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Safety Management Systems for aviation: a practical guide

SMS 9

Safety management systems for RPAS

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Remotely piloted aircraft system operators

The purpose of a safety management system (SMS) is to provide organisations with a systematic approach to managing safety, including the necessary organisational structures, accountabilities, responsibilities, policies, and procedures. An SMS goes further than just encouraging people to be safe. It is designed to improve safety performance through the identification of hazards, collection and analysis of safety data and information, and the continuous assessment of safety risks.

An SMS is of equivalent relevance to remotely piloted aircraft system (RPAS) operators as it is for air transport operators and airports. This booklet is designed for use by commercial RPAS operators, with the information contained within this booklet targeted towards remotely piloted aircraft operator certificate (ReOC) holders who have either no formal SMS or only a basic SMS in place. It provides guidance on the elements of a SMS for organisations to consider when implementing, evaluating, or enhancing their SMS.

Other organisations may also find the information useful. While this booklet covers RPAS SMS considerations, it is designed to be used in conjunction with the other eight booklets in the SMS resources toolkit. Where there is more detailed and in-depth SMS information relevant to RPAS beyond the details in this booklet you will find a note directing you to other booklets from the toolkit.

A full copy of the safety management system resource kit can be found at:

casa.gov.au/search-centre/safety-kits/resource-kit-develop-your-safety-management-system

The RPAS sector, as the relative newcomer to the aviation industry, has seen unprecedented levels of growth over the past ten years. In 2018 the number of RPAS operators overtook the number of piloted operators, making it the fastest growing sector within aviation in Australia. The capability of RPAS to deliver solutions which traditional crewed aviation cannot offer, coupled with the cost-effectiveness of operating an RPA versus crewed aircraft will undoubtedly see the continued growth of RPAS, including into services which are not currently in place.

Naturally, regulators, other aviation participants, and the public will seek assurance that an expansion of RPAS into unchartered territories is safe. An effective SMS will assist with demonstrating levels of safety within the sector and therefore instilling confidence which will be essential to enable continued growth of the RPAS industry.

While accidents within the RPAS sector are not uncommon, it has an enviable safety record in terms of the exceptionally low rate of injuries it has caused or contributed to. Continued growth in the sector is expected to see bigger remotely piloted aircraft (RPA) operating over built up areas more frequently. An accident of significant consequence will impact the public perception of the safety of RPAS and undermine the confidence of regulators to approve more complex operations without imposing further conditions.

RPAS and SMS

Regardless of an organisation's activities, size and complexity, all elements of the SMS framework are relevant and can be tailored to every organisation. What will vary is the specific content of the SMS. This will depend on various specific organisational factors including size, complexity and level of risk associated with your aviation activities.

An SMS must consider the complexity of the activities undertaken and the interfaces with external organisations, including contractors and third parties. Your SMS should connect with and complement other systems, which will be different for each ReOC holder. As far as is possible, elements of an SMS should be integrated with other processes within your organisation to ensure it is not a standalone system.

Implementing an SMS may initially appear to be a daunting and costly task. However, it is likely some, and probably many, of the elements that make up an SMS are already in place at your organisation, but perhaps they are not formalised or clearly documented.

It is important to realise that there is no one size fits all in terms of SMS development and implementation; what is important is to develop an SMS that works for your organisation that is effective in managing your safety performance. Large ReOC holders will tend to have relatively complex and sophisticated processes, which may be burdensome for smaller ReOC holders to implement and manage. No matter an RPAS operator's size and complexity, the same SMS components and elements apply for all. These are as follows:

SMS Component	Elements
Safety policy and objectives	Management commitment
	Safety accountabilities and responsibilities
	Appointment of key safety personnel
	Coordination of emergency response planning
	SMS documentation
Safety risk management	Hazard identification
	Safety risk assessment and mitigation
Safety assurance	Safety performance monitoring and measurement
	Management of change
	Continuous improvement of the SMS
Safety promotion	Safety training and education
	Safety communication

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An organisation's safety culture is crucial to its safety performance.

Just culture

An effective SMS also requires a positive safety culture to be in place, this includes what is known as a 'just culture.' A just culture encourages and supports people to provide essential safety related information in a non-threatening environment but is clear about where the line is drawn between acceptable and unacceptable safety behaviours.

The ideal safety culture supports people and systems, recognises errors will be made and believes blaming individuals will not solve problems. A positive and supportive safety culture encourages open and honest reporting, seeks to learn from its failures and is open and fair in dealing with those involved.

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What can go wrong

A DJI Phantom 4 RPA suffered a mid-air collision with a US Army UH-60M Black Hawk helicopter. The helicopter sustained minor damage to a main rotor blade, a window frame, and its transmission deck. The RPA was destroyed, and several components were lodged in the helicopter.

While the pilot flying the helicopter saw the RPA before the impact and immediately applied flight control inputs to keep clear of the RPA, there was insufficient time to avoid the mid-air collision.

The remote pilot was operating the RPA below 400ft, however was 4kms away from it and well beyond the required visual line of sight at the time of impact. The remote pilot was also unaware of a temporary flight restriction in effect for the area of the flight, having relied upon the DJI GO4 app for airspace awareness. The RPA pilot's tablet containing the DJI GO4 app was not, however connected to the internet and therefore did not receive the update of the temporary flight restriction. In addition, the DJI GO4 app was non-certified.

While all these risks would have still been present if the operator had an SMS, the use of an SMS would have increased the likelihood for them to have been identified and mitigated prior to the event having occurred. This can be seen through the SMS elements of procedural documentation, hazard identification and risk mitigation processes and enhanced safety awareness through safety promotions.

Benefits of implementing an SMS

An SMS is not a silver bullet which guarantees the elimination of risks to an organisation, but an effective SMS is the most important defensive system an organisation can implement to manage its safety risks.

Regulations are important risk controls as they provide minimum requirements for organisations to achieve baseline levels of safety. However, regulations can take a long time to change and do not always maintain pace with the industry. Regulations are developed to cover entire sectors or sub-sectors within the industry and are not written with only one operator in mind. Conversely, individual organisations operating within the same sector will have different risks, or appropriately different levels of risk for hazards which are common to all operators. These levels of risk depend on an individual operator's context, which includes their culture, systems, operating environment, and experience levels.

An SMS helps identify, assess, and manage specific risks for individual operators, putting them in control of their own safety. While some risks will be common across multiple ReOC holders, their assessment and controls will vary. An example is the risk of a mid-air collision between an RPA and a crewed aircraft. Organisations operating RPA near high traffic areas will have a higher likelihood of collision than those who operate in remote areas, and the consequence will vary depending on the mass of the RPA.

An SMS takes time, resources, and effort to implement and maintain. But rather than thinking of an SMS as a cost to the business, think of it as an investment which will reduce the likelihood of accidents and incidents, which can easily cost more than implementing and maintaining an SMS.

