Australian Government
Civil Aviation Safety Authority

SMS 3

SMS FOR AVIATION–A PRACTICAL GUIDE | 2ND EDITION

Safety risk management

Contents

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What is safety risk management?

Safety risk management: the identification, analysis and elimination (and/or mitigation to an acceptable or tolerable level) of the hazards, as well as the subsequent risks, that threaten the viability of an organisation. (ICAO Safety Management Manual (Doc. 9859) 3rd edition)

Before an SMS can be effectively built or improved, you must identify the safety hazards to your operation and ensure you have controls in place to manage risk. An SMS should be risk based. For example, the risks involved in operating helicopters regularly at low level are quite different to those of an RPT service, so each operator's SMS will need to reflect that.

Safety risk management is a careful examination of what, in your work, could cause harm, so that you can weigh up whether you have taken enough precautions, or should do more to prevent harm.

History shows that aircraft accidents not only ruin lives, but also affect business if output is lost, assets or equipment are damaged, insurance costs increase, or you have to go to court. Legally, you must assess the risks to safe operations in your workplace, and implement a plan to control those risks.

Safety risk management is a key component of an SMS and involves two fundamental safety-related activities:

1. Identifying safety hazards
2. Assessing the risks and mitigating them (reducing the potential of those risks to cause harm).

Identifying safety hazards

A *hazard* is anything that could cause harm, damage or injury, or have a negative consequence, such as bad weather, mountainous terrain, FOD, lack of emergency equipment, high workload/ fatigue or use of alcohol and other drugs.

There are many ways of identifying hazards and quantifying risks, but to do it successfully you have to think laterally, unencumbered by past ideas and experiences. Operational hazards can be obvious, such as lack of training, or they may be subtle, such as the insidious effects of long-term fatigue.

There are several useful methods of identifying hazards:

- Brainstorming - small discussion groups meet to generate ideas in a non-judgmental way
- Formal review of standards, procedures and systems
- Staff surveys or questionnaires
- One person standing back from the operation and monitoring it critically and objectively
- Internal or external safety assessments
- Hazard reporting systems.
- Use of conceptual models such as:
  - SHELL model
  - Reason's accident causation model

To begin the safety risk management process, you have:

1. List the hazards you have identified in your organisation
2. Rank these hazards. Which ones do you have to prioritise—action sooner rather than later?
3. Then, having listed and prioritised your hazards, you begin the risk management process.

If you are a small aviation organisation with only a few staff, you simply need to apply discipline and make the time to examine all facets of your operations and identify any applicable safety hazards. You need to either eliminate the hazards where possible, vary the operation, or redesign in a practical way to protect from the hazards. You need to be able to be satisfied that all risks are acceptable.

For larger organisations, setting up discussion groups with as many staff and line managers as possible is a good way of identifying hazards. The group discussions will also encourage staff to become more actively involved in establishing or improving your SMS.

To avoid accidents and incidents any organisation should have multiple layers of controls or defences in place. However, controls are never foolproof – for example, having well-trained maintenance engineers does not ensure that aircraft components are always fitted correctly, and standard operating procedures for flight crew are only as effective as those who follow them.

Regularly identify what defences you have against recognised safety hazards.

Seven simple steps are suggested as an early warning safety system:

1. Communicate and consult with your stakeholders – internal and external. You need to identify who they are, what their objectives are, and the best way to involve them. You need their buy-in to make your hazard ID and risk management effective.
2. Identify safety hazards across your operations that could harm people, equipment, property or the environment.
3. Rank the likelihood and severity of these hazards
4. Identify the current defences/controls in place to manage them
5. Evaluate the effectiveness of each defence/control
6. Identify additional defences/controls where required
7. Record/(and continue to monitor) all this information in a hazard register.

Step 1: Communicate and consult

Talk to your stakeholders, both inside and outside your organisation. Who are they? What do they want? What is the best way to involve them? For your safety system to be effective, you need to have everyone's buy-in.

Step 2: Identify safety hazards

Focus group discussions should ask participants to brainstorm the types of safety hazards they think may threaten the safety of passengers, employees or contractors. The group should also consider those hazards which could damage equipment, or harm the environment. For example, for flight crew, fuel exhaustion would be a hazard that could result in the loss of both an aircraft and its passengers. For maintenance engineers, fatigue might be a hazard during night shift operations.

There may also be systemic hazards – organisational factors that could result in the loss of an aircraft, or injury to or the death of passengers. These hazards include: insufficient training; lack of policies or procedures; and people not following these policies or procedures.

Step 3: Rank and assess the severity of the safety hazards

Assess the hazards critically. Factors to consider are the likelihood (how often the hazard might result in a safety occurrence), and the severity (how bad the outcome would be) of any consequences. For example, a serious in-flight fire might be an unlikely occurrence, but it would be catastrophic if it were to occur. It would rank above a bird strike which, although much more likely to occur, tends to be less severe. Keep the process simple and get global views about how significant an issue the hazard really is, in the context of all the hazards identified.

OUTBACK maintenance services

Outback Maintenance Services has a close call involving engine cowl fasteners. Mick Jones, the safety officer and senior LAME, hears from the apprentice, Ryan Johnson, that an aircraft went out with the fasteners missing. The other LAME, Geoff White, was due to finish the service on his shift, but had footy practice for the finals that weekend, and left in a rush, saying over his shoulder as he raced out of the hangar, 'Mate, she's all done. Just give her a wipe-over; the doc will be here in the morning'. Ryan had done double shifts— 16 hours straight—and had to have the Beechcraft finished for the local doctor to fly to the city in the morning. During the graveyard shift, he wipes away an oil leak on the hydraulics, but bone tired, does not notice the missing fasteners.

