



Australian Government
Civil Aviation Safety Authority

**Safety Management Systems
for aviation: a practical guide**

SMS 3

Safety risk management

3rd Edition

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Contents

What is safety risk management?	2
Identifying safety hazards	5
Identifying safety risks	8
Safety risk assessment and mitigation	11
Completing a risk assessment	13
Documentation	21
Human factors related risks	22
ALARP and SFAIRP	22
Outcomes-based and PSOE considerations	26
Toolkit – Booklet 3: safety risk management tools	28

What is safety risk management?

Safety risk management is the identification, analysis, and elimination or mitigation to an acceptable or tolerable level of the hazards, and their subsequent risks, that threaten the viability of an organisation (International Civil Aviation Organization [ICAO] Safety Management Manual, Doc. 9859).

Before a safety management system (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 and will vary depending on the type of aviation activity. For example, the risks involved in operating helicopters regularly at low level are quite different to those of regular scheduled passenger services, or those of a maintenance organisation. Accordingly, each operator's SMS will need to reflect the nature of the risks that are identified.

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.

Safety hazards are inevitable within aviation. However, the manifestation and potential adverse consequences can be addressed through mitigating actions that aim to control potential hazards, resulting in unsafe conditions. Aviation

activities can co-exist with hazards if they are controlled appropriately. Therefore, hazard identification is the first critical step in the safety risk management process, requiring a clear understanding of your hazards and their related consequences to maintain an acceptable level of safety within your operations.

History shows 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.

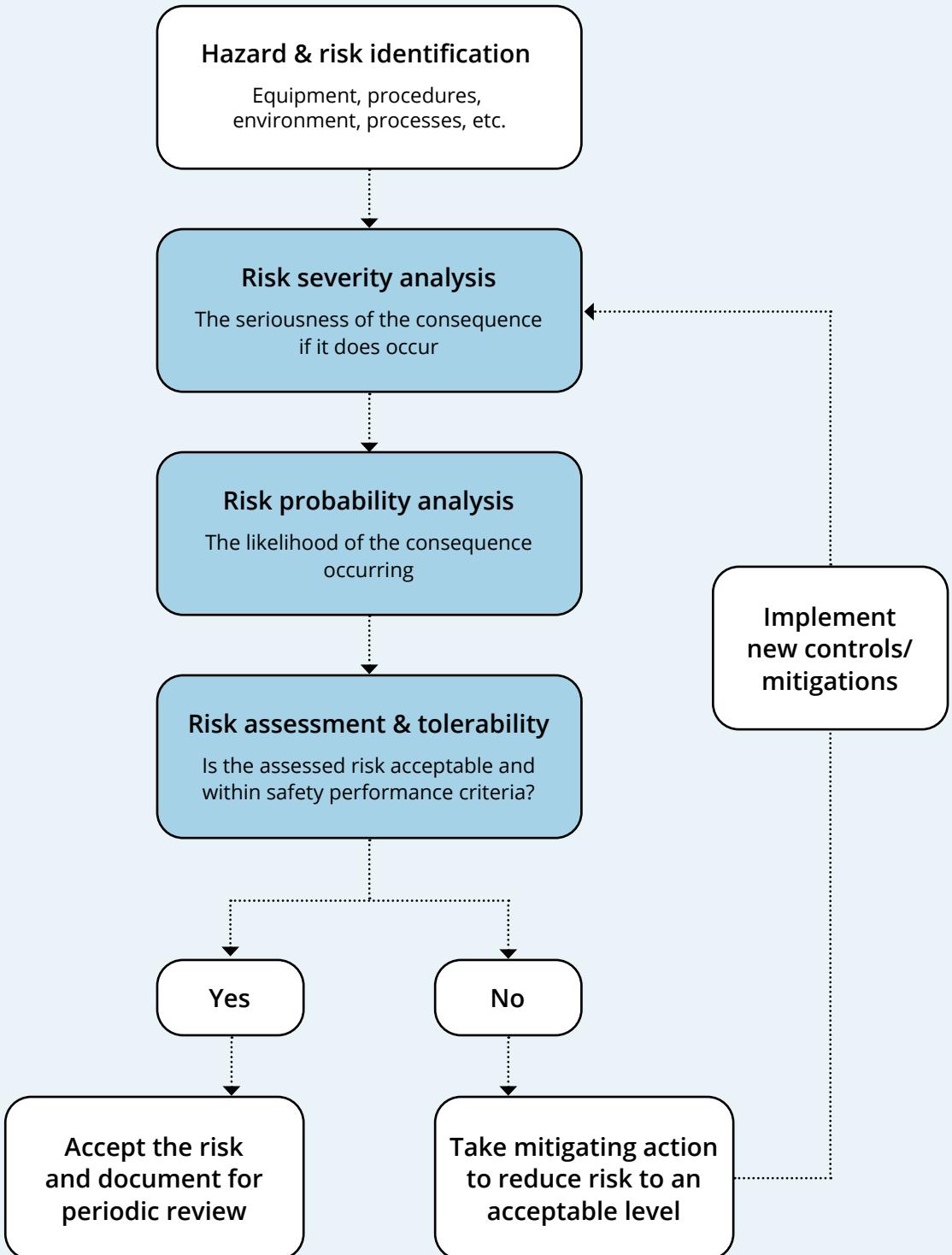
Safety risk management is a key component of an SMS and involves two fundamental safety-related activities:

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

SMS Component	Element
Safety risk management	Hazard identification
	Safety risk assessment and mitigation

Risk management is an integral component of safety management and involves some essential steps, as shown in the figure on page three.

Essential steps involved in safety risk management



Aviation safety vs corporate risk management

Aviation safety risk management is the process and procedures used to manage risks relating to aviation activities, with the key outcome to enhance operational safety. This is relative to aviation hazards; that is, a condition or an object with the potential to cause or contribute to an aircraft incident or accident.

Corporate or business risk management encompasses all business-related risks materially affecting the achievement of an organisation's functions, expectations or goals. While in some organisations, this may include aviation safety risks, as they impact on business outcomes, the key outcome from corporate risk management is the achievement of business objectives (e.g. profits, market share).