An SMS can provide a return on investment through allowing ReOC holders to operate in inherently more risk-exposed environments where profits can be the greatest and competition the lowest. For potential clients who hold safety in high regard, having an effective SMS can provide an advantage over competitors as it can clearly demonstrate the safety performance and risk controls in place for higher risk operations.

The antidote to reducing organisational accidents is an effective SMS which is integrated with the entire operation. The RPAS sector has the benefit of learning from traditional crewed aviation and other high-risk industries, by implementing safety thinking which addresses all factors and identifies the risks in each category through an effective SMS.

An SMS takes time to mature, although it could be argued it never fully matures, as a specific element of an SMS is continuous improvement. Experience from the traditional crewed aviation sector tells us that an SMS can take between 2 and 5 years to reach a point of 'maturity'. Maturity for an SMS is where it is integrated seamlessly within the organisation and its third-party service providers, processes are bedded-in, and the organisation is proactive in its approach to managing risk.

While this kit is focussed on the aviation aspects of managing safety within a ReOC holders' operations, an SMS is equally as effective at managing workplace health and safety (WHS) aspects. Workplace injuries can cost tens or hundreds of thousands of dollars. An effective SMS can reduce the likelihood of workplace injuries occurring. It is also worth considering if you already have a WHS management program or plan in place many of your WHS processes can be adapted or extended to include aviation hazards and as such, aviation safety, to form the SMS as well.

In **Booklet 1: SMS Basics** – casa.gov.au/sms you will find more detailed information on the benefits of SMS and an effective safety culture.

image: Adobe Stock | kemaltaner

SMS implementation planning

As with the implementation of any new system, careful planning is needed to ensure an understanding of what needs to be implemented, how it will be implemented, and who will implement it.

To implement your SMS, you need to identify which SMS components and elements you already have, and what you need to add or modify to meet SMS requirements. Most ReOC holders will have at least some elements of an SMS already in place, but some may not be formalised or documented. To assess the elements currently in place, ReOC holders should conduct a gap analysis which is the starting point for the implementation plan. A gap analysis is how an organisation can identify and analyse gaps between the current and targeted end state.

Once you have completed and documented your gap analysis (your gaps are the items identified as missing or deficient) you can begin to flesh out your SMS implementation plan.

Your gap analysis is likely to identify deficiencies in your readiness to implement an SMS, so it makes more sense to have a phased approach to bringing it in. With a phased approach your implementation plan will need to include timelines for starting and completing each of the major SMS elements.

Your SMS implementation plan will need to detail the development of processes, such as hazard identification and risk assessments, reporting processes, and how you intend to implement the key SMS components and elements.

In Booklet 1: *SMS Basics* you will find more detailed information around SMS implementation planning and conducting a gap analysis. Also refer to **Booklet 8: Resource Kit** – casa.gov.au/sms for a copy of a comprehensive gap analysis tool and SMS implementation guidance.

Safety policy and objectives

Developing a safety policy should be the first step in formalising the SMS within your organisation. It sets the tone and expectations for all staff to adhere to, and the remaining elements of the SMS should be implemented with alignment to the commitment made in your safety policy.

This safety policy should be endorsed (signed) by your organisation's accountable manager. The policy should detail your safety reporting procedures, show clearly what constitutes unacceptable safety behaviours and highlight conditions where disciplinary action would apply to unacceptable safety behaviours, and where it would not apply to human errors.

Your safety policy should include a commitment to:

- continuously improve the organisation's level of safety performance
- promote and maintain a positive safety culture
- provide the necessary resources to deliver and maintain safety standards
- ensure safety is a priority consideration and responsibility for all managers
- ensure it is understood, implemented, and maintained at all levels of the organisation.

Safety objectives are more detailed than safety goals. Safety objectives should follow the SMART principle, so that you can measure their effectiveness, in that they are:

S Specific

M Measurable

A Achievable

R Relevant

T Timely

A key consideration with your safety objectives is the relevance and achievability for the size and complexity of your organisation. The most effective safety objectives are those setting specific safety goals reflecting the organisation's safety vision and senior management's commitment to the systematic management of safety. Effective safety objectives are those which provide a call to action and develop commitment from, and engagement of, staff.

You can also document your safety objectives in terms of short, medium, and longer term desired goals. For example:

- to encourage the immediate reporting of all incidents, no matter how trivial they may seem
- providing feedback to staff on safety reports within two weeks
- ensure all staff receive safety training when commencing in their role.

image: Civil Aviation Safety Authority

To be able to achieve each specified safety objective, you need a documented action plan which incorporates a phased approach to SMS implementation. For example:

- Phase 1: short-term objectives to be addressed within six months
- Phase 2: medium-term objectives to be addressed within 12 months
- Phase 3: long-term objectives to be addressed within 24 months.

Safety performance indicators (SPIs) and safety performance targets (SPTs) are needed to monitor the achievement of safety objectives and are further elaborated on in **Booklet 4: Safety assurance** – casa.gov.au/sms.

You need to review your safety objectives periodically to ensure they are still relevant and helping to achieve your safety goals.

Management commitment

For an SMS to be successful, the accountable manager, or chief executive officer (CEO), of the organisation must drive and champion it. Management commitment is more than just 'talking the talk' by signing a safety policy and attending meetings. Managers must 'walk the walk,' leading by example in taking safety seriously and providing adequate resources to ensure the success of the SMS. Managers need to take the lead with establishing the safety culture of the organisation, which takes a long time to build, and can be undone by just a few poor decisions or actions.

This senior management commitment is the single most important factor determining whether your SMS will be effective and successful. This can be broken down into two key elements:

1. Management commitment:
   - the organisation's senior management must be committed to develop, implement and continuously improve the SMS
   - a management team must be recruited, or in place, appropriate to the size and complexity of the organisation, to support the organisation's SMS
   - senior management must take an active part in developing and disseminating the organisation's safety policy and safety objectives
   - senior management must have documented and defined roles, responsibilities, and accountabilities to support the organisation's SMS.
2. Organisational structure:
   - senior management must develop an organisational structure showing who is responsible and accountable for which roles to support the effective functioning of the SMS
   - the organisational structure or organisational chart must have a clear line of communication from the safety manager or safety officer direct to the CEO (accountable manager).

Organisations need to carry out an analysis of their activities to determine the right level of resources they need to manage the SMS. This should include determining the organisational structure required to manage the SMS effectively, both during implementation and ongoing. This analysis should include considerations of who will be responsible for managing and maintaining the day-to-day activities of the SMS, what safety committees are needed, and any need for specific safety specialists.

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Safety accountabilities and responsibilities

While the ultimate accountability for safety sits with the CEO or equivalent of your organisation, each member of the workforce is also accountable for their actions and the way they fulfil their responsibilities. Managers and supervisors are expected to show leadership and commitment to the SMS through their behaviours and actions.

