has the best available on-board crew rest facilities.
- All crew members flying the new operation are domiciled in the departure city.
- All crew members flying the new operation receive specific education on personal and organizational strategies for managing fatigue on the A-B-A operation. This includes discussion on how to make best use of in-flight and layover sleep opportunities.
- All crew members have protected time off duty to enable two full nights of sleep in the departure city time zone, so that they have the opportunity to begin the A-B-A operation fully rested.
- There is a clear policy defining on-call arrangements and the provisioning of relief crew.
- The flight crew includes two captains and two first officers, so that a single captain does not have sole command responsibility for entire ULR flights. This is in accordance with the Flight Safety Foundation ULR recommendations.
- There is a clear policy on the distribution of in-flight rest opportunities, so that crew members can plan how best to use them.
- Each crew member has two rest opportunities per flight, to ensure that he has at least some rest time overlapping his normal sleep time and that he has a second opportunity to get some sleep if, for any reason, he is unable to sleep during his first in-flight rest period.
- Meals may be taken by the flight crew on the flight deck, in order to maximize the amount of time for sleep during in-flight rest periods.
- The layover hotel has been carefully vetted to ensure that it provides adequate facilities for sleep, eating and exercise.
- A procedure is implemented between Flight Operations and the layover hotel to provide notification of delays without having to wake crew members.

- There are clear procedures on the management of flight delays.
- There are clear procedures on the management of flight diversions.

The following safety performance indicators are identified:

- Data collected during the first four months of the A-B-A operation will be compared with model predictions and with the same measures from the C-D-C validation, to establish whether crew member fatigue and alertness levels are in the range predicted.
- By the fourth month of the A-B-A operation, the fatigue reporting rate (reports/flight segment) and average fatigue report risk level should be comparable to existing long-haul routes. No “intolerable” fatigue reports should be received (see Table 4-2.d).

4.7.6 Step 6 – Monitor effectiveness of controls and mitigations

There is a defined validation period for the first four months of the operation that involves more intensive monitoring. The Fatigue Safety Action Group will have regular oversight of all data and fatigue reports coming in and will act in a timely manner when issues arise.

At the end of the validation period, a report will be compiled and routine processes will be defined for fatigue risk monitoring and management on the A-B-A route. This report will be available to all interested parties. If the performance indicators are acceptable, the A-B-A operation will revert to routine monitoring.

4.7.7 Linking to FRMS safety assurance processes

Normally, the FRM processes do not operate in isolation from the FRMS safety assurance processes (described in detail in the next chapter). However, when setting up FRMS in an organization, or for a new type of operation, the data needed for FRMS safety assurance processes are not available before the operation(s) begin flying. This means that it is necessary to have a staged approach to FRMS implementation, which is described in Chapter 7.

Chapter 5. FRMS safety assurance processes

5.1 INTRODUCTION TO FRMS SAFETY ASSURANCE PROCESSES

The FRM processes described in Chapter 4 are the part of the day-to-day FRMS operations that focus on identifying fatigue hazards, assessing safety risks, putting in place controls and mitigation strategies, and monitoring their effectiveness.

This chapter works through the basic steps in FRMS safety assurance processes, which form another layer in an operator's defenses against fatigue-related risk. FRMS safety assurance processes are also part of the routine operation of the FRMS, and they monitor how well the entire FRMS is functioning. They:

- check that the FRMS is functioning as intended;
- check that it is meeting the safety objectives defined in the FRMS policy;
- check that it is meeting regulatory requirements;
- identify where changes in the operating environment have the potential to increase fatigue risk; and
- identify areas for improvement in the management of fatigue risk (continuous improvement of the FRMS).

To do this, FRMS safety assurance 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 (see Section 4.5), and they may need to be revised as operational circumstances change.

Figure 5-1 outlines the linkages between the FRMS safety assurance processes and other components of the FRMS. The information, data and safety performance indicators from the FRM processes provide a source of information for the FRMS safety assurance processes. In addition, the FRMS safety assurance processes:

- use information and expertise from other sources, both from within the operator's organization and external to it, to evaluate the functioning of the FRMS;
- evaluate trends in safety performance indicators to identify emerging or changed hazards and refer these back to the FRM processes;
- identify changes in the operating environment that could affect fatigue risk and refer these back to the FRM processes; and
- provide input about ways to improve the operation of the FRMS.