Safety hazards vs WHS hazards

Safety risks associated with compound hazards simultaneously impacting aviation safety as well as workplace health and safety (WHS) should be managed through a parallel risk mitigation process to address the separate aviation and WHS consequences, respectively. Alternatively, an integrated aviation and WHS risk mitigation system may be used to address compound hazards.

An example of a compound hazard is a lightning strike on an aircraft at an airport transit gate. This hazard may be deemed by a WHS inspector to be a 'workplace hazard' to ground personnel within their workplace. However, within aviation safety, it is also an aviation hazard with risk of damage to the aircraft, and a potential risk to passenger safety through a consequential aircraft incident or accident. It is important to consider both the WHS and aviation safety consequences of such compound hazards, as they are not always the same. The purpose and focus of preventive controls for WHS and aviation safety consequences may differ. As a result, organisations need to consider that if they have already identified a WHS hazard and implemented controls to manage a WHS risk, these may not be effective controls for aviation safety risk management.

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, lack of emergency equipment, high workload, fatigue, or use of alcohol and other drugs.

The risk management process systematically identifies hazards that exist within the context of the organisation. These may result from systems that are deficient in their design, technical failures or human-machine interfaces. However, hazards can also result from failures of existing processes or systems to adapt to changes in the operating environment.

It's not unusual for people to confuse hazards with their consequences. A hazard is a condition or object that could cause or contribute to an unsafe outcome, whereas a consequence is the outcome that is triggered by the hazard.

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 bad weather, or they may be subtle, such as the insidious effects of long-term fatigue.

The dynamic and variable nature of human behaviour, human performance and cultural elements should also be considered routinely throughout the risk management process. Unlike operational hazards, these human behaviour, performance and culturally driven hazards are more likely to change and shift, while also compounding and influencing operational hazards.

When identifying hazards and aviation safety risks, organisations should consider risks regardless of whether their source is under their control. While hazards can arise from sources or threats you cannot directly control, your organisation can develop controls or mitigations to reduce any potential safety risks arising from these sources. This is highly relevant in our industry, where we routinely operate in environments outside our control (e.g. hazards or threats posed from weather, wildlife).

There are several useful methods of identifying hazards:

- brainstorming: small discussion groups meet to generate ideas in a non-judgemental way
- research of historical safety papers and articles
- 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 and audit reports
- safety incident reviews or investigation reports
- hazard and safety reporting systems
- use of conceptual models such as:
 - SHELL model
 - Reason's accident causation model
 - bow-tie analysis.

There are two main methodologies for identifying hazards:

- **reactive:** involves analysis of past outcomes or events. Hazards are identified through investigation of safety occurrences. Incidents and accidents are an indication of system deficiencies and therefore can be used to determine which hazards contributed to the event
- **proactive:** involves collecting safety data of lower consequence events or process performance, and analysing the safety information or frequency of occurrence to determine if a hazard could lead to an accident or incident. The safety information for proactive hazard identification primarily comes from flight data analysis programs, safety reporting systems and the safety assurance function.

Hazard identification should be a continuous and ongoing activity. Some conditions may warrant more detailed investigation or assessment to determine potential hazards, including:

- instances where the organisation experiences an unexplained increase in safety-related events or regulatory non-compliances
- any significant changes to the organisation and its activities.

The goal is to proactively identify hazards before they lead to an unsafe outcome, whether it is a safety-related occurrence, incident or accident. An important mechanism for proactive hazard identification is a voluntary safety and hazard reporting system. Information collected via a safety reporting system can be supplemented by observations or findings recorded during site inspections, safety toolbox talks or audits.



Image: Civil Aviation Safety Authority

Hazards are conditions or objects with potential to cause or contribute to an aircraft accident or incident

(ICAO Doc. 9859).

Safety reporting

The main source of identifying hazards is an organisation's safety reporting system, including voluntary and mandatory safety reports. While mandatory reporting is normally used for incidents that have occurred, voluntary reporting provides an additional reporting channel for potential hazards, near misses and errors that have not resulted in a safety incident.

It's important and paramount for the effectiveness of an SMS that organisations provide appropriate protections to encourage safety reporting, especially voluntary reporting. Operators should consider clearly documenting and communicating that safety reports will be used solely to improve safety and not for enforcement or other punitive actions. The intent is to promote an effective safety culture and proactive identification of hazards before operational incidents occur.

Personnel at all levels across the organisation should be actively encouraged to identify and report hazards and other safety issues. To be effective, safety reporting systems should be readily accessible to all personnel. Depending on the size of your organisation, a paper-based, web-based or desktop form could be used. Having multiple entry methods available maximises the likelihood of staff engagement. Everyone should be made aware of the benefits of safety reporting, what should be reported and how to submit a safety report.

Voluntary safety reporting systems should provide the ability to report confidentially, requiring that any identifying information about the reporter is known only to the custodian of confidential safety information for follow up. The role of custodian should be kept to a few individuals, typically restricted to the safety manager and personnel involved in the safety investigation. In smaller organisations, this role may be fulfilled by a single person, whereas in larger organisations, you may have a team of safety custodians in charge of confidential safety data.

Promoting voluntary reporting, supported by the ability for confidential reports, helps facilitate disclosure of hazards, especially those resulting from human error, without fear of retribution or embarrassment. While not encouraging a no-blame reporting culture, it allows for individuals to feel supported in reporting when they have made an error so the system can work towards identifying ways to reduce the potential for these errors to occur again or lead to unsafe outcomes.

Voluntary safety reports may be de-identified and archived once necessary follow-up actions are taken. De-identified reports can support future trend analysis to track the effectiveness of risk mitigation and to identify emerging hazards.

1 Hazard identification checklist

- The organisation has established various ways to proactively identify hazards through discussion groups, reporting or surveys.
- The organisation uses the database of reported hazards to:
 - identify hotspots 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.

Identifying safety risks

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. From your identified hazards – something that can cause harm – you need to determine what the potential safety risk could be, that is, the unsafe outcome that could result from the hazard.

For example, wildlife on the runway is a safety hazard, whereas the risk is the outcome this hazard could cause. An example might be kangaroos on the runway during aircraft landing resulting in aircraft wildlife strike causing aircraft damage and potential passenger injuries.

For some hazards, there may be more than one possible outcome or safety risk. In these instances, you should record all potential safety risks. However, you may find when undertaking your risk assessment processes that addressing the most significant risk could also address other possible risks arising from the same hazard.