Organisations need to identify who will be responsible and accountable for implementing and maintaining the SMS, documenting the key safety roles of 'who does what'. It is important to communicate these roles and responsibilities throughout your organisation so that all staff are aware of their and other's responsibilities. For small organisations, this structure may be very simple and consist of the person in charge, being the accountable manager (CEO or owner) and a few key staff members who have a role in how the organisation is managed on a day-to-day basis.

The safety responsibilities of all the workforce should be documented to ensure there is no ambiguity in expectations. Depending on the organisation's existing processes, responsibilities could be documented in position descriptions or detailed separately in the SMS manual.

Safety accountabilities should acknowledge the safety manager or safety department are not the sole persons responsible for safety. The safety manager or safety department is there to facilitate and manage the safety processes, and not necessarily to 'do safety' for everyone else. The risks within a ReOC organisation are allocated to and owned by the appropriate managers who are responsible for ensuring risks within their area are identified, assessed, and controlled.

Appointment of key safety personnel

Critical to the success of the SMS is the appointment of a well-respected and competent safety manager. In the same way as a ReOC holder would not allow an untrained person to service or operate an organisations RPA, safety managers need to have or gain knowledge in the principles of running an SMS.

A smaller, non-complex ReOC holder may add the safety manager duties to an existing role, for example your operations manager. Alternatively, you may appoint a part-time employee to the role of safety manager – this could be a new part-time role, or you may have someone who already works part-time in another role that can take on the extra duties making them a full-time employee instead.

Medium-sized ReOC holders may have a separate full-time safety manager, possibly even with a small number of staff.

Larger-sized ReOC holders may have a head of safety with a dedicated safety department. In any organisation, the safety manager should have a direct reporting or communication line to the person with ultimate accountability, usually the CEO or equivalent. More detailed information on the role, responsibilities and recommended competencies of a safety manager can be found in **Booklet 2: Safety policy and objectives** – casa.gov.au/sms.

Another key appointment in an SMS is the safety committee or safety action group (SAG), which are established to help implement and maintain the SMS, as well as ensure involvement of a cross-section of the workforce.

For smaller ReOC holders your safety committee could consist of a few key personnel and appropriate people from other organisations or groups that your organisation interfaces with, such as third-party providers or contractors. Whereas medium-sized ReOC holders will tend to have a safety committee which includes representation from each functional area within the organisation. Large organisations usually have multiple SAGs which may report to one or more safety committees who in turn report to a senior management safety review board that provides governance over the safety performance of the organisation.

These meetings may be regular planned monthly or bi-monthly committee meetings or could take the form of:

- management meetings with dedicated time allocated to safety on the agenda
- safety stand-down days.

It is important that the relevant people, both within your organisation and those that interface with it, meet to discuss safety-related issues on a regular basis.

Emergency response planning (ERP)

Emergency response planning (ERP) is an integral part of managing ongoing safety which facilitates the management of a hazardous event or accident and mitigates the impact on normal operations. ReOC holders should have an ERP for all operational locations and maintain a robust means of coordinating these with the main ERP coordination procedures. The plan should detail:

- who is authorised to perform certain actions, such as speaking with the regulator, investigators, or the media
- a checklist outlining responsibilities for actions, assisting in ensuring each step is completed
- phone numbers of key internal personnel, clients, and stakeholders

Managing the risks associated with emergency or contingency responses forms a part of your broader safety performance. The way you respond and manage an emergency can create hazards and risks to safety, both during the emergency but also during your return to normal operations.

Your ERP does not necessarily have to be contained within your SMS manual. Your SMS should at least refer to your ERP regardless of where or how it is documented.

Small ReOC holders may even consider combining the ERP with a business continuity plan (BCP). A BCP differs from an ERP in that the ERP is focussed on dealing with emergencies, whereas the BCP is focussed on dealing with business interruptions such as the IT system crashing or electricity being down for an extended period. While medium and large ReOC holders would tend to have a separate ERP and BCP.

Regardless of where it is documented your ERP needs to be available to, and understood by, all key personnel. It also needs to have easily accessible and routinely updated emergency contact numbers, both for internal and external contacts. An ERP should be periodically tested through a desktop or live exercise using realistic scenarios so that all personnel are prepared for what they need to do and to ensure the plan would work in a real emergency.

image: Civil Aviation Safety Authority

SMS documentation

Your SMS should be supported by robust, current, controlled and freely available documentation. Your safety documentation delivers procedures and other SMS instructions which also demonstrate to all personnel and third parties that your business is based on safety management principles.

If your procedures are in separate manuals, as can happen in larger ReOC holders, this must be made clear, so everyone can find detailed information about your SMS procedures and processes simply and efficiently.

Any sized ReOC holder should have the following SMS documentation as a minimum:

- safety policy and objectives of the SMS
- responsibilities of the accountable manager and key safety personnel
- any safety-related processes, procedures, or checklists (including your ERP)
- results of, and subsequent actions from, any safety audits or assessments
- results of any risk assessments and mitigation measures (controls or defences) in place
- a hazard and risk register.

Smaller ReOC holders may have a separate SMS manual, or it may be easier to document the SMS within existing manuals. The SMS will contain other documents and not just your SMS manual – these include things like your hazard or safety reports, training records etc.

Once the SMS manual is developed, it must be available to your workforce, and not just be 'the safety manager's manual'. It must not sit on the shelf and gather dust. If it does, then it may be an indicator of a poor safety culture.

Your SMS manual and supporting documents may be held either as hard copies or electronically. However you keep a record of your SMS, the system should be reliable and the records secure. For example, information technology systems should be backed up and protected from damage and enable easy access and retrieval of the information.

Contractor and third-party interfaces

Your SMS must ensure your organisation's safety is not adversely affected by contractors and third-party suppliers or service providers. RPAS service providers may employ contractors (third parties) in areas such as aircraft maintenance and training programs.

You have probably always had contractual arrangements with your providers. Your SMS provides an opportunity (and an obligation) to extend these contractual arrangements to include safety performance. While a contractor provides a service, the ReOC holder will still hold overall responsibility for the safety of services they provide. The safety standards specified in your SMS must not be eroded by any products and services provided by external organisations.

Managing these third-party relationships can at times be a significant area of risk for organisations. Your third-party providers or contractors could be a source of safety risks, a potential risk control and either an enabler or disabler of your organisation's safety culture.

Therefore, any contract between ReOC holders and third parties should specify what safety standards must be met. You as the ReOC holder are then responsible for guaranteeing the contractor complies with the safety standards specified in the contract.

Within your SMS documentation you should:

- keep and maintain a register of all third-party contractors and suppliers
- incorporate third-party contractors and suppliers into your safety assurance, including your safety audit program
- identify and mitigate any potential safety risks associated with third-party contractors and your risk-based procedures for managing your third-party relationships.