Some of the FRMS safety assurance processes can be undertaken by the Fatigue Safety Action Group, while others (for example, audits of the FRMS) would normally be undertaken by other units within the operator's organization. The responsibility for different FRMS safety assurance activities may be distributed differently, depending on the size of the organization. For example, larger operators may have a separate FRMS safety assurance team and/or a designated FRMS safety assurance manager. Communication (in both directions) between the FRMS safety assurance processes and the SMS is necessary, since the safety performance of the FRMS will impact on the overall safety performance of the operator.

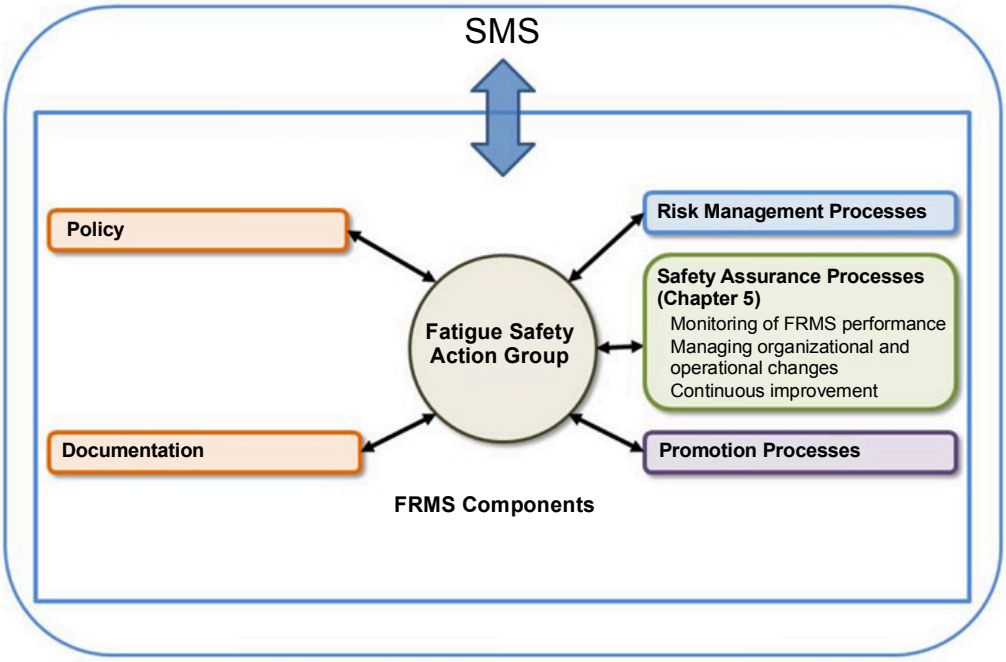


Figure 5-1 Linkages between FRMS assurance processes and other FRMS components

The ICAO requirements for FRMS safety assurance processes are as follows.

Appendix 8:
3. FRMS Safety Assurance Processes

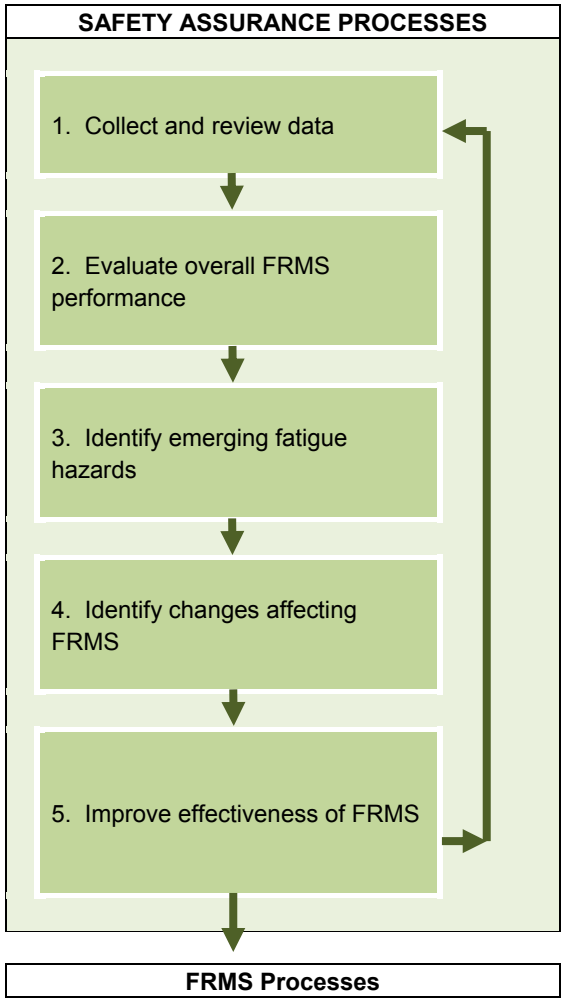
The operator shall develop and maintain FRMS safety assurance processes to:

a) 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) audits and surveys; and
   3) reviews and fatigue studies;

b) provide a formal process for the management of change which shall include but is not limited to:
   1) identification of changes in the operational environment that may affect FRMS;
   2) identification of changes within the organization that may affect FRMS; and
   3) consideration of available tools which could be used to maintain or improve FRMS performance prior to implementing changes; and

c) 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 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; and
   3) the determination of the need to introduce new processes and procedures to mitigate emerging fatigue-related risks.

Figure 5-2 summarizes the steps in FRMS safety assurance processes. Each step is described in more detail below.



1	FRMS safety assurance processes draw together internal and external sources of information to check that the FRMS is functioning as intended.
2	Evaluate FRMS effectiveness against safety performance targets. Is it meeting the safety objectives defined in the FRMS policy? Is it meeting regulatory requirements?
3	Do trends in performance indicators identify emerging or changed hazards? (If so, loop back to FRM processes to assess risk, develop and implement appropriate and relevant controls and mitigations.)
4	Use FRM processes to identify potential fatigue hazards arising from changes in the operating environment or organizational change. Assess risk, develop and implement controls and mitigations.
5	Review effectiveness of all FRMS components. Review controls and mitigations. Effective controls require no change. Ineffective controls should be modified. Controls that are no longer needed can be eliminated.

Figure 5-2. FRMS safety assurance processes

5.2 FRMS SAFETY ASSURANCE PROCESSES

5.2.1 Step 1 – Collect and review data

Step 1 involves bringing together and reviewing information gained through the FRM processes to examine the overall performance of the FRMS. Performance of the FRMS should be examined by identifying a variety of safety performance indicators. These should include those specific to the FRMS as well as SMS safety performance indicators. Examples of safety performance indicators specific to an FRMS will include measures obtained through the FRM 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 flight crews on a specific pairing (trip);
- the ratio of fatigue reports from ULR operations covered by the FRMS to fatigue reports from the long-haul operations covered by the prescriptive flight and duty time regulations;
- attendance at FRMS training sessions;
- results on FRMS training assessments;
- the level of crew member participation in fatigue-related data collection;
- the number of times fatigue is identified as an organizational factor contributing to an event.

Appendix 8 to ICAO Annex 6, Part I, indicates that identification of safety performance indicators may result through examination of:

1. Hazard reporting and investigations;
2. Audits and surveys; and
3. Reviews and fatigue studies.

1. Hazard reporting and investigations

Trends in voluntary fatigue reports by crew members and others can provide valuable insights into the effectiveness of the FRMS. Safety events in which crew member fatigue has been identified as a contributing factor will 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 using appropriate methods for analysing the role of fatigue (see Chapter 4 and Appendix A).

2. 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).

Audits focus on the integrity of, and adherence to, the FRM processes. These audits should answer questions such as:

- Are all departments implementing the recommendations of the Fatigue Safety Action Group?
- Are crew members using mitigation strategies as recommended by the Fatigue Safety Action Group?
- Is the Fatigue Safety Action Group maintaining the required documentation of its activities?

Audits can also periodically assess the effectiveness of the FRMS, for example, by looking at the status of FRMS safety performance indicators and targets.

Audits are external to the Fatigue Safety Action Group, but may still be internal to the operator, i.e., conducted by other units 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 to have an independent scientific review panel periodically review the activities of the Fatigue Safety Action Group and the scientific integrity of their decisions. A scientific review panel can also provide the Fatigue Safety Action Group with periodic updates on new scientific developments relevant to the FRMS.