Hazard and risk identification should also consider risks that are generated outside of the organisation and outside the direct

control of the organisation, such as extreme weather, wildlife or volcanic ash. Hazards related to emerging industry safety risks are also an important way to prepare for situations that may eventually occur.

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

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

To avoid accidents and incidents, organisations should implement multiple layers of controls or defences. However, controls are never foolproof. For example, having well-trained maintenance engineers does not ensure aircraft components are always fitted correctly, and standard operating procedures for flight crew are only as effective as competency will allow.

Safety risks are the consequences or outcomes of hazards.

(ICAO Doc. 9859)

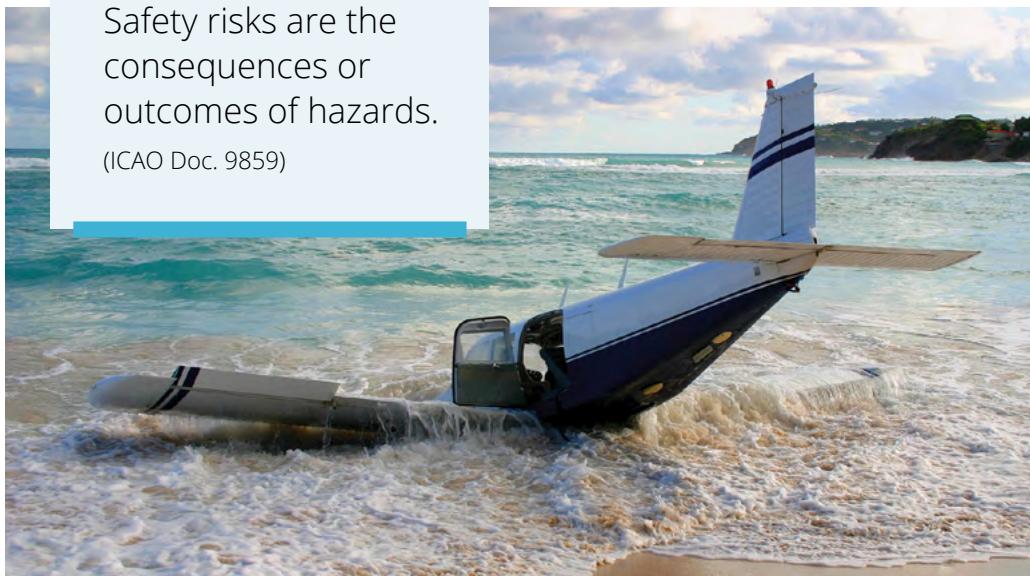


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Communicate and consult

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.

Involving all stakeholders also allows for different perspectives to be considered when identifying hazards and risks, conducting risk assessments and identifying controls. As not all parts of the organisation will see hazards and risks in the same light, bringing in all relevant stakeholders allows for a wider consideration of your current hazards and how well you are managing your risks.

Bringing together relevant stakeholders allows for the consideration of their objectives, perceptions, and potential biases. Risk perception varies across your stakeholders due to different assumptions and needs. Factoring in these different perspectives is an integral part of effective risk management.

Focus group discussions should ask participants to brainstorm types of safety hazards they think may threaten the safety of passengers, employees, or contractors. The group should also consider hazards that 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 and could result in maintenance errors. Even a procedure developed in one part of your organisation could create a hazard in another.

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

Case study



Image: Civil Aviation Safety Authority

OUTBACK maintenance services

Outback Maintenance Services has a close call involving engine cowl fasteners. Mick Jones, the safety officer and senior licensed aircraft maintenance engineer (LAME), hears from the apprentice, Jayne Yaeger, 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, all done. Just give the aircraft a wipe-over; the doc will be here in the morning'. Jayne 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, she wiped away an oil leak on the hydraulics, but, bone tired, did not notice the missing fasteners.

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

Peter Lawson called 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.'

Safety risk assessment and mitigation

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 that are more prone to risk. If so, check that you have taken reasonable precautions to avoid incidents.

Current controls and their effectiveness

Once you identify your hazards and risks, you should identify possible defences, controls or mitigations already in place to manage them.

One defence against an inflight 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 and defences against each risk, recognising that some controls will defend against multiple risks.

You also need to assess how effective each control and defence is. 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 control is by asking, for example: 'Does the crew know how to use the fire extinguishers, and are the extinguishers correctly maintained?' Or ask yourself, if that control did not exist, what the possible outcome could be.

Be honest and pragmatic about control effectiveness, as not all controls will be as effective as others. This is especially true of administrative controls compared to engineering controls. Another consideration for the effectiveness of administrative controls is to recognise whether all staff are actively aware of them and have been trained appropriately on them. For more information on types of controls, see *Hierarchy of controls* in the toolkit at the end of this booklet.

You will then have a list of effective controls, as well as a list of which controls need improvement.

If you run a small organisation and are confident you understand what's involved, you can do the assessment yourself, but having another set of eyes to crosscheck your assumptions is always a preferred method. You do not have to be, or employ, a risk specialist, as you will most likely know the risks in your small business the best. They are often the stress points already causing some concerns for you.

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.

Safety risk assessments and risk mitigations need to be continuously reviewed and updated to ensure they remain effective in managing and maintaining risks within your organisation. This is especially critical anytime there is a change in your operating environment, as changes can have unintended consequences on the previously listed effectiveness of controls, or they can introduce new hazards into your organisation.

7 basic steps for risk management

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



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Completing a risk assessment

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 additional tips to help you identify the ones that matter:

- Walk around your workplace, observing work as it's happening, 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 incident and 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.

For 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 – Identify the risks

Decide what might be harmed and how the harm might be caused, that is, the risks. For each hazard, you should identify what might occur. You will also need to identify the possible reasons; these are the root causes or contributing factors for the risk.

An online search for SMS software will provide numerous potential suppliers of affordable software to manage all this. For smaller operators, this could be as simple as using a spreadsheet to record these events. However, as your organisation grows, move to a software solution so you don't lose all the hard work and risk management knowledge you have built.

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 or freight on the flight
- information entered incorrectly into the flight management system.