You also need to be able to demonstrate that all third-party service providers are providing trained, competent personnel with the relevant qualifications to carry out the work. Third parties need to understand your SMS and how they interact with it, especially for the identification and reporting of safety hazards and your expected acceptable and unacceptable safety behaviours.

Refer to **Booklet 2: Safety policy and objectives** – casa.gov.au/sms for more detailed and in-depth information to assist you with developing these core elements.

Safety risk management

Traditional safety risk management emphasised the individual, focusing on unsafe acts and conditions, and often excluded the environment and organisational factors in the analysis. It was more reactive, often leading to constraints on operations, reduced training effectiveness and outcomes, and occasionally resulted in poor organisational morale.

The current SMS approach is proactive, seeking to identify factors contributing to an incident or accident before it occurs. This process uses the knowledge of those who fly, maintain, build, support, plan, or control RPAs to better inform the organisation.

Organisations pursuing a proactive strategy for safety risk management believe the risk of accidents and incidents can be minimised by identifying weaknesses and taking necessary action to reduce the risk of adverse consequences arising from them.

Therefore, safety risk management is the identification, analysis, and mitigation, or where possible elimination, of risks the organisation encounters. Systematically identifying and treating organisational risks and hazards is fundamental to an SMS, with ongoing monitoring and communication of the risk management process to improve its effectiveness.

Regardless of the size of a ReOC holder, scalability of your SMS is also a function of the inherent safety risks of your operational activities. Even small ReOC holders may be involved in activities that entail significant aviation safety risks. This means your safety risk management capability and activities should be commensurate with the risks you are trying to manage.

For ReOC holders, risk assessments cover the broad ranging hazards encountered within the organisation, as well as the potential for hazards associated with RPA, checked through the pre-flight risk assessments carried out before each flight.

Safety risk management elements and their intended outcomes are the same regardless of the size and complexity of your organisation. However, the breadth and degree of the functions within the elements is where you can tailor your risk management to your size, complexity, and specific ReOC operating environment.

image: Adobe Stock | Lourenço Furtado

Loss of separation

An RPA was conducting an aerial photography survey of a mine site. An Ayres S2R crewed aircraft was conducting aerial agricultural operations nearby at the same time.

After completing the pre-flight preparations and a risk assessment, but before commencing flight, the remote pilot heard the crewed aircraft operating nearby. The remote pilot broadcast on the area frequency the intention to conduct RPAS aerial photography operations but did not hear a response. The RPA pilot asked the mine manager to contact the farmer who was loading fertiliser into the hopper of the crewed aircraft, to advise that the RPA was conducting aerial photography in the area.

The pilot of the crewed aircraft was informed of the aircraft conducting aerial photography in the area but assumed it would be a fixed-wing crewed aircraft operating at above 500 ft above ground level (AGL), and the pilot intended to remain at or below 350 ft AGL to ensure separation was maintained.

Part way into the survey the remote pilot heard increasing noise and observed the crewed aircraft cross the northern boundary of the site, conduct a 180° turn followed by a full 360° turn. The RPA was at about 380 ft AGL and estimated the crewed aircraft at about 100 to 150 ft AGL, with about 100 m of horizontal separation.

The remote pilot attempted to contact the crewed aircraft pilot over the radio but did not receive a response. Both aircraft subsequently landed without incident.

This incident shows that although the remote pilot had taken all necessary steps to manage safety, a simple assumption on the part of the pilot of the crewed aircraft resulted in a loss of separation of the two aircraft. Reiterating the need for remote pilots to always be vigilant of their surroundings when conducting operations and being prepared to take action when needed.

Hazard identification

A hazard is a source of potential harm, or a situation with the potential to cause loss. Hazard identification is fundamental to risk management. If a hazard cannot be identified, it cannot be controlled. At times people can be confused by the difference between a hazard and a risk. A risk is the potential outcome from the hazard and is usually defined in terms of the severity of the consequences and the likelihood of the harm occurring.

Examples of hazards include bad weather, mountainous terrain, fatigue, and a lack of training. In general terms you can consider that a hazard exists in the present whereas the risk associated with it is the potential future outcome.

The starting point for safety risk management must be establishing the context and identifying your hazards. Hazard identification must be systematic and comprehensive because any hazards not identified will be excluded from risk analysis and mitigation. Meaning you will have uncontrolled safety risks within your operation. Identifying hazards requires thinking 'outside of the box' and reactive, proactive, and predictive processes.

Reactive hazard identification involves looking at events which have already occurred to the ReOC holder, such as incidents and accidents, and what may have contributed to them.

Proactive hazard identification seeks to identify hazardous conditions which may occur but have not happened to the ReOC holder yet. These hazards can be identified through targeted hazard identification sessions, such as conducting workplace inspections, analysing organisational processes, or identifying incidents and accidents which have occurred to other ReOC holders.

Predictive hazard identification is a proactive process that uses data analysis to identify trends to predict when safety performance will drop below acceptable levels and what may cause the decrease in performance.

The most effective SMSs have higher percentages of proactive and predictive hazard analyses. However, it takes time for your SMS to mature. Initially, a SMS will normally have a higher percentage of reactive hazard analyses because it is easier to identify things which have already occurred. Until the safety culture has evolved and processes become embedded, hazard analysis will usually focus on past events, which is a necessary stage in the implementation of your SMS. The real value of an SMS comes with an increase in the percentage of proactive and predictive hazard analyses. It is far more effective to put a control measure in place beforehand than to wait for an incident or accident to happen before treating something as a risk.

image: CSIRO, CC BY 3.0, via Wikimedia Commons

At its core, the hazard identification process is your formal means of collecting, recording, analysing, acting on and generating feedback about hazards that affect the safety of your operations.

When looking at hazard identification you should be able to demonstrate the following as a minimum:

- hazard identification is used regularly to assess changes within the organisation and include:
  - an organisational (structural) change
  - rapid expansion or contraction
  - new equipment or procedures being introduced
  - changes to key personnel positions
  - whenever the organisation believes a new risk may be encountered
- your hazard identification process is a simple, confidential (and open and fair) and convenient safety reporting process.

A key consideration to remember is that hazard identification is not a static one-off process. It needs to be performed whenever you plan internal or external changes within your operational environment.

There are various ways to identify hazards and depending on the size of the ReOC holder some may be more useful and useable then others. Refer to **Booklet 3: Safety risk management** – casa.gov.au/sms for more detailed and in-depth information regarding hazard identification sources.

Safety reporting systems

Using a confidential hazard or safety reporting system, underlying situations or conditions that have potential to impact safety can be identified. Safety reporting can be reactive, after an event has occurred, or proactive, trying to predict what might happen in the future.