When the GP arrives in the morning, he discovers the missing fasteners on his walk-around, and is understandably unimpressed. 'If you can't get this right, what else have you missed?' he asks pointedly.

Peter Lawson calls a toolbox meeting. 'There are things that stand between us and an accident. We've got to make sure they're working properly. How do we learn from this, and make sure it doesn't happen again? Bush Aviation won't want us doing any more of their maintenance, nor will Outback Exploration, if we can't show more professionalism.'

Step 4: Identify the controls/ defences in place to manage the hazards

Once you list the hazards and rank their order of risk, you should identify possible defences (hazard controls) against them. One defence against an in-flight fire is a fire extinguisher; a defence against aircraft fuel contamination is correct fuel filtration procedures and regular fuel testing. This step should provide a list of current controls/defences against each hazard: some controls will defend against multiple hazards.

Step 5: Assess the effectiveness of the current controls/defences

How effective is each hazard control/defence? Would the control prevent the occurrence (i.e. does it remove the hazard?), or just minimise the likelihood or the consequence? You can determine how effective a hazard control is by asking, for example: 'Does the crew know how to use the fire extinguishers, and are the extinguishers correctly maintained?' You will then have a list of effective controls, as well as a list of which controls need improvement.

Step 6: Identify further controls/ defences required

Examine each hazard and its control/s to determine whether the risk is adequately managed or controlled. If it is, the operation can continue. If not, consider how to improve the hazard control, or to remove or avoid the hazard entirely. For example, you could provide recurrent training for crew in the correct use of fire extinguishers.

You should manage the risk to a point of ALARP—as low as reasonably practicable. You should consider/ apply all possible means of mitigation until the cost of mitigation is grossly disproportionate to the benefit you obtain.

In some instances, there could be a range of solutions to manage a risk. Typically, some are engineering solutions (e.g. redesign), which, although probably the most effective, may also be expensive. Others involve control (e.g. operating procedures) and personnel (e.g. training) and might be less costly. The solution need not be costly to be effective.

Step 7: Record all this information in a hazard register

This is important not only for your internal risk management processes, but also in case you ever need to provide information to CASA, the ATSB or other regulators.

After completing these steps, you should have the following:

» A list of safety hazards identified by employees, ranked in order of importance

» A list of current controls/defences in place to manage these hazards

» A list of further controls/defences required to improve safety across the operation

» Staff involvement in identifying safety deficiencies and priority areas for improved risk management

» Who is going to do it.

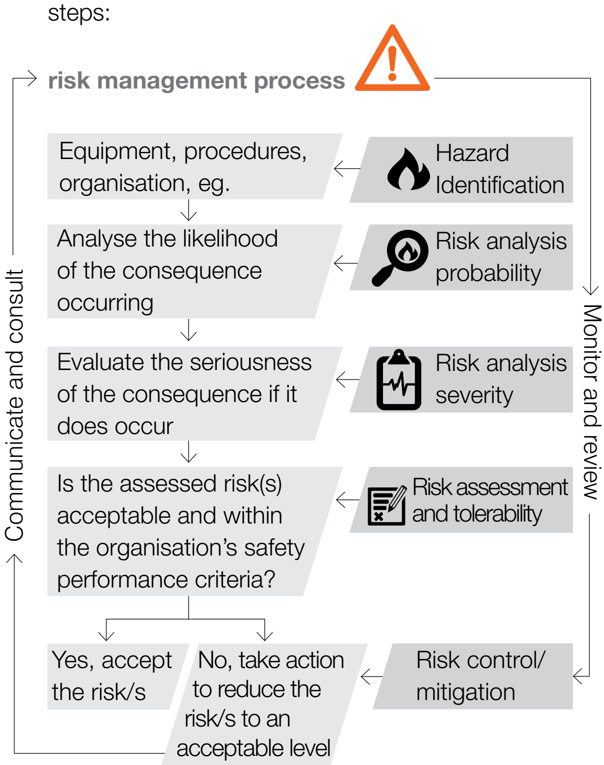
Hazard identification checklist

- The organisation has established various ways to proactively identify hazards through discussion groups (confidential where possible – in some smaller organisations this may be difficult or impossible), reporting, or surveys.
- The organisation uses the database of reported hazards to:
  - identify hot spots needing particular attention
  - conduct trend analysis which can help to improve hazard identification.
- Procedures are maintained for the internal and external reporting and recording of hazards and other safety-related issues to enable analysis and organisational learning.
- The organisation has processes in place to ensure identified hazards are dealt with in a timely manner, and the results of any actions are fed back to staff.

Risk assessment and mitigation

The term *risk* refers to the chance that somebody could be harmed by various hazards, together with an indication of how serious the harm could be.

Risk management is an integral component of safety management and involves five essential steps:



Don't overcomplicate the process. You should already have a good idea of the risks and of any control measures that you can easily apply. You probably already know whether, for example, you have employees who commute a long distance to work areas, or areas of maintenance which are more prone to risk. If so, check that you have taken reasonable precautions to avoid incidents.

If you run a small organisation and are confident you understand what's involved, you can do the assessment yourself. You do not have to be a risk specialist.

If you work in, or run a larger organisation, you can ask an advisor to help you. If you are not confident, ask someone competent for advice. In all cases, you should make sure that you involve your staff or their representatives in the process. They will have useful information about how the work is done that will make your risk assessments more thorough and effective.