Surveys can provide information on the effectiveness of the FRMS. For example, they can document how schedules and rosters are affecting crew members, 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 (see Chapter 4 and Appendix A). A high response rate (ideally more than 70 per cent) 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").

3. Reviews and fatigue studies

In general, safety reviews are used to ensure that safety performance is adequate during times of change, for example, during the introduction of a new type of operation or a significant change to an existing operation covered by the FRMS.

A review would start by identifying the change (for example, 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 relating 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).

Fatigue studies as part of FRMS safety assurance processes are undertaken when an operator 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 operators, industry-wide or State-wide studies, and scientific studies. These sources of information can contribute in situations when safety arguments based on the limited experience and knowledge within that operator may not be enough. Fatigue studies in this context are mainly used for gathering information about large-scale issues in FRMS, rather than for identifying specific fatigue hazards.

5.2.2 Step 2 – Evaluate FRMS Performance

The aim of Step 2 is to validate the effectiveness of the fatigue controls and mitigations (Appendix 8 to Annex 6, Part I). It involves analysing the information gathered in Step 1 to check whether:

- all specified FRMS safety performance targets are being met;
- all specified FRMS safety performance indicators remain in the tolerable region defined in the risk assessment process (see Section 4.5);
- the FRMS is meeting the safety objectives defined in the FRMS policy; and
- the FRMS is meeting all regulatory requirements.

The following are examples of safety performance targets that could be used in FRMS safety assurance processes and that correspond with the safety performance indicators identified above (for additional examples see Section 5.8 of this chapter).

- 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 three months.

- By the fourth month after the introduction of a new operation, there should be a stable low number of voluntary fatigue reports per month, or a clear downward trend in the number per month (allowing time for crew members and other affected personnel to adjust to the new operation). The Fatigue Safety Action Group should provide 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.

- No specific pairing (trip) exceeds the average fatigue call rate by flight crews by more than 25 per cent.

- ULR operations covered by the FRMS do not attract any more fatigue reports than the long-haul operations covered by the prescriptive flight and duty time regulations.

- In the last quarter, the Fatigue Safety Action Group has met as often as is required in the FRMS policy and has maintained all the documentation of its activities that is required for internal and regulatory auditing.

- All personnel responsible for schedule design and rostering have met annual FRMS training requirements as specified in the FRMS promotion processes.

- Measures of the effectiveness of FRM training and education programmes (see Chapter 6 for examples).

- Quarterly levels of absenteeism are below the target specified for each operation covered by the FRMS.

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 re-entering the FRM processes at Step 2 or beyond (see Figure 4-2). Regulators should require that operators notify them when values for specific safety performance indicators reach particular values. The regulator can then assess how the operator intends to address this problem and monitor its progress.

For the operator, it may be appropriate to seek additional information from outside the organization (for example, by looking at fatigue studies). It may be necessary to undertake a review of compliance of crew members and other departments with the recommendations of the Fatigue Safety Action Group. It may also sometimes be necessary to review the functioning of the Fatigue Safety Action Group itself, to find out why the FRMS is not working as intended.

Figure 5-3 tracks a measure of the effectiveness of the Air New Zealand FRMS across time[1]. It shows that the percentage of pilots reporting duty-related fatigue occurring at least once a week has declined across a series of surveys conducted between 1993 and 2006.