ReOC holders should strive to achieve a positive safety culture which includes a just culture. In these environments, the workforce will be encouraged to report hazards without fear or favour. Hazard identification is not a process that should be left up to the safety manager or safety department – they are there to facilitate the process – as all areas of the organisation should contribute.

Voluntary reporting of less serious incidents or non-significant matters should be actively encouraged and promoted as they provide a useful source of hazard identification. Higher numbers of reports, even if they are classified as minor or non-significant issues, allow you to monitor your overall safety performance and to identify developing safety trends. This voluntary non-significant reporting also allows you to better identify those latent hazards that could be related to organisational processes or human errors – which if left unmanaged could line up under some circumstances to result in a serious incident or accident.

All personnel and third-party interfaces (contractors) need to actively participate in your safety reporting system, and need to understand what to report, how to report and who to report to. It is important everyone in your organisation understands that information from these reports is used to identify safety risks so appropriate action can be taken to maintain or improve overall safety performance.

It is important your safety reporting system uses the information provided to enhance safety rather than to apportion blame, especially if individuals are reporting instances of genuine errors or mistakes. The reasons for the errors should be analysed to understand what may have led them to occur and for safety lessons to be learnt.

Regardless of the size and complexity of your organisation you need to encourage reporting without fear of repercussions to the report author. It is imperative individuals feel there is an open and just culture within your organisation. It is also important that adequate feedback is given to individuals reporting an incident.

Systematically identifying and treating organisational risks and hazards is fundamental to an SMS. Ongoing monitoring and communication of the risk management process will improve its effectiveness.

Certain events are reportable to the Australian Transport Safety Bureau (ATSB) under the *Transport Safety Investigation Act 2003*. These are commonly known as immediately reportable matters (IRMs) and routine reportable matters (RRMs). The Transport Safety Investigation Regulations list the matters which are required to be reported to the ATSB. Additionally, certain events are reportable to the state or territory-based WHS regulator (Safework, Worksafe, WHS Queensland etc) through the relevant state or territory-based legislation. The list of matters which are required to be reported is available through the relevant state or territory regulator's website.

image: Adobe Stock | SFIO CRACHO

Loss of control and collision with terrain

A DJI Inspire 2 RPA was being used for aerial photography and videography and flown to as low as approximately 10 m above ground level. Shortly after take-off the RPA unexpectedly accelerated away from the remote pilot. The remote pilot attempted to control the RPA and arrest its movement however, the RPA was unresponsive to control inputs.

The RPA continued to accelerate to its maximum speed while flying away from the remote pilot and towards nearby buildings. The RPA struck the window of a building, injuring the room's occupant and the RPA was destroyed.

An investigation into the accident identified that shortly after take-off the compass on the RPA failed due to electromagnetic interference. This resulted in the RPA becoming unresponsive to control inputs. The failure of the compass also disabled the failsafe return to home function, meaning the compass failure had a two-fold effect rendering the RPA uncontrollable, while simultaneously disabling the failsafe designed to prevent a fly-away occurrence.

Following the outcomes from this investigation the manufacturer updated user manuals, providing additional guidance regarding the use of fully manual attitude flight mode in the event of compass interference.

In the event of a compass failure, switching to the fully manual attitude flight mode may assist regaining control of the RPAS. Whereas, following a loss of signal to the RPA, the last remaining risk control to prevent a fly away are built-in design features such as the failsafe return to home.

This accident highlights that while the reliability of RPAs is generally high, they are not infallible. In fact, ATSB reportable occurrence data indicates that RPA fly-away occurrences are not a rare event. This reinforces the need for ReOC holders to conduct risk assessments to identify controls to manage the risk of loss of control, and to not solely use the failsafe return to home feature as an effective control.

Source: ATSB Transport Safety Report AO-2021-001: 'Loss of control and collision with terrain involving DJI Inspire 2 remotely piloted aircraft Darling Harbour Sydney, New South Wales on 15 January 2021'.

Risk assessment and mitigation

The purpose of the risk assessment process within your SMS is to allow you to assess the level of risk associated with your identified hazards. Risks should be assessed in terms of consequence, severity, and likelihood.

When assessing risks, the worst-case feasible scenario should be assessed. For hazards identified through a reactive process, this should be the potential risk not the actual consequence of the event. As an example, if a hazard of lack of training results in minor damage to the RPA on landing, assess the risk of substantial damage to the RPA (worst case feasible), not the minor damage that actually occurred.

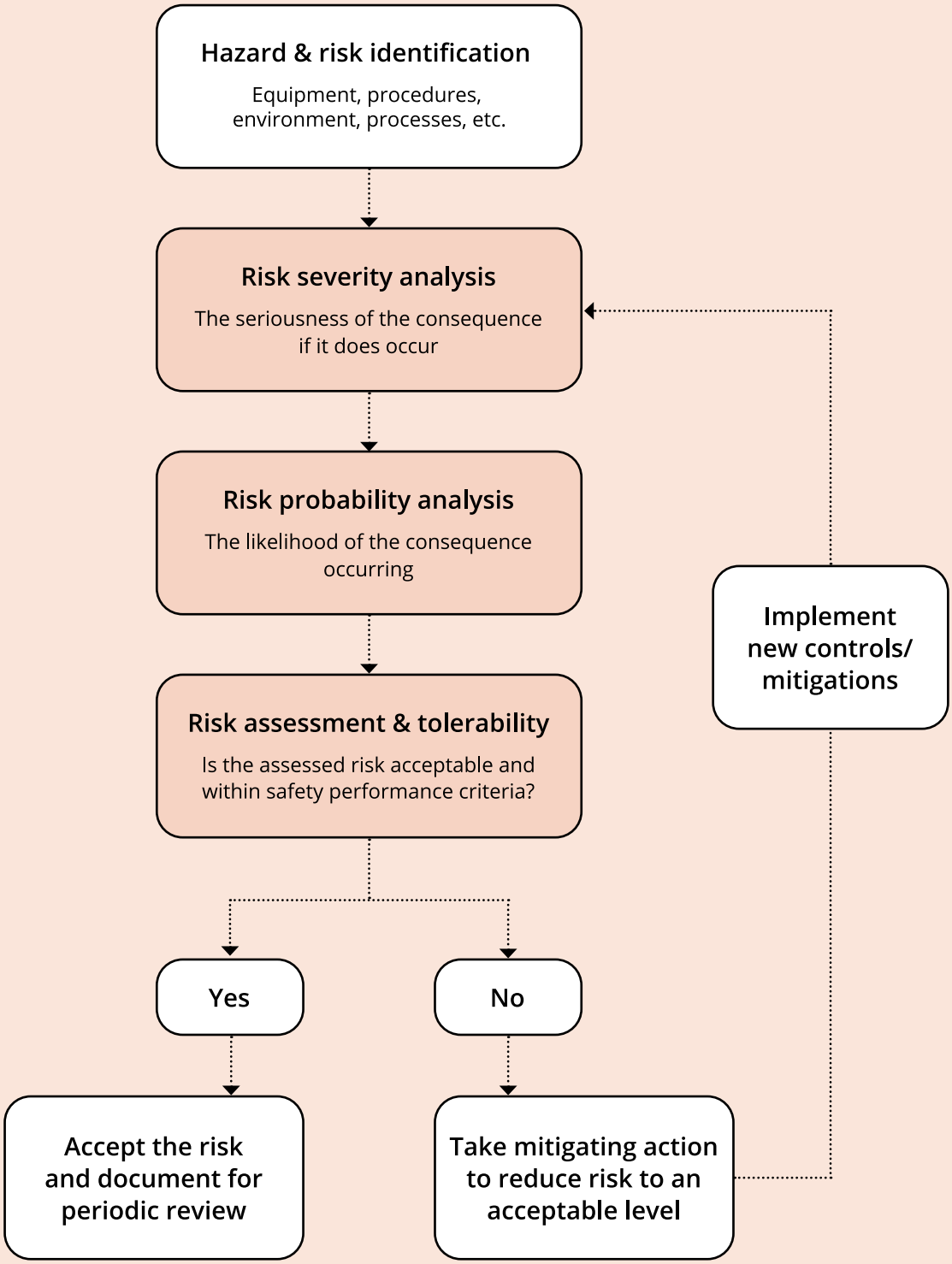
Then depending on the level of risk, appropriate mitigation or control measures can be taken to either eliminate the risk or reduce the risk to a lower level, in order to be acceptable to your organisation. Mitigating measures should be implemented to either reduce the likelihood of the risk occurring or reduce the severity of the outcome if it does occur.