Step 1: Identify the hazards

Work out how safe operations could be harmed. The hazard identification methods already mentioned are a good start. However, when you are in your workplace day after day, it is easy to overlook hazards, so here are some tips to help you identify the ones that matter:

» Walk around your workplace looking for things that could reasonably be expected to cause harm. Involve your employees: they may have noticed things that are not immediately obvious to you.

» Review your accident records—they can often help to identify less-obvious hazards.

» Review previous safety occurrences and maintenance errors. These will help in understanding risks and their potential likelihood and consequences.

» Review CASA or ATSB reports.

» Ask similar organisations what they found and have done about it.

Example: One of the safety concerns for air transport operators is incorrect loading of passengers or freight on the aircraft, which can lead to accidents.

Step 2: Decide what might be harmed and how the harm might be caused

For each hazard you need to be clear about what might cause harm. This will then help you identify the best way to manage the risk. That doesn't mean listing everyone by name, but rather identifying groups of people (e.g. flight crew, cabin crew and passengers).

In each case, you should identify what might occur. You will also need to identify the possible reasons (root causes) of the hazard.

An online search for SMS software will provide numerous potential suppliers of affordable software to manage all this.

What?

Incorrect aircraft loading can affect the safety of flight crew, cabin crew, passengers on board and people on the ground.

Causes?

Incorrect aircraft loading can result from:

- Poor weight and balance calculations
- Failure to weigh baggage correctly
- Miscommunication between flight crew and aircraft loading staff
- Failure to secure freight properly
- Loading of the wrong baggage/freight on the flight
- Information entered incorrectly into the flight management system.

Identification of the severity/consequence of the event

Take into account any current mitigation measures and assess the severity in terms of the worst possible realistic scenario.

Likelihood of occurrence

Take into account any current mitigation measures and whether they are currently used and assess the likelihood/probability of the risk occurring.

Likelihood	Meaning	Value
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that this event will occur	1

ICAO SMM 2.14.6

Value	Severity/ Consequence	Meaning
A	Catastrophic	» multiple deaths » equipment destroyed
B	Hazardous	» A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely » Serious injury » Major equipment damage
C	Moderate	» A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency » Serious incident » Injury to persons
D	Minor	» Nuisance » Operating limitations » Use of emergency procedures » Minor incident
E	Negligible	» Few consequences

The safety manager/safety officer will enter the results into the safety report and hazard log.

Use the risk tolerability matrix to assess how tolerable the risk is using the results obtained from the assessment of the consequences and likelihood.

ICAO SMM Safety Risk Assessment Matrix

Risk probablility		Risk severity				
		A	B	C	D	E
		Catastrophic	Hazardous	Moderate	Minor	Negligible
5	Frequent	5A	5B	5C	5D	5E
4	Occasional	4A	4B	4C	4D	4E
3	Remote	3A	3B	3C	3D	3E
2	Improbable	2A	2B	2C	2D	2E
1	Extremely improbable	1A	1B	1C	1D	1E

Step 3: Evaluate the risks

Having identified the hazards, you then have to decide what to do about them. You must ‘do everything reasonably practicable’ to mitigate the risks of identified hazards. You can work this out for yourself, but the easiest way is to compare what you are doing with good practice and/or with what your competitors are doing.

Examine what you are already doing. Think about what controls you have in place and how the work is organised. Then compare this with good practice and see if there is more you should be doing to bring yourself up to standard. Ask yourself:

» Can I eliminate the hazard altogether? If not, how can I control the risks so that harm is unlikely?

» Can I try a less risky option? Prevent access to the hazard? Reduce exposure to the hazard?

Improving safety need not cost an enormous amount. For instance, placing a mirror on a dangerous blind corner of the airport apron to help prevent vehicle accidents is a low-cost precaution, considering the risks. Failure to take simple precautions can be much more costly if an accident does happen.

Evaluate risk level – An important task in analysing risk is to determine the risk level based on its *likelihood* and *consequence*.

Likelihood consists of two parts:

» The likelihood of a single event occurring

» The likelihood of the event occurring based on exposure and repetition (how often the task is performed, such as cycles of aircraft maintenance etc.)

A simple way to determine the *likelihood* is to rank the hazard based on its potential frequency of ocurrence. This can be done on a simple five-point scale, from ‘rare’ to ‘almost certain’.

Consequence is the potential impact or outcome that may result from the hazard. This can range from insignificant to catastrophic.

Aircraft loading is a regular activity, so the *likelihood* of incorrect loading into the wrong hold is assessed as ‘possible’ and the *potential consequence* can be ‘moderate’, resulting in ‘incorrect loading’ being categorised as ‘high’, given the potential for damage to aircraft structure, or the aircraft being out of weight and balance tolerances.

Decide on precautions – Once you determine the risk levels, assess the safety defences or controls in place to work out how effective they are against the hazard or hazardous event.

> Safety defences/controls in place to prevent incorrect aircraft loading:
>
> » Standard industry weights used for passengers
>
> » Securing cargo more effectively
>
> » Cargo and baggage weighed separately
>
> » Standard load sheet used by pilots to calculate weight and centre of gravity of the aircraft
>
> » Correctly calibrated scales

Step 4: Record your findings and implement them

Having assessed the risk and the defences in place, decide how to implement your risk management plans. You may avoid the risk, accept the risk in order to pursue an opportunity, remove the risk, or share the risk with another party (see ISO 31000:2009).

Putting the results of your risk assessment into practice will make a difference when looking after people and your business.

Record the results of your risk assessment and share them with your staff. It is important to document what you have done so that you can review it at a later date if anything changes.