Step 3 – Evaluate the risks

Having identified the hazards and their potential risks, you then need to decide what to do about them. You must ‘do everything reasonably practicable’ to mitigate the risks. You can work this out for yourself, but the easiest way is to compare what you are doing with good practice 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 or reduced further?
- 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

Factors to consider are the severity (how bad the outcome would be) of any consequences arising from the hazard, and the associated likelihood (how often the hazard might result in the identified potential safety occurrence).

For example, a serious inflight fire would be catastrophic if it were to occur, but it might be an unlikely occurrence. This may then rank above a bird strike which, although in many cases they tend to be less severe, they are much more likely to occur. Keep the

process simple and get global views about how significant an issue the hazard really is in the context of all the risks identified.

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

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

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)

A simple way to determine the likelihood is to rank the risk based on its potential frequency of occurrence. This can be done on a simple five-point scale, from ‘extremely improbable or rare’ to ‘frequent or almost certain’.

Assessing risk severity or consequence

The procedures for risk management in your SMS should contain a risk assessment matrix accompanied by descriptors for levels of severity or consequence. With reference to these descriptors, consider any current mitigation measures and assess the severity in terms of the worst possible realistic scenario. Realistic is the operative word here; don’t automatically jump to the absolute worst possible scenario, be realistic as to what is the most realistic unsafe outcome. However, don’t underplay unsafe outcomes either. Saying ‘It’s never happened to us before’ is also not realistic.

Likelihood of occurrence

Similar to assessing severity or consequence, SMS procedures for assessing risks should define different levels of likelihood. Consider any current mitigation measures, their effectiveness to address the root causes and contributing factors or minimise the consequence, and whether they are currently used. Then assess the likelihood or probability of the risk occurring.

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

Use a risk tolerability matrix to assess how tolerable the risk is using the results obtained from the assessment of the consequences and likelihood. Tolerability matrixes should be designed with reference to other risk principles designed to assist in determining whether all relevant, reasonably practical measures have been taken to manage risks accordingly (see the ALARP/SFAIRP section later in this booklet for more information).

Safety risks can be conceptually assessed as acceptable, tolerable or intolerable. These levels are generally also displayed in a colour-coded traffic light system of green, amber and red to drive attention for recommended actions. To determine whether a risk is tolerable, you also need to consider your legal/legislative requirements, expert judgements, cost-benefit analysis and industry best practice. For example, you cannot deem a risk acceptable or tolerable if regulations, legislation or other laws require additional actions be taken. This includes not only CASA legislation, but also WHS, state and federal legislation. While an SMS is designed to be outcomes based, there will still, in some instances, be prescriptive compliance requirements to be met when addressing risks.

Safety risks assessed as initially falling in the intolerable region are unacceptable under any circumstances. The severity or probability of the consequences of the hazards are of such a magnitude, and the damaging potential of the hazard poses such a threat to safety, that mitigation action is required, or activities are stopped.

Safety risk description	Recommended action
Intolerable	Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventive controls are in place to bring down the safety risk index to tolerable.
Tolerable	Can be tolerated based on the safety risk mitigation. It may require a management decision to accept the risk.
Acceptable	Acceptable as is. No further safety risk mitigation necessarily required.

ICAO Safety Risk Assessment Matrix

ICAO Document 9859: *Safety management manual* provides an example of a risk assessment matrix that illustrates how the risk severity and probability work together in the risk assessment, resulting in a green, amber or red tolerance within the matrix, as illustrated below.

It should be noted, however, that this is only one example of how risk levels and ratings can be assigned and is not the only way to perform risk assessments within safety risk management.

		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



Image: Adobe Stock | Martin D Brown

Value	Severity/ Consequence	Meaning
A	Catastrophic	<ul style="list-style-type: none"> • Multiple deaths • Equipment destroyed
B	Hazardous	<ul style="list-style-type: none"> • A large reduction in safety margins, physical distress, or a workload such that the operators cannot be relied on to perform their tasks accurately or completely • Serious injuries or death • Major equipment damage
C	Moderate	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Nuisance • Operating limitations • Use of emergency procedures • Minor incident
E	Negligible	<ul style="list-style-type: none"> • Few consequences

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

Step 4 – Risk mitigation

Once you determine the risk levels, assess the safety defences or controls in place to work out how effective they are against the risk. If you determine they are fully effective, the operation can continue. If not, consider how to improve controls, or to remove or avoid the hazard entirely.

You should manage the risk to the point of being as low as reasonably practicable (ALARP) or so far as is reasonably practicable (SFAIRP). You should consider and apply all possible means of mitigation until the cost of mitigation is grossly disproportionate to the benefit you obtain. Don't just stop your risk mitigation when you reach your so-called green tolerability threshold – stop when all reasonable and practicable steps are in place.

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 administrative (e.g. operating procedures) and personnel (e.g. training) controls, and might be less costly. The solution need not be costly to be effective, as long as it is designed to reduce your overall safety risk.

For example, safety defences or controls in place to prevent incorrect aircraft loading include:

- 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 that are routinely calibration tested.

However, you cannot continue operations if a risk is assessed as 'intolerable' until that risk is mitigated to acceptable level. Be reasonable and realistic with your risk action plans. Don't take extra time if a mitigation can be implemented effectively in the shorter term, and even consider the ability to put temporary risk mitigations or controls in place while more permanent effective mitigations and controls are being developed.

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 and consider the effectiveness of controls post implementation and in your subsequent risk assessments (see Steps 6 and 7).

While many safety defences and controls in place may be assessed as effective, additional measures may still be required, which you will detail in a risk management action plan outlining short-term and longer term measures, as shown in this example for our loading risk.

Short term

- Extra nets and straps to be made available to secure cargo correctly
- Standard load sheet to always be held in the cockpit

Long term

- Standard initial and recurrent training for all people involved in baggage handling and aircraft loading

It is important to involve the 'end users' and subject matter experts in determining appropriate safety risk controls. Ensuring the right people are involved maximises the practicality of risk mitigations.

A determination of any unintended consequences, particularly the potential introduction of new hazards, should be made prior to the implementation of any mitigations or controls.

Step 5 – 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 to pursue an opportunity, remove the risk, or share the risk with another party (see ISO 31000:2018).

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 later if anything changes. 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.

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

- you made a proper check
- you asked who might be affected
- you dealt with all the significant hazards and their identified safety risks, considering the number of people who could be involved
- your precautions are reasonable, and any residual risk is as low as reasonably practicable
- you involved your staff, or their representatives, in the process.