In most cases, each control will reduce either the likelihood or consequence but rarely both. As an example, the worst feasible consequence of a medium RPA (between 25 kg and 150 kg) suffering a mid-air collision with a crewed aircraft is catastrophic. Effective training, following procedures and establishing radio communications between the two pilots are control measures which reduce the likelihood, but do not alter the consequence if the risk eventuated. Insurance can reduce the level of financial consequence to the ReOC holder; however, such a control is regarded as transferring the risk rather than reducing it.

Where risk is concerned, there is no such thing as absolute safety. Risk management is often based on the concepts of as low as reasonably practicable (ALARP) or so far as is reasonably practicable (SFAIRP). 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. Refer to **Book 3: Safety risk management** – casa.gov.au/sms for more detailed and in-depth information on the application of ALARP and SFARIP principles.

Risk assessment and mitigation, the core of risk management, is an integral component of safety management and involves some essential steps.

Essential steps involved in safety risk management



> The key to risk assessment and mitigation is to keep the process simple and related to your organisations operating environment.

When considering risk assessment and mitigation all ReOC holders should be able to demonstrate the following as a minimum:

- any identified safety hazards, risk assessments and subsequent follow-up actions are clearly documented
- risks are being assessed in terms of consequence severity and likelihood
- risk assessments are being carried out to determine the level of risk
- appropriate measures are being taken to eliminate, or mitigate, the risks to be ALARP or SFAIRP
- mitigations, controls, or defences are periodically reviewed to ensure they remain valid and relevant.

Most ReOC holders will already have a good idea of their core risks and any control measures that can easily be applied. You do not have to be, or employ, a risk specialist as you will most likely know the risks in your organisation already. They are often the stress points already causing you some concerns.

It is important to include people with relevant expertise and experience in the risk assessment process to ensure robustness as all risk assessments are reliant on the quality of the information used during the assessment and the knowledge of the people conducting it.

Smaller ReOC holders may have a manager who feels confident they understand their hazards and risks, and that they can undertake a risk assessment on their own. But having another set of eyes crosschecking your assumptions is always the preferred method.

Refer to **Book 3: Safety risk management** – casa.gov.au/sms for more detailed and in-depth information to assist you with these core elements.

image: Adobe Stock | VAKSMANV

Case study: Aggie Air risk assessment

Aggie Air, a medium-sized ReOC holder operating multiple RPAs for agriculture services, is expanding their fleet to enhance their services from mapping to also include spraying and spreading. They are undertaking risk assessments for the first time, using their risk assessment matrix to evaluate identified hazards and risks.

Aggie Air Risk Assessment Matrix

		Risk severity				
		A	**B**	**C**	**D**	**E**
Risk probability		**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

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 on to perform their tasks accurately or completely • Serious injuries or death • 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

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

The CEO gathers a team together, and when they review their current hazards their most reported hazard is weather. They conduct a risk assessment and record the results in their newly established risk register. The outcomes are as follows:

Aggie Air Risk Register

Hazard	Risk description	Current controls	Initial risk			Tolerate	Additional controls	Residual risk			Risk owner	Review date
			Consequence	Likelihood	Risk rating			Consequence	Likelihood	Risk rating		
Weather	Bad weather results in loss of control of RPA and subsequent collision with terrain	Only remote pilot licence holders conducting flights. Pre-flight situational risk assessment required before each flight. Operations manual requires consideration of current and forecast weather conditions.	B - Hazardous	2 – Improbable	2B – Medium	No, treat	Prescriptive limits on wind and visibility to be determined and documented in operations manual.	B - Hazardous	1 – Extremely improbable	1B - Low	Chief remote pilot	6 months

image: Civil Aviation Safety Authority

Safety assurance

An SMS is not a 'set and forget' system, and safety assurance monitors the overall safety performance of your organisation and the effectiveness of your SMS. Your safety assurance element gives confidence that for all your identified hazards and risks the appropriate mitigation measures applied are implemented and achieving their intended outcomes.

It includes reviewing and evaluating safety performance as well as the SMS processes and practices to ensure the SMS is functioning as intended. It provides the checks and balances to demonstrate the SMS is working, and ensures the SMS continues to mature.

For ReOC holders regardless of the size and complexity, you want to be able to monitor your safety performance and review the effectiveness of your SMS. How you go about this and what functions you use will vary depending on your size and operating environment.

Safety performance monitoring and measurement

To be able to manage your safety performance you need to be able to measure it in some way and for that you will need safety data that can be used to track the achievement of your safety objectives.

The first step in monitoring your safety performance is to identify what safety performance indicators (SPIs) will be used. SPIs should be linked to your safety objectives, and they provide a progress towards achieving the safety objectives, and overall, how your safety performance is tracking. What SPIs you use will depend on your organisation, its size, complexity and especially your operating environment. Refer to **Booklet 4: Safety assurance** – casa.gov.au/sms for more detailed information and examples of SPIs.