A risk assessment does not have to be perfect, but it must be suitable and sufficient. You need to be able to show that:

» you made a proper check

» you asked who might be affected

» you dealt with all the significant hazards, taking into account the number of people who could be involved

» your precautions are reasonable and any residual risk is low

» you involved your staff, or their representatives, in the process.

If, as in many organisations, you find that there are a number of improvements to be made, both large and small, do not try to do everything at once. Make a plan of action to deal with the most significant risks first. CASA inspectors acknowledge the efforts of aviation organisations that are clearly trying to make improvements.

However, you cannot continue operations if a risk is assessed as 'intolerable', until that risk is mitigated to acceptable level.

You need to allocate tasks to the right people, with timelines for getting the job done. One large successful operator makes sure things are done by having the CEO as the only person who can approve extensions. There must be a very good reason for any extension request.

A good plan of action often includes a mixture of different things. There may be a few cost-effective or easy improvements you can do quickly, perhaps as a temporary solution until more reliable controls are in place. Remember to prioritise and tackle the most important things first. As you complete each action, tick it off your plan.

> While the majority of safety defences/controls in place were assessed as effective, additional measures are required, which are detailed in a risk management plan outlining short-and longer-term measures:
>
> **Short-term**
>
> » Extra nets and straps to be made available to secure cargo correctly
>
> » Standard load sheet to be held in the cockpit at all times.
>
> **Long-term**
>
> » Standard training for all people involved in baggage handling.

Step 5: Monitor the effectiveness of your implementation

Monitor your agreed implementation solutions to make sure they are working, and if they are not, reassess.

Step 6: Review your assessment and update if necessary

Few workplaces stay the same. Sooner or later, you will bring in new equipment and procedures which could lead to new hazards. It makes sense, therefore, to review what you are doing regularly. As a minimum, once a year you should review where you are, to make sure you are still improving, or at least not sliding back.

Review your risk assessment. Have there been any changes? Are there improvements you still need to make? Have your workers spotted a problem? Have you learnt anything from accidents or near misses? Make sure your risk assessment stays up to date.

When you are running a business it is all too easy to forget about reviewing your risk assessment, until something goes wrong and it is too late.

Set a review date for this risk assessment. Write it down and note it in your diary as an annual event, or enter it in your online calendar.

During the year, if there is a significant change, don't wait. Check your risk assessment and, where necessary, amend it. If possible, think about the risk assessment when you are planning the change – that way you can be more flexible and proactive.

Monitoring process documented:

» Internal audit conducted every six months on aircraft loading procedures

» Date for an independent annual audit noted in diary

» Staff to be reminded formally at least twice in scheduled monthly safety briefings about the safety reporting process in place to report aircraft loading issues

» Results of reports communicated to staff through company education program.

ALARP

Where risk is concerned, there is no such thing as absolute safety. Risk management is often based on the concept of ALARP or 'as low as reasonably practicable'. There is wide acceptance that not all risk can be eliminated. There are practical limits to how far the industry and the community will go in paying to reduce adverse risks.

The ALARP principle and cost-benefit analysis

» All efforts should be made to reduce risks to the lowest level possible until a point is reached at which the cost of introducing further safety measures significantly outweighs the safety benefit.

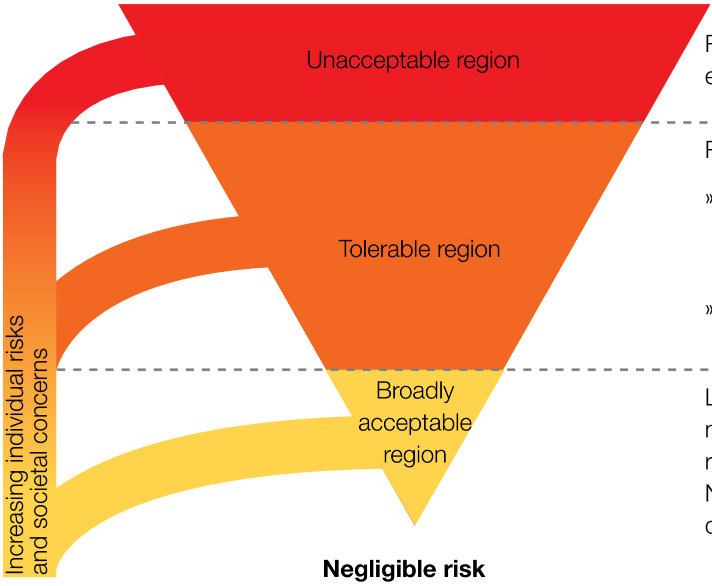
» A risk should be tolerated only if it can be demonstrated that there is a clear benefit in doing so (i.e. there is a compelling operational need in the organisation).

The ALARP principle identifies three categories of risk:

1. **Unacceptable** risks are classified as unacceptable regardless of the benefits associated with the activity. An unacceptable risk must be eliminated or reduced so that it falls into one of the other two categories, or there must be exceptional reasons for the activity or practice to continue.

2. **Tolerable** risks that people are generally prepared to tolerate to secure their benefits. Tolerable risks must be properly assessed and controlled to keep the residual risk ALARP, and must be reviewed periodically to ensure they remain that way (e.g. the potential risk of pedestrians, walking between the terminal and the aircraft, being struck by a moving vehicle is only tolerated IF appropriate barricading, security escort and lighting are in place).