1 Figure 5.3 is used by kind permission of Dr David Powell.

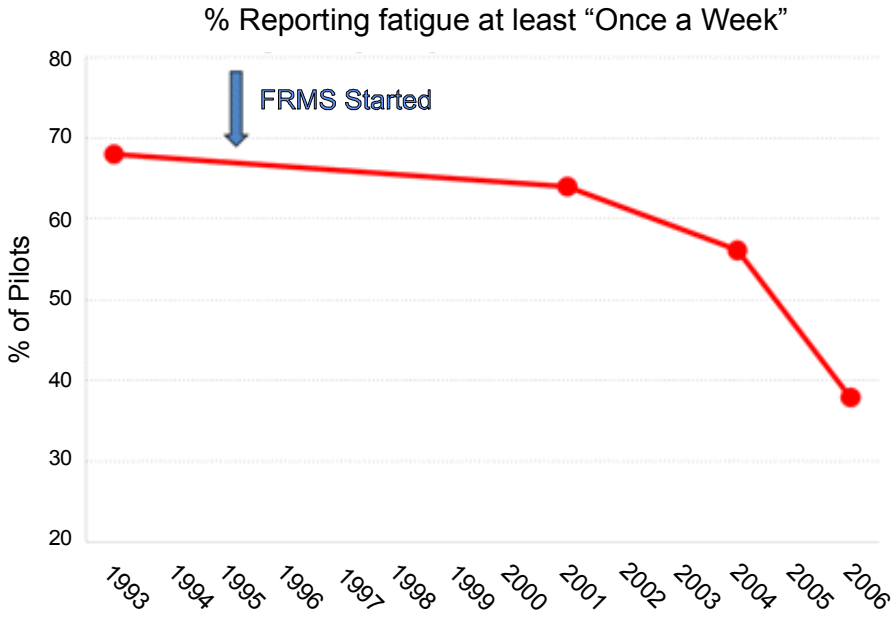


Figure 5-3 Declining reports of crew member fatigue across successive Air New Zealand surveys

5.2.3 Step 3 – Identify emerging hazards

Analysis of trends in safety performance indicators may indicate the emergence of fatigue hazards that have not previously been recognized through the FRM processes. For example, changes in one part of the organization may increase workload and fatigue-related risk in another part of the organization. Identifying emerging fatigue risks is an important function of FRMS safety performance processes, which take a broader system perspective than FRM processes. Any newly identified fatigue risk, or combination of existing risks for which current controls are ineffective, should be referred back to the Fatigue Safety Action Group for evaluation and management using FRM processes (risk assessment, design and implementation of effective controls and mitigations).

5.2.4 Step 4 – Identify changes affecting FRMS

In our dynamic aviation environment, changes are a normal part of flight operations. They may be driven by external factors (for example, new regulatory requirements, changing security requirements or changes to air traffic control) or by internal factors (for example, management changes, 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. Step 4 of the FRMS safety assurance processes aims to identify when new hazards may be a result of change.

Appendix 8 to ICAO Annex 6, Part I, requires that an operator has FRMS safety assurance processes that provide a formal methodology for the management of change. These must include (but are not limited to):

1. identification of changes in the operational environment that may affect FRMS;

2. identification of changes within the organization that may affect FRMS; and

3. consideration of available tools which could be used to maintain or improve FRMS performance prior to implementing changes.

A change management process is a documented strategy to proactively identify and manage the safety risks that can accompany significant change in an airline[2]. When a change is planned, the following steps can be followed:

- Use the FRM processes to identify fatigue hazards, assess the associated risk, and propose controls and mitigations.

- Obtain appropriate management and/or regulatory sign-off that the level of residual risk is acceptable.

- During the period of implementation of the change, use the FRMS safety assurance processes to provide periodic feedback to line managers that the FRMS is functioning as intended in the new conditions. An example would be having a validation period for a new ULR route, during which additional monitoring of crew member fatigue is undertaken, together with more frequent assessment of FRMS safety performance targets and indicators. Documentation of the change management strategy in relation to fatigue management is also the responsibility of the Fatigue Safety Action Group.

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, adjustments to training programmes, etc. The Fatigue Safety Action Group should propose such changes and obtain approval for them from appropriate management.

5.2.5 Step 5 – Improve effectiveness of FRMS

Ongoing evaluation by the FRMS safety assurance 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 then modified or eliminated through the FRM processes. Examples include:

1. Routine evaluations of facilities, equipment, documentation and procedures; and

2. The determination of the need to introduce new processes and procedures to mitigate emerging fatigue-related risks.

It is important that changes made to the FRMS be documented by the Fatigue Safety Action Group so that they are available for internal and regulatory audit.

5.3 ASSIGNING RESPONSIBILITY FOR FRMS SAFETY ASSURANCE PROCESSES

To deliver effective oversight of the functioning of the FRMS, and to examine its functioning in relation to the SMS, the FRMS safety assurance processes need to operate in close communication with the Fatigue Safety Action Group, but with a degree of independence from it. The aim is to avoid the Fatigue Safety Action Group reviewing its own performance. Figure 5-4 describes an example of how responsibility for the FRMS safety assurance processes might be assigned in a large organization.

2 ICAO's *Safety Management Manual (SMM)* (Doc 9859).