In smaller ReOCs, low levels of safety data may mean it is more difficult to identify trends or changes in safety performance. This may require meetings to raise and discuss safety issues with appropriate experts. This tends to be more qualitative than quantitative, but it will help identify hazards and risks for your operation. In these instances, collaborating with other RPAS operators or industry associations can be helpful since they may have data that you do not, but as they operate in similar environments to you it is still relevant.

When you do have limited safety data available safety performance trends may be difficult to define and it will be more important to analyse and investigate individual events and look for trends even in small numbers.

SPIs do not always need to be based on events, for example consider safety reporting levels as an SPI. This can progress with sufficient data to a review of safety reports, which can include categorisation of safety reports into types of events, types of RPA or operations involved, and contributing factors (organisational and human factors). Another SPI example is the frequency and attendance at safety meetings of your staff.

As part of your SMS, you also need to monitor compliance of all personnel with your SMS policy and procedures. Ideally, this is achieved through an independent assessment to ensure you are managing safety in accordance with your documented SMS and that your SMS is working effectively.

The organisation should have performance monitoring and measurement processes that enable you to:

- review how your organisation complies with your documented SMS through internal audits
- verify that safety performance indicators are linked to safety objectives through management reviews
- assess how effectively the SMS procedures and processes described in the SMS manual (or SMS documentation) are implemented and practised through management reviews and periodic safety committee reviews.

In a small ReOC holder organisation where everyone may be involved in the SMS it will be challenging to establish an independent review or audit. In this case, you could use external auditors, or consult with other similar RPAS operators or industry bodies which may provide information against which you can benchmark your organisation's performance.

Safety investigations

Safety investigations are conducted as part of your SMS to support hazard identification and risk assessment processes. They also provide a mechanism for monitoring safety performance. Investigations provide valuable sources of hazard identification and to identify weaknesses in risk controls so that effective corrective actions can be designed and implemented.

Your internal safety investigations should include occurrences which you do not necessarily have to report to the Australian Transport Safety Bureau (ATSB) or CASA. While these safety occurrences may often appear minor, including them in a systematic investigation may reveal potentially hidden hazards.

The size and scope of the investigation needs to be appropriate, sufficiently detailed, and big enough to identify and validate any potential hazards. The effort you put in should be in keeping with the benefit your organisation will gain from identifying hazards and risks. Your investigations should include what happened, when, where, how and who was involved. With the key focus being to understand why it happened, that is to identify the contributing factors, to prevent it reoccurring rather than finding someone to blame for the event. Your staff undertaking investigations will also need to be suitably trained or experienced to be able to conduct the detailed analysis required during the investigation process.

Your safety committee should review the findings from all incident analysis or investigations and any identified recommended improvements. It is imperative any safety lessons learned are shared both within your organisation and with relevant third-party organisations.

ReOC holders should have the following as a minimum:

- a simple, user-friendly reporting system which can be based on, for example a simple Excel spreadsheet, accessible to all relevant personnel
- objective internal investigations with the focus being on the ‘what’ and ‘how’ rather than on ‘who’ was to blame
- a review of all findings from incidents and recommendations for improvements, changes, or amendments to the SMS, if required, by the safety committee
- dissemination of any lessons arising from investigations throughout the organisation, and where possible other similar organisations. You can communicate these by:
  - site-based briefings
  - meetings with other operators or industry bodies
  - email
  - company intranet
  - safety bulletins.

image: Adobe Stock | zephyr_p

Accident outcomes

A ReOC holder was conducting aerial photography within an urban environment, the city centre. Prior to the flight, the remote pilot conducted the pre-flight inspection of the RPA and found it to be serviceable, with no evidence of damage or cracking. It was a clear day with no winds and the weather forecast was for fine conditions across the day.

The remote pilot launched the RPA from the rooftop of a nine-storey building. About 30 seconds into the flight, the remote pilot heard a loud crack and observed the RPA roll rapidly onto its back. The remote pilot commanded the parachute to deploy, however the parachute deployment was ineffective due to RPA orientation. The RPA descended rapidly and collided with the roof of a parked car in the street below. The RPA was destroyed, and the car roof was dented, but no one was injured.

The investigation found one of the arms was fractured and only remained attached to the main frame by the motor cable running through it. It was determined an internal crack in the arms existed, which was not visible to the remote pilot during an external inspection. It was most likely a pre-existing fault from either an earlier minor impact or mishandling during transport. Although the parachute gas canister was empty, indicating the RPA attempted to deploy the parachute, it was ineffective due to the RPA rolling onto its back.

Following the investigation findings, the ReOC holder implemented new procedures to include a test fight prior to conducting similar operations, as well as ensuring all RPAs were transported in specifically designed cases to reduce potential for damage to arms.

Management of change

Regardless of a ReOC holders' size and complexity, your operation and the aviation environment are dynamic, and changes will frequently occur. As such you will need a process to help identify potential hazards and safety impacts of any changes.

The management of change should be a formal process to identify external and internal changes that may affect established processes and services. It uses the organisation's existing risk management processes to ensure there is no adverse effect on safety. Change can also introduce new hazards that could affect the appropriateness and effectiveness of any existing risk mitigation.

Whether change is brought about through changes in your operating environment, new projects, or through modifications to operating procedures, it will involve risks.

There is a very strong link between change management and risk management, the two processes support each other and should be used together.

Management of change within an SMS should focus on hazard identification and controls or defences related to the safety of operations. Other potential risk factors, such as lack of business growth, may also be considered, as while they are additional to the scope of SMS change management, they may affect operational safety.

ReOC holders should be able to demonstrate the following as a minimum:

- there is a process or procedures in place to be able to recognise an upcoming change to your operation, either through internal changes or external operating environment changes, to trigger your management of change process
- the management of change process follows the same structured approach you use for normal risk assessment.

Management of change within your SMS is a different process to management of change in the regulatory context. Regulatory change management is aimed at organisations that are required to have a change process outside of the scope of an SMS. The regulatory context includes consideration of significant changes which require CASA mandatory notifications and approvals. Under your SMS, management of change is a process that occurs regardless of any regulatory requirements for notification and approvals. Regulatory change management is directly linked to your CASA regulatory authorisations, these may leverage off or have implications for your SMS, but your SMS change management should always be occurring regardless.

image: Civil Aviation Safety Authority

Continuous improvement of the SMS

Your SMS should be an integral part of your organisation. It should be dynamic rather than static and it needs to continuously improve the safety performance of your organisation.

Like all systems within an organisation, an SMS must be reviewed and worked on to reach improved levels of maturity. It takes time and effort to improve the SMS, but it is worth it. A mature SMS is seamlessly integrated with other systems and becomes the way the ReOC holder does business. A mature SMS increases the level of proactive safety by identifying hazards and deficiencies before accidents and incidents occur thereby saving the organisation resources and money.