If, as in many organisations, you find that there are several improvements to be made, both large and small, do not try to do everything at once. Create an action plan to deal with the most significant risks first. CASA inspectors acknowledge the efforts of aviation organisations that are clearly trying to make improvements, recognising effective risk mitigating actions can sometimes take time.

Step 6 – Monitor the effectiveness of your implementation

Monitor your agreed implementation solutions to make sure they are working as intended, and if not, reassess. Safety performance should be monitored to assure the effectiveness of any risk control. This is necessary to verify the integrity, efficiency and effectiveness of the new risk controls under operational conditions.

Be open to feedback from staff if a control is not working, and honest in your own assessments of the effectiveness of new controls once they have been implemented. It is better to roll back a control that is not managing a risk than to allow it to sit on your register, so it looks like you did something when in fact your control is ineffective, and your risk remains 'intolerable'.

Step 7 – Review your assessment and update if necessary

Few workplaces stay the same. Sooner or later, you will bring in new equipment and procedures that 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. While initially reviewing your risk assessment once a year may be appropriate, this timeline could be pushed out further using a risk-based approach (e.g. every 18–24 months), or more frequent when there are significant changes within your organisation or several smaller changes happening over a period.

Aviation is a complex, constantly changing operating environment, so you also need to consider any other external factors that have changed in your operating environment that can impact your risks, such as a change in ownership of one of your third-party providers, or new taxiway procedures at an aerodrome you operate into.

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. Your risk assessments cannot be a set and forget process – nothing in our industry remains unchanged, so don't let yourself be lulled into a false sense of security over your safety risks.

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.

For example, for our loading risk scenario, the documented monitoring process could include:

- 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
- training records reviewed every six months to ensure all mandatory baggage handling and loading training is current
- results of reports communicated to staff through company education program.

Set a review date for all risk assessments. This may be an elapsed period after implementation, or maybe a trigger date based on another event, possibly even a seasonal change or type of operation required to test the effectiveness.

Documentation

All safety risk management outputs should be documented. This should include the hazard and associated risks, the safety risk assessment and any safety risk control actions taken. These are often captured in a register so they can be tracked and monitored.

These risk management documents become an historical source of organisational safety knowledge, which can be used as a reference when making safety decisions and for safety information exchange. This safety knowledge provides material for safety trend analysis and safety training and communication. It is also useful for internal audits to assess whether safety risk controls and actions have been implemented and are effective.

Risk management 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:
 - communicate and consult
 - establish the context
 - identify risks
 - analyse risks
 - evaluate risks
 - treat/mitigate risks
 - 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.

Human factors related risks

Consideration of human factors has particular importance in safety risk management as people can be both a source and solution to safety risks through:

- contributing to an incident or accident through variable performance due to human limitations
- anticipating and taking appropriate actions to avoid hazardous situations
- solving problems, making decisions and taking actions to mitigate risks.

Assessing risks associated with human performance is more complex than risk factors associated with technology or environment. This is because:

- human performance is highly variable, with a wide range of interacting influences, internal and external to the individual. Many of the effects of the interaction between these influences are difficult or impossible to predict
- the consequences of variable human performance will differ according to the task being performed and the context.

This complicates how risk severity and probability are assessed. It is therefore important to involve people with appropriate human factors expertise or experience in the identification, assessment and mitigation of risks.

See Booklet 6: *Human factors and human performance* for more information on how human factors can influence safety.

ALARP and SFAIRP

Where risk is concerned, there is no such thing as absolute safety. Risk management is often based on the concepts of ALARP or SFAIRP.

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. Both ALARP and SFAIRP principles are designed to assist in determining whether all relevant, reasonably practical measures have been taken to manage risks accordingly. However, be aware, even if your risk is showing in the acceptable category, the so-called green or low risk level, this still may not mean all reasonably practical measures have been taken. Under ALARP and SFAIRP, you do not just stop at broadly acceptable if there are still reasonable practical mitigation measures available.

When considering reasonably practicable, you should be assessing what should and can be done unless it is reasonable in the circumstances to do something less. This approach is consistent with the aim of providing the highest level of safety that is reasonably practicable. The greater the degree of harm that could result from the hazard or risk, the more significant this factor will be when weighing up all matters to be considered and identifying what is reasonably practicable.

In practical terms, this means, when dealing with future uncertainty within risk assessments, you should not just ask 'Is the problem bad enough that we need to do something?', and instead say 'Here is a good control to mitigate a critical safety risk. Why wouldn't we do it?' This shift presents a positive, outcome-driven approach, always testing for anything else that can be done rather than trusting an unrepeatable subjective estimation of rarity for why you wouldn't.

Principles and cost-benefit analysis

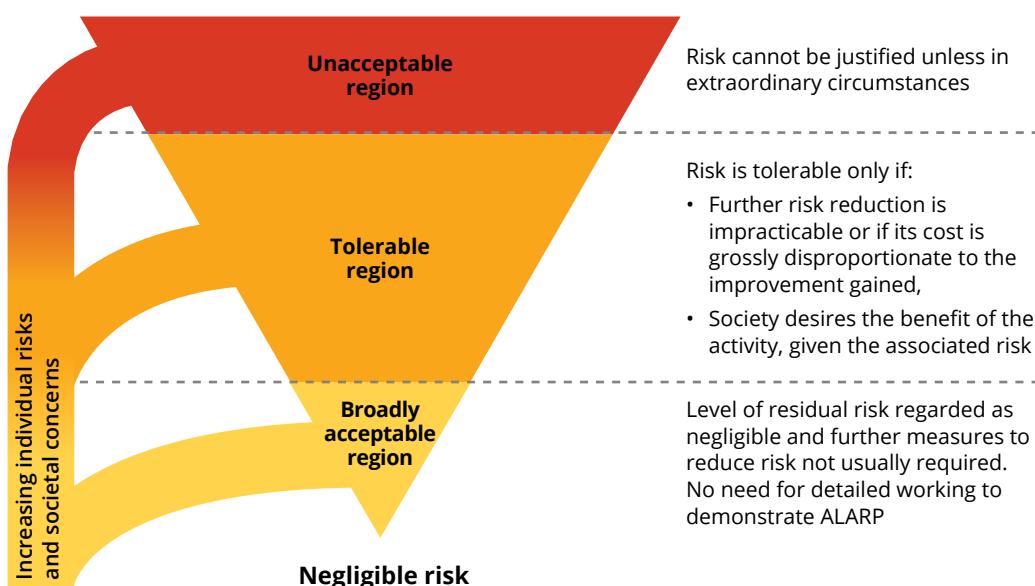
- All efforts should be made to reduce risks to the lowest level possible until a point is reached at which the cost of introducing further safety measures significantly outweighs the safety benefit.
- A risk should be tolerated only if it can be demonstrated that there is a clear benefit in doing so (e.g. there is a compelling operational need in the organisation).