The ALARP approach



Risk cannot be justified unless in extraordinary circumstances

Risk is tolerable only if:

» Further risk reduction is impracticable or if its cost is grossly disproportionate to the improvement gained,

» Society desires the benefit of the activity, given the associated risk

Level of residual risk regarded as negligible and further measures to reduce risk not usually required. No need for detailed working to demonstrate ALARP

3. **Broadly acceptable** risks are considered sufficiently low and well controlled. Further risk reduction is required only if reasonably practicable measures are available. Broadly acceptable risks are those that people would regard as insignificant or trivial in their daily lives, or which exist, but have no practicable mitigator (e.g. most organisations accept that staff could be injured on their way to work, but have little control over what happens on public roads).

To determine whether a risk is tolerable (in the ALARP approach), you need to consider a number of criteria:

» **Legal requirements**—Aviation organisations must comply with applicable CASA and relevant state-based legislation. A control based on a legal requirement must always be considered 'reasonably practicable'.

» **Expert judgement**—A proposed control should be considered reasonably practicable if an appropriate group of experts has established it has a clear safety benefit, and the costs associated with its introduction are considered reasonable.

» **Cost-benefit analysis**—Where expert judgement or contemporary good practice does not provide clear evidence that a specific control or group of controls are reasonably practicable, a cost-benefit analysis may be necessary. This establishes whether the cost of implementing a specific control is grossly disproportionate to its safety benefit.

» **Industry good practice**—If the proposed control represents current, relevant, established good practice, that is sufficient evidence to conclude that it is reasonably practicable. For example, it:

- complies with aviation industry standards, rules or procedures
- is a practice of other operators that are similar in scale and operation to your own
- is established and widely implemented in another industry sector
- matches other countries' legislated enforcement of the practice
- is proven to have demonstrably improved safety, or can be implemented without significant modification or cost.

ALARP application

1. **Identification of hazard**

A small certified aerodrome operator, located in outback Australia, identifies a safety hazard – wildlife wandering on to the runway, and potentially colliding with aircraft.

Hazard = *wildlife on runway, specifically wallabies, feral camels and donkeys.*

2. **Decide who should be involved in the assessment process**

Aircraft operations during taxiing, take-off and landing are exposed to this hazard. The hazard is caused by inconsistent wildlife management, seasonal conditions and the absence of a perimeter fence.

3. **Evaluate the risks and decide on precautions**

Discussions with aircraft operators and other stakeholders using the aerodrome reveal no identified incidents involving wildlife have resulted in a collision. However, over the last six months there have been five near-miss reports, two of which involved minor evasive action (braking by the pilot in command) to avoid collision. The risk is assessed as 'moderate', based on a combination of 'possible' (likelihood) and 'minor' (consequence).

The aerodrome operator decides that two controls could manage the risk: an improved wildlife management program, including possible seasonal eradication of animals; and constructing an airfield perimeter fence to prevent wildlife access.

The airport operator decides the airport perimeter fence is the most effective control of the two available, and applies ALARP to determine if this is justifiable. They consider the following to determine whether the risks are tolerable:

Legal requirements—This is a certified aerodrome under CASR Part 139, with only one weekly RPT service and a variety of charter and general aviation operations. Therefore, there is no explicit aviation regulatory requirement for a perimeter fence.

Expert judgement—Stakeholders consulted about the possible construction of a fence agree that it is an effective control, but the fence must be maintained and inspected regularly.

Cost benefit analysis—The cost of the perimeter fence construction and ongoing maintenance program is determined to be beyond the funds of the aerodrome operator, and local government is unable to assist with finances. The small number of incidents therefore suggests that the cost is not justifiable.

Industry practice—A quick survey of similar-sized registered aerodromes suggests that not all have perimeter fences, and some are only partially fenced. While perimeter fencing is recommended, industry practice suggests that this is not consistent.

4. **Record your findings and implement them**

The aerodrome operator decides therefore that a perimeter fence is not justified, based on its cost to build, that such a fence is not consistent with industry practice, and that there is a limited risk of wildlife on the runway colliding with an aircraft. However, to ensure that the risks are 'acceptable' based on ALARP principles, they decide to improve wildlife management through a more targeted seasonal wildlife management program – keeping the grass down to minimise food supplies and regular sweeps of the runway to deter wildlife.

5. **Review your assessment and update if necessary**

They review the wildlife management program annually, with aerodrome users reminded to report wildlife activity on or near the aerodrome.

They also contact CASA for resources to assist in wildlife identification and management, and develop a wildlife hazard management plan.

Risk mitigation checklist

- ■ The organisation has a formal safety risk management process used to:
  - ■ identify hazards associated with the organisation's operations
  - ■ analyse and assess the risks associated with those hazards
  - ■ implement controls to prevent future accidents, incidents or occurrences.
- ■ This safety risk management process meets the following risk management requirements to:
  - ■ (a) communicate and consult
  - ■ (b) establish the context
  - ■ (c) identify risks
  - ■ (d) analyse risks
  - ■ (e) evaluate risks
  - ■ (f) treat/mitigate risks
  - ■ (g) monitor and review.
- ■ There is a formal record of each stage of the risk management process, including assumptions, methods, data sources, analysis, results and reasons for decisions.

Case study – fatigue risk management

What is fatigue?

Fatigue is an experience of physical and/or psychological weariness.

If you become fatigued, the effect can be the same as if you have consumed alcohol. Fatigue can, for example, affect your ability to react quickly to emergencies; communicate clearly and determine the safe limits of your actions; as well as your ability to operate productively.

Managing fatigue is an important component of safety management, given that it is a significant and preventable factor in transport incidents/accidents. For example, 20-30 per cent of road incidents and 5-15 per cent of all fatal road accidents involve driver fatigue.

What causes fatigue?

Both work-and non-work-related factors affect fatigue.

Work-related fatigue factors:

» The hours you have to work (and the impact of these hours on the opportunity to sleep)

» The timing and duration of breaks within shifts

» The work you do

» Your work environment.

Non-work-related fatigue factors:

» Long commutes to and from work

» Sleep disorders affecting the quantity and/or quality of your sleep recovery

» Your family and social responsibilities

» Having a second job.

Consequences of fatigue

General consequences can include:

» Lapses in attention/concentration

» Poor risk assessment, and incomplete or inaccurate assessment of potential consequences

» Inefficiency in production, on-time performance, resource use (e.g. fuel), and/or motivation

» Impaired or delayed decision making

» A higher likelihood of focusing on the most obvious data or stimuli, to the exclusion of other equally important information.

The table below indicates the typical behavioural symptoms of fatigue. If an employee has experienced three or more of the specified symptoms in a 15-minute period they are likely to be fatigued.

Fatigue management countermeasures

Counter measures to prevent fatigue-related errors are listed below:

Napping

Generally, the longer the nap the greater its recovery value. Naps should provide at least 20 minutes of sleep, but no longer than two hours, to be of the greatest benefit.

Longer naps can lead to ‘sleep inertia’ - the groggy feeling you have when someone wakes you up during a deep sleep. So, before returning to work after such a nap, people should have 10-20 minutes of ‘recovery’ to overcome the effects of sleep inertia.

Behavioural symptoms of fatigue

PHYSICAL SYMPTOMS	MENTAL SYMPTOMS	EMOTIONAL SYMPTOMS
» Yawning » Heavy eyelids » Eye rubbing » Head drooping » Inappropriate or unintentional napping » Falling asleep » Poor coordination	» Difficulty concentrating on the current work task » Lapses in attention » Difficulty remembering what you are meant to be doing » Failure to communicate important information to a colleague » Failure to anticipate events or actions » Unintentionally doing the wrong thing (errors of commission) » Unintentionally failing to do the right thing (errors of omission)	» More quiet or withdrawn than normal » Lethargic or lacking in energy » Lacking in motivation to do the task well » Irritable or bad-tempered behaviour with colleagues, family or friends

Small- to medium-sized air transport operators do not currently need custom-built crew rest facilities for napping on their aircraft. Consider a simple but effective strategy used by one helicopter charter operator:

Napping facility

A Bankstown-based helicopter charter operator recognises that after long and demanding operations, its aircrew get into their cars and in some cases drive for up to two hours to get home. To offset the risk of fatigue, all aircrew have access to a dedicated rest facility located at the rear of the maintenance hangar. The chief pilot believes that this allows his crew to take naps, and is one of their most valuable fatigue countermeasures.

Supervisor and co-worker monitoring

If your workers are at increased risk of a fatigue-related error, you may be able to ask peers or supervisors to monitor fatigue-related behaviours. However, you need to guide people about what to look out for. You must provide this information in advance, to minimise misperceptions that people are being watched.

You can make monitoring as simple as more frequent verbal contact (for example, regularly throughout the shift), or you can make it more formal by mandating verified additional supervisory checks (at hourly intervals during night shift work, for example) for safety-critical duties.

NOTE !

Maintenance engineer peer monitoring

Look out for the following symptoms that may indicate you or your co-workers are fatigued:

- Communication that goes unanswered, or checklists that go unchecked
- Diminished motor skills – writing that trails off into nothing, poor concentration, impaired driving skills
- Obvious tiredness – drooping head, eyes half closed or staring
- Diminished vision – difficulty in focusing
- Slow reactions
- Short-term memory problems – unable to remember information you have just been told
- Channelled concentration – fixation on a single, possibly unimportant issue, neglecting others, and unable to maintain an overview of the job
- Easily distracted by trivia or, at the other extreme, fixation on a single issue
- Poor or clumsy handling of tools/operation of equipment
- Increased mistakes – making poor decisions, or no decisions at all
- Abnormal moods – mood swings, depressed, periodically elated and energetic, diminished standards.

If you notice any of these symptoms, what should you do?

- Deal with the problem within your own team first by raising it (do not accuse) with the person concerned. 'I notice you are looking very tired; is everything OK?'
- Try to find out why the person is fatigued
- Ask how you can help
- If the problem continues, reach agreement with the person that their supervisor should be involved to allow for more formal fatigue countermeasures
- Emphasise that fatigue is a safety-critical issue, and work cannot continue until it is dealt with.

Task rotation and/or task reallocation

Task rotation has significant potential as a fatigue control measure. In many cases, workload can be made more engaging by varying the tasks undertaken across a shift.

Task rotation can be more difficult in small organisations with limited numbers of skilled staff. However, where you have groups of skilled staff, and particular rosters are known to be more susceptible to fatigue, or a safety-critical task is under time pressure, a tag team approach to the job can be useful. You might be able to alternate staff between doing the job and quality control cross-checking.

When fatigue-related symptoms are recognised, either by self-assessment or supervisor monitoring, consider task reallocation, especially where there are high risks to the individual, to peers, and/or to the general public.

For example, less risky tasks might be simple procedural tasks, word and data processing, quality checks and basic communication. This control only reduces exposure to high-impact hazards, but does not mitigate the fatigue itself.

Suitable overnight accommodation and meals

If your organisation conducts overnight operations, you may want to organise minimum accommodation requirements with your customers to ensure your staff have adequate food and rest facilities.

A small aircraft charter organisation has the following policy:

Minimum accommodation requirements for all overnight operations

To ensure aircrew have the best opportunity for good-quality sleep during overnight operations, they require the following minimum accommodation:

- A single room for each aircrew member, which:
  - has easy access to the worksite
  - is air conditioned
  - is comfortable, clean and to a high standard.
  - has access to quality in-house meals.