ALARP and SFAIRP principles generally identify 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 are those 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 or SFAIRP, 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).
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).

ALARP and SFAIRP categories of risk acceptability



To determine whether a risk is tolerable, you need to consider several criteria:

- **Legal requirements:** aviation organisations must comply with applicable CASA, WHS and other 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 and SFAIRP application

1. Identification of hazard and risk

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.*

Risk = *aircraft striking wildlife, resulting in aircraft damage and passenger injuries.*

Aircraft operations during taxiing, take-off and landing are exposed to this risk. The root causes or contributing factors are inconsistent wildlife management, seasonal conditions and the absence of a perimeter fence.

2. 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 'minor' consequence and 'possible' likelihood.

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 and SFAIRP 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 scheduled passenger service and a variety of non-scheduled passenger private charter services 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.

3. Record your findings and implement them

The aerodrome operator decides 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 and SFAIRP 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.

4. 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.



Image: Adobe stock | Jacob Lund

Outcomes-based and PSOE considerations

To move from compliance-based safety risk management to become outcomes-based, organisations cannot simply document the elements of this component. Instead, you need to consider how your documented elements will actually be displayed, monitored and evidenced as being a lived safety management process.

For example, having a safety reporting system in place for hazard identification is compliance-based, but ensuring that staff are appropriately trained in what to report and how, providing feedback to reporters on their reports, and ensuring reports are

trended and analysed to assess whether they identify any unmitigated hazards demonstrates an active risk management process, which can be evaluated to determine the effectiveness of safety risk management procedures.

The overall outcomes-based approach strives for key personnel through the organisation to be aware and understand risks relative to their responsibilities and are continuously seeking out new hazards and risks, while also re-evaluating existing risks and controls.

As your SMS moves from implementation, to operational and through to maturing, the Present, Suitable, Operating and Effective (PSOE) evaluation of your safety risk management should also naturally shift, as shown in the examples below.



Safety risk management				
Evaluation				
Implementing	Present	Suitable	Operating	Effective
Safety risk management processes have been outlined but are not yet fully developed.	<p>There is a process that defines how hazards are identified through reactive and proactive methods.</p> <p>There is a process for the analysis and assessment of safety risks.</p> <p>The level of risk the organisation is willing to accept is defined.</p>	<p>Multiple sources of hazards are considered and reviewed, as appropriate.</p> <p>Severity and likelihood criteria are clearly defined and fit the organisation's actual circumstances.</p> <p>Risk matrix and acceptability criteria are clearly defined and usable.</p> <p>Responsibilities and timelines for accepting the risk are clearly defined.</p>	<p>Hazard and risk registers are being built up and risks are starting to be managed in a proactive manner.</p> <p>Risk analysis and assessments are carried out in a consistent manner based on the defined process.</p> <p>Human and organisational factors related to hazards are being identified.</p>	<p>The organisation is continuously identifying hazards and understands its biggest risks and is actively managing them, with proactive safety management.</p> <p>Risk controls are practical and sustainable, applied in a timely manner, and do not create additional risks.</p> <p>Risk controls take human factors into consideration.</p>

See Booklet 8: *SMS Resource Kit* for the SMS evaluation tool to assist with evaluating this element of your SMS using PSOE.



Image: Civil Aviation Safety Authority

Toolkit

Booklet 3: safety risk management tools

This toolkit contains the following:

- Toolkit purpose and use
- Error prevention strategies for organisations
- Bowtie model
- Hierarchy of controls
- Risk register example
- Case study: Outback Maintenance's hazard and risk identification
- Involving staff in safety risk management
- Case study: Bush Aviation's Hazard report form
- Fatigue risk management system

Toolkit purpose and use

Contained within the following toolkit are examples of ways an organisation can develop certain elements within the safety risk management component of an SMS. These are examples only to assist in building overall SMS knowledge, being compiled from various sources, and are in no way a CASA recommendation regarding templates or standards to meet regulatory compliance.

Error prevention strategies for organisations

Three strategies aimed at error prevention, which is 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 can be felt. Error capturing does not directly reduce or eliminate the error.

- Error capturing strategies include post-task inspection, verification or testing (e.g. crosschecking 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 and 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 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.

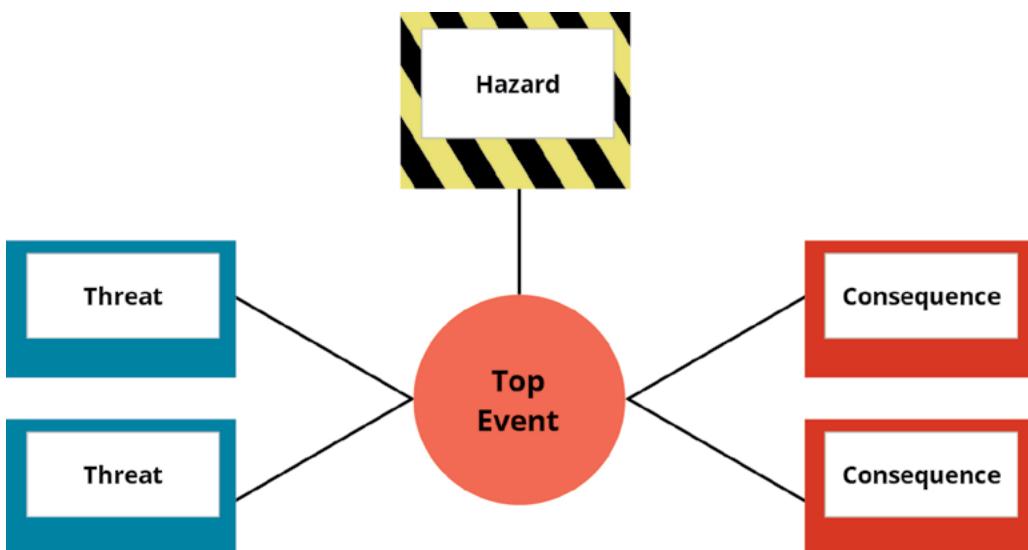
The importance of reporting hazards and having a systematic and effective process for reporting them cannot be over stressed.