If these minimum conditions are not met, please inform the chief pilot immediately.

Strategic use of caffeine

Caffeine can provide a short-term improvement in alertness. How intense and long lasting that effect is depends on how much caffeine the body is used to, and how often it is consumed. Not surprisingly, the more frequent and the higher the caffeine intake, the less noticeable will be the improvement in alertness, so it should only be used (with caution) as a contingency.

Regulatory requirements

Two principal regimes require Australian aviation operators to manage fatigue: the various state and territory *Workplace Health and Safety* (WH&S) Acts and CASA regulations.

The various *Workplace Health and Safety* Acts adopt a generalised 'duty-of-care' approach – employers must ensure that their workplaces are as free from risk of harm as reasonably possible. The broad formulation of this duty covers the risks posed by fatigue.

All AOC holders must manage the fatigue risk associated with their operation by complying with prescriptive limits, or under an approved fatigue risk management system (FRMS). CASA expects that most operators, under the new Civil Aviation Order (CAO) 48.1, will choose to comply with prescriptive limits requiring hazard identification and fatigue risk management. An SMS would meet this requirement.

SMS and FRMS compared

An FRMS is really a safety management approach to dealing with the risks imposed by fatigue, so there are similarities between the components of an SMS and FRMS, as shown below.

Fatigue risk management system (FRMS)

Fatigue risk management systems are increasingly being adopted by air transport operators to control the risks of fatigue-related accidents and incidents. An FRMS is simply a component of the overall safety management system and includes controls such as:

- **Policy and procedures** – documents how fatigue risk is managed and by whom
- **Evaluation and review** – measures program effectiveness and recommends improvements
- **Audit** – assesses operational compliance with the fatigue program policy, procedures documents and ongoing legislative requirements
- **Record keeping** – provides documented evidence of fatigue risk management and is one element of an evaluation and review process
- **Education and training** – trains individual employees and stakeholders to manage fatigue risk competently
- **Communication and consultation** – communicates and coordinates information about fatigue.

An effective fatigue program requires multiple fatigue countermeasures or defences:

- Provide sufficient sleep opportunities to all employees. Employees should take advantage of these. Adopting prescriptive duty time limitations and designing rosters to manage fatigue are other possible controls.
- Ensure employees take responsibility for obtaining sufficient sleep, and report to you if that has not been possible. Encourage employees to report any fatigue risk issues through their direct supervisor, or by using a more formal safety occurrence report form.
- Train your employees to recognise their own (and others'), fatigue-related behavioural symptoms, and manage them appropriately. Provide fatigue management training at induction, as well as ongoing fatigue management refreshers for employees, contractors and stakeholders.

This framework reduces the likelihood that an individual will be exposed to fatigue-related risk. However, fatigue-related risk cannot be eliminated. Implement countermeasures such as task rotation, task allocation, strategic use of caffeine, napping and co-worker/peer monitoring to reduce the risk of fatigue-related errors.

Once a fatigue-related incident has been reported, carry out a thorough investigation to identify any additional risk controls or risk management strategies required.

Busy lifestyles, long commuting distances and family responsibilities can lead to fatigue. Therefore, it is important to acknowledge that no one is immune to fatigue. All staff and contractors have a role to play in contributing to managing and mitigating its potentially hazardous effects.

For further information regarding FRMS, see CAO 48.1 and the CASA website: www.casa.gov.au/fatigue

Toolkit

Booklet 3 - Safety risk management tools

- Error prevention strategies for organisations
- Risk register
- Sample hazard ID
- Guidance on job and task design
- A six-step method for involving staff in safety hazard identification
- Hazard reporting form

Index of toolkit items

This is *your* safety toolkit with some best-practice tips and practical tools that can be adapted to meet your organisation's needs. We hope you find them useful, whether you are further developing your SMS, starting an SMS from scratch, or simply looking for some ideas to improve your existing SMS.

This list summarises the checklists/templates you will find at the back of each of the respective booklets.

This is not an exhaustive list of resources.

NB: There are many systems and products across various industries, so this toolkit can only include a very small sample of practices and/or tools for information.

Inclusion of materials does not imply endorsement or recommendation. Each organisation must select the most appropriate products for its individual and specific needs.

Booklet 1 – Basics

» Jargon busters

» References.

Booklet 2 – Safety policy and objectives tools

» SMS organisation checklist

» Safety policy statement

» Safety manager's job description

» Role of the safety committee

» SMS implementation plan

» Ten steps to implementing an SMS

» SMS gap analysis checklist

» An effective emergency response plan (ERP)

» Language and layout of procedures/documentation

» Document register

» Sample safety leadership rules

» Aviation safety lifesavers policy

» Healthy safety culture procedure

» Appendix A – Workflow process for applying the healthy safety culture procedure

» Appendix B – Bush Aviation and Training counselling/discipline decision chart.

Booklet 3 – Safety risk management tools

» Error prevention strategies for organisations

» Risk register

» Sample hazard ID

» Guidance on job and task design

» A six-step method for involving staff in safety hazard identification

» Hazard reporting form.

Booklet 4 – Safety assurance tools

» Generic issues to be considered when monitoring and measuring safety performance

» Audit scope planner

» Basic audit checklist

» Information relevant to a safety investigation

» Event notification and investigation report

» Aviation safety incident investigation report

» Corrective/preventative action plan

» Checklist for assessing institutional resilience against accidents (CAIR)

» Practical safety culture improvement strategy

» Safety culture index.

Booklet 5 – Safety promotion tools

» How to do a training needs analysis

» Sample safety information bulletin on fatigue

» How to give a safety briefing/toolbox talk

» Aviation safety toolbox talk

» Safety briefing/toolbox meeting attendance form.

Error prevention strategies for organisations

Three strategies aimed at error prevention, which is actually a form of risk mitigation, are briefly outlined below. These strategies are relevant to flight operations, air traffic control, or aircraft maintenance.

Error reduction strategies are intended to intervene directly at the source of the error itself, by reducing or eliminating the contributing factors to it. They seek improved task reliability by eliminating any adverse conditions leading to an increased risk of error. Error reduction is the most frequently used strategy.

» Examples of error reduction strategies include improving the access to a part for maintenance, improving the lighting in which the task is to be performed and providing better training.

Error capturing assumes the error has already been made. The intent is to 'capture' the error before any adverse consequences of the error are felt. Error capturing does not directly reduce or eliminate the error.

» Error capturing strategies include post-task inspection, verification or testing, for example, cross-checking a checklist. (However, a possible drawback to this error prevention strategy is that people may be less vigilant when they know there is an extra defence in place to capture their errors.)

Error tolerance refers to the ability of a system to accept an error without serious consequence. For example, as a strategy to prevent the loss of both engines on an aircraft involved in extended twin-engine operations, some regulatory authorities prohibit the same maintenance task being performed on both engines prior to a flight.

» Examples of measures to increase error tolerance are the incorporation of multiple hydraulic or electrical systems on the aircraft, and a structural inspection program allowing multiple opportunities to detect a fatigue crack before it reaches critical length.

Guidance on error prevention/risk mitigation issues to be considered by organisations

ICAO advocates some fundamental strategies aimed at error prevention, which is a form of risk mitigation. These include:

» An open and transparent error-reporting program (not one focusing on culpability and blame)

» Human factors training provided with the specific application of error identification, capture and management

» Non-jeopardy-based observational auditing programs that examine the threat and error management skills of safety-critical workers

» The organisation advocating strict adherence to standard operating procedures (SOPs) and standard communication phraseology

» Equipment design being human-centred

» Systems to continually learn the lessons of previous occurrences

» Consideration given to using automation where possible, particularly for routine and monotonous tasks relying heavily on operator vigilance.

The importance of reporting hazards, and having a systematic and effective process for reporting them cannot be over stressed.

This must be supported by management commitment and responsibility—the culture of the organisation, which must encourage employees to report errors and to identify, report and monitor hazards.

Risk register

[insert name of organisation]			**Risk register**					**Log number**				
Report reference number	The risk • What can happen? • How can this happen?	Date entered in register	Existing controls	The consequences of an event happening			Additional mitigation required	Residual risk			Action and owners	Monitoring and review requirements
				Severity	Likelihood	Level of risk		Severity	Likelihood	Level of risk		
Date: xx/xx/xxxx		Version: x		Form SMS 3								

OUTBACK maintenance services

Sample hazard ID

Hazard ID	**Shift handover & fatigue**			
Mitigators	Effectiveness	Reason	Further controls/defences required	Responsibility
Shift handover procedures	No	In a manual in Peter's office – nobody reads them	Half-hour overlap between shifts to allow for proper briefing, and for log to be fully completed	Cheryl Lawson
Shift handover log	No	Not in central enough place – goes missing	To be transferred to hangar PC, and completed online	Cheryl Lawson
Regular staff safety meetings	No	Not held consistently enough	Schedule regular fortnightly toolbox meetings.	Mick xxx (safety officer)
Rostering	No	Not enough staff to cover the required shifts	With planned growth, take on new staff	Peter Lawson
Recording	No	Ad hoc system – is only done sometimes	Hazard & risk register on hangar PC. Everyone gives and receives feedback	Mick xxx & Cheryl Lawson

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A seven-step method for involving staff in safety hazard identification and risk assessment

» To avoid accidents and incidents, any organisation should have multiple layers of controls or defences. However, controls are never foolproof – for example, having well-trained maintenance engineers does not ensure that aircraft components are always fitted correctly. Standard operating procedures for flight crew are only as effective as those who follow them. Air transport operators and maintenance organisations should regularly identify what defences they have to contain recognised safety hazards as an early warning safety system.

» To achieve this, seven simple steps are suggested:

1. Communicate and consult
2. Identify safety hazards across your operations that could harm people, equipment, property or the environment.
3. Rank the likelihood and severity of these hazards
4. Identify the current defences/controls in place to manage them
5. Evaluate the effectiveness of each defence/control
6. Identify additional defences/controls where required
7. Record all this information in a hazard register.

After completing these steps, you should have the following:

» A list of safety hazards identified by employees, ranked in order of importance

» A list of current controls/defences in place to manage these hazards

» A list of further controls/defences required to improve safety across the operation

» Staff involvement in identifying safety deficiencies and priority areas for improved risk management.

BUSH
aviation and training

Hazard report form

Reported by:

Name: ________________________________ Position: ________________________

Subject:

[ ] Workplace hazard [ ] Hazardous work practice [ ] Public hazard [ ] Aviation safety hazard

Description of hazard and any action taken:

____

____

____

Is further action required? Yes [ ] No [ ]

Reported to: ______________________________

Aviation safety officer: ______________________________

Safety committee/rep: yes/no

Reporting person's name: ___________________________Signature: ______________________________

Date:_____ /_____ /_____

Supervisor use only

Date report received:_____ /_____ /_____

Action taken or recommended:

____

____

Date implemented: _____ /_____ /_____

Name:____ Signature: ______________________________

Further notes

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