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.

Bowtie model

The bowtie model consists of different elements that build up a safety risk picture. Bowtie is one of many barrier risk models available to assist the identification and management of risk. Bowtie is a visual tool which effectively depicts risk providing an opportunity to identify and assess the key safety barriers either in place or the ones lacking, between a safety event and an unsafe outcome.

Organisations can elect to use the bowtie model as part of their hazard and risk identification processes within their SMS. However, it is only one of several useful methods in this process and is not essential for safety risk management – like all methods or models available operators need to identify which work best for their operation when considering size, complexity, and activities.



The bowtie safety risk picture revolves around the hazard (something in, around or part of an organisation or activity which has the potential to cause damage or harm) and the top event (the release or loss of control over a hazard known as the undesired system state).

Consideration is then turned to the threats (a possible direct cause for the top event), consequences (results of the top event directly ending in loss or damage) and the controls (any measure taken which acts against some undesirable force or intention).

The controls can be populated on either side of the model showing:

Left hand side of the model	Right hand side of the model
Preventative measures which eliminate the threat entirely or prevent the threat from causing the top event recovery.	Measures which reduce the likelihood of the consequence owing to the top event being "live" or mitigate the severity of the consequence

The bowtie model explores the escalation factors (the reasoning to why a control may be defeated or less effective) of all controls allowing the allocation of escalation factor controls. These prevent the escalation factors having an impact on the prevention or recovery controls. Further attributes, such as control effectiveness or criticality can be allocated to the bowtie model to evaluate the safety risk picture as part of an effective SMS.

In the bowtie, controls change the likelihood or consequence of a risk, but escalation factors are conditions that can vary the effectiveness of likelihood or consequence controls. Escalation factors might include fatigue impairment, technical competency, the environment, human error, etc.

Some benefits of using bowtie include:

- full range of initiating causes can be shown
- existing controls are depicted
- causal pathway in which these combine and escalate can be shown
- consequence management (right) side shows post-event controls
- multiple possible consequence outcomes can be depicted
- causal pathway effects of controls are made explicit

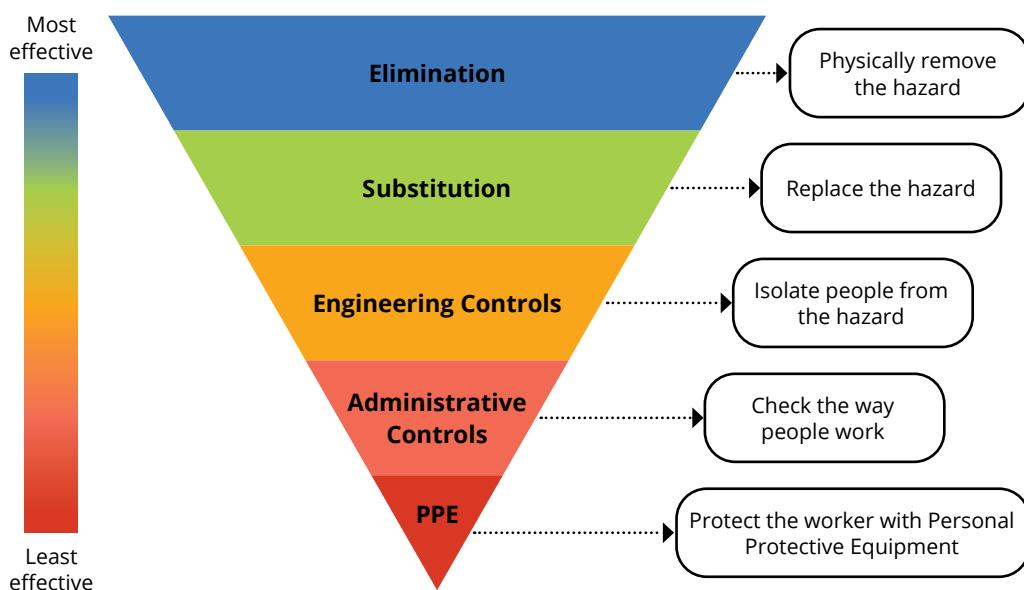
Experience has shown that the most effective format for building the bowtie is within a facilitated workshop, involving all relevant parties who can contribute to managing the risk. As with any risk assessment it is essential to have input from the relevant subject matter experts (SMEs) to identify the important issues and produce an assessment that is a realistic representation. Not only that but involving various stakeholders provides a more comprehensive risk picture, creates understanding of roles between different stakeholders in mitigating a shared risk, and assisting in identifying any potential transfer of risk between different stakeholders.

The UK Civil Aviation Authority has developed a bowtie document library against the significant seven, being the seven top safety risks identified by the CAA. In total, three bowties for each of the significant seven were identified with a core bowtie selected and developed for each topic to address the highest risk scenarios. They include all the basic bowtie components plus additional classifications and ratings for the various diagram elements to maximise their potential. For example, the expert judgement of SMEs was an important component for decisions related to the control effectiveness ratings. These can be found at: <https://wwwcaa.co.uk/safety-initiatives-and-resources/working-with-industry/bowtie/bowtie-templates/bowtie-document-library/>

Hierarchy of controls

Selecting the most appropriate risk treatment option or control involves balancing potential benefits derived in relation to the achievement of safety outcomes against efforts and disadvantages of implementation. This directly links back to ALARP and SFAIRP philosophy for risk management.

Risk treatment options are not necessarily mutually exclusive or appropriate in all circumstances. When determining appropriate controls, the hierarchy of controls pyramid can assist in decision-making.



Control	Details
Elimination	<p>Eliminating the hazard and the risk it creates is the most effective control measure. The best way to eliminate a hazard is to not introduce the hazard in the first place. For example, you can eliminate the risk of a fall from height by doing the work at ground level.</p> <p>It may not be possible to eliminate a hazard if doing so means you are unable to deliver your service. If it is not possible to eliminate the hazard, then you can still attempt to eliminate as many of the risks associated with the hazard as possible.</p>
Substitution or isolation	<p>Substitution is the process of removing a risk by replacing it with another risk that is either less likely to occur or less severe in its potential damages. Isolation is performed by placing some form of barrier between the person and the risk factor to provide protection.</p> <p>It's important to conduct a new risk assessment after substitution or isolation has been completed to identify any new risks created by the substitute/isolate process.</p>
Engineering	<p>Reduce the risks through engineering changes or changes to systems of work. Engineering controls is the process of designing and installing additional safety features in the workplace or on equipment.</p> <p>System redundancy features within aircraft design is an example of engineering risk controls enacted at the aircraft manufacturing stage.</p>
Administrative	<p>Use administrative actions to minimise exposure to hazards and reduce potential level of harm. Administrative controls are work methods or procedures designed to minimise exposure to a hazard. In most cases, administrative controls use systems of work to control the risk.</p> <p>Measures could include developing standard operating procedures, providing dedicated training targeted at the risk or using signs to warn people, such as minimum equipment list or unserviceable tags.</p>
Personal protective equipment (PPE)	<p>Use PPE to protect people from harm. This level is designed around assuming an incident will occur and protecting an employee from harm when it does.</p> <p>PPE includes items such as hard-hats, hi-vis clothing, noise-reducing ear protection or cut-resistant gloves.</p>

While implementing and using administrative controls and PPE are often the simplest and most cost-effective means, they do not control the hazard at the source. They also rely on human behaviour and supervision and, used on their own, tend to be least effective in minimising risks.

Use administrative controls and PPE only:

- as last resorts when there are no other practical control measures available
- as an interim measure until introducing a more effective way of controlling the risk
- to increase the effectiveness of higher level control measures.

When considering each control or combination of controls, you must consider the likelihood of a particular control being effective. Isolation guards designed to reduce aircraft/ground equipment collision may be removed, standard operation procedures may not be understood and

followed, and PPE may not always be worn. Further controls, such as signs or supervision, may be needed to make a control more likely to be effective or to raise awareness of the control in the first place.

However, be aware that using a hierarchy of control response and ALARP or SFAIRP can result in hazard controls sinking to the bottom and resulting in ineffective risk mitigation.

Some examples of hazard sinking mentality that undermines safety culture and risk management are shown in the following figure.

The hierarchy of responses – How hazards sink to the bottom

1

Eliminate the Hazard

*"That's far too expensive. Tell Ops they'll have to manage this"
"You know this one is one of the most profitable lines..."*

2

Substitute the Hazard

*"No, changing the process will be really difficult"
"Have our competitors done this?"*

3

Isolate the Hazard

*"Not really practical. Put a sign on it and tell them to be careful"
"We may replace this process in the refurb in 3-years. Let's wait"*

4

Use engineering controls

*"No we can't change the tooling as it's approved. Not viable for us"
"Have you got a budget for this?"*

5

Use Administration Control

*"We're really busy right now. Can we do the training next year?"
"Do we really need a procedure for this. It's common sense..."*

6

Use Personal Protective Equipment

*"What do you mean the equipment is uncommittable"
"Sorry, that's the job. You're going to have to deal with it!"*

Risk register example

Hazard and risk identification



Hazard	Fatigued personnel at shift handover
Risk	Fatigued staff resulting in inadequate shift handover leading to missed procedures and maintenance errors

Current controls/ mitigations	Control effectiveness	Reason	Further controls/ defences required	Responsibility
Shift handover procedures	Low	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	Low	Not in central enough place – goes missing	To be transferred to hangar PC, and completed online	Cheryl Lawson
Regular staff safety meetings	Low	Not held consistently enough	Schedule regular fortnightly toolbox meetings.	Mick Slater (safety officer)
Rostering	Low	Not enough staff to cover the required shifts	With planned growth, take on new staff	Peter Lawson
Recording	Low	Ad hoc system – is only done sometimes	Hazard & risk register on hangar PC. Everyone gives and receives feedback	Mick Slater & Cheryl Lawson

Involving staff in safety risk management

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, 7 simple steps are suggested for involving staff in the process:

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

After completing these steps, you should have:

- a list of safety hazards and risks identified by employees, ranked in order of importance
- a list of current controls and defences in place to manage these risks
- a list of further controls and defences required to improve safety across the operation
- staff involvement in identifying safety deficiencies and priority areas for improved risk management.

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: _____

Fatigue risk management system

Fatigue risk management systems (FRMS) are increasingly being adopted by air transport operators to control the risks of fatigue-related accidents and incidents. An FRMS is simply an extension of the overall SMS and should leverage off all the elements of your SMS that are already in place.

SMS component	Elements	Fatigue management aspects
Safety policy and objectives	<ul style="list-style-type: none"> • Safety policy • Management responsibilities and accountabilities • Key personnel • Safety committee 	<ul style="list-style-type: none"> • Fatigue risk management policy • Management and employee fatigue responsibilities • Key fatigue roles and accountabilities • Fatigue safety committee
Safety risk management	<ul style="list-style-type: none"> • Hazard and risk identification • Risk assessment and mitigation 	<ul style="list-style-type: none"> • Specific fatigue hazard identification processes: proactive, predictive, and reactive • Specific fatigue mitigations/controls: strategic and tactical • Monitoring fatigue control effectiveness • Fatigue risk assessment procedures • Fatigue risk registers
Assurance	<ul style="list-style-type: none"> • Monitoring and measuring performance • Safety investigations • Data analysis and information • Management review and improvement 	<ul style="list-style-type: none"> • Fatigue safety performance indicators • Fatigue management audits and reviews • Fatigue assessments in safety investigations
Training and promotion	<ul style="list-style-type: none"> • Training and education programs • Communication and consultation 	<ul style="list-style-type: none"> • Training in fatigue science and fatigue risk management for involved personnel • Fatigue specific communication strategies.

As fatigue is a safety hazard in all aviation operations, regardless of whether you are developing an FRMS, your SMS still needs to manage the risk of fatigue within your operation, like any safety risk.

For further information regarding fatigue management and FRMS, see the CASA website: casa.gov.au/operations-safety-and-travel/safety-advice/fatigue-management



casa.gov.au