The best way to improve the SMS is to critically review it from time to time. For small ReOC holders, this could be as simple as an SMS audit, health check or effectiveness review. Using a fresh set of eyes is always a good way to look at what processes are in place and why they are done that way. A gap analysis can be re-used to ensure each element is in place but expanded to look at whether the elements are operating and effective.

Another option for small ReOC holders is to partner with similar sized ReOC holders and review each other's SMS to share learnings. Collaborating with similar organisations is sensible because when it comes to safety, there should be no competitors. High levels of safety and SMS maturity are good for the entire RPAS and aviation industry and will result in further growth which is good for every ReOC holder.

You should be able to demonstrate continuous improvement of your SMS by:

- periodically monitoring and reviewing the risk management process
- implementing recommendations from incident investigations and audit reports
- involving all personnel in safety meetings
- networking with other similar organisations and sharing safety information.

Refer to **Book 4: Safety assurance** – casa.gov.au/sms for more detailed and in-depth information to assist you with scalability of these core elements.

image: Adobe Stock | Gorodenkoff

Safety promotion

Your SMS must include safety promotion, which includes safety training and education, and safety communication. Safety promotion communicates the organisation's expected safety behaviours, safety lessons learned, safety information, safety procedures, and key safety messages from senior management to foster improved safety performance.

You must ensure that your personnel are trained and competent to perform their roles within the SMS, and that the training programs are tailored to suit the needs and complexity of your organisation. Safety communication assists in setting the safety tone for the organisation and helps to build a robust safety culture.

For the RPAS sector, the safety promotion component of an SMS is of particular importance. Persons can operate RPA or perform RPAS safety sensitive aviation activities without the depth of experience and training required in the crewed aviation sectors. In the latter, SMSs have been in place for several years and are an accepted part of the industry.

To help embed the SMS approach within the RPAS sector, particular focus should be applied to safety promotion especially for those ReOC holders who use personnel without prior experience in aviation safety management processes or procedures.

Safety promotion helps build the ReOC holder's safety culture. Regular communication of safety expectations and allowing time for the workforce to be involved in safety training and education demonstrates management's commitment to the SMS. It opens lines of communication to help implement and mature the SMS.

Safety training

Providing appropriate safety training to all personnel highlights your management's commitment to providing an effective SMS. The purpose of safety training is to ensure all personnel are competent to carry out their safety roles and responsibilities. The core outcome of safety training is creating awareness of the organisation's safety objectives and the importance of creating a positive safety culture.

Your safety training needs to focus on identifying and reducing hazards in the system, and why the 'human factor' is significant in achieving this. Like all elements of the SMS, the ReOC holder's approach to safety training and education should be formalised through a documented process.

Your safety training should include the following topic areas:

- your organisation's SMS
- your safety policy and objectives
- hazard and safety reporting procedures
- safety responsibilities, including acceptable and unacceptable safety behaviours
- how individuals can contribute to safety across all levels of the organisation.

> Training should be tailored not only to your organisation but also to the individuals' roles.

All ReOC holders should be aiming for the following as a minimum:

- ensure all personnel have undertaken initial and ongoing refresher safety training, including training assessments
- maintain records of all personnel's safety training
- make all personnel aware of the safety hazards and risks associated with their duties
- lessons arising from investigations should be disseminated effectively.

Safety communication

An ongoing safety communication program should ensure your personnel benefit from safety lessons learned and continue to understand the organisation's SMS. Safety communication is essential to maintaining two-way communication, ensuring that all personnel are informed, and that feedback is captured and acted upon where appropriate.

Your organisation's safety communication should:

- ensure all staff are aware of the organisation's SMS
- convey safety-critical information
- explain why particular actions are taken
- assist in change management, by keeping staff informed of the process
- explain why safety procedures are introduced or changed.

It is also valuable to communicate 'good-to-know' safety principles and information to personnel. Efforts should be made to share best practice and relevant safety-related information with other similar ReOC holders, as a two-way street by passing on your learnings as well as gathering theirs.

All ReOC holders should be aiming to:

- promote your SMS so that everyone is aware of their safety roles and responsibilities. You can achieve this through regular safety communications including:
  - meetings: regular staff meetings or site-based briefings
  - visuals: signs, posters, visual cues like high-vis vests when undertaking safety-critical work
  - written: safety newsletters, safety bulletin, note with pay slip, email, company intranet etc.
- ensure safety-critical information related to analysed hazards and assessed risks is disseminated
- ensure relevant safety information is distributed to contractors and third-party providers for your organisation.

An effective way to drive a positive safety culture in the organisation is to recognise and reward individual contributions to the safety system. This can be as simple as public acknowledgement of safety reports which highlighted risks of significant potential, and which were controlled before an accident or incident occurred. Recognition can also be in the form of rewarding staff who consistently demonstrate positive safety behaviours. Through communicating these safety recognitions across your organisation, you are further promoting positive safety behaviours and enhancing your overall safety culture.

Refer to **Book 5: Safety promotion** – casa.gov.au/sms for more detailed and in-depth information to assist you with scalability of these core elements.

Human factors integration

Consideration of human factors (HF) has particular importance in safety 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.

Integrating HF into your SMS gives you a framework to ensure you systematically identify and analyse any HF issues and fix them. 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 with many of the effects of the interaction between these influences being difficult or impossible to predict
- the consequences of variable human performance will differ according to the task being performed and the context.

While there is learning about several human factors which can be brought across from the traditional crewed aviation sector (for example fatigue, communication, and situational awareness), the RPAS sector brings about a whole new set of human factor challenges. The very nature of remotely piloting an aircraft means the senses are not able to be used in the same way as in piloting a crewed aircraft. For beyond visual line of sight (BVLOS) RPA operations, the pilot is entirely reliant upon the information fed back to them through a communication or data link.

In a crewed aircraft, systems could be shut down and the pilot would still have an opportunity to sense what is happening.

Human factor considerations for an RPAS need to reflect the unique operating environment, operational challenges faced, and what errors can occur. Assuming or hoping human errors will not occur is flawed safety thinking. Proper safety thinking is identifying which errors may be made by humans and putting controls in place to reduce their likelihood or consequence.

All ReOC holders should be able to demonstrate that HF has been integrated into the organisation's SMS, for example:

- ensure organisational processes and actions are transparent, staff know and understand who does what, and why
- involve staff by respecting and valuing their input, which is especially important in risk management and management of change
- encourage timely, relevant, and clear two-way communication through feedback from audits, safety reviews or safety reports
- ensure a just culture with an open safety reporting process which includes timely incident follow-up and systemic investigation findings
- be able to demonstrate that the organisation is adopting HF training
- ensure HF and human performance limitations have been assessed as potential contributing factors during safety investigations.

Case study

image: Adobe Stock | blackdiamond67

RPAS and human error

The remote pilot of an RF Designs Mephisto RPA was conducting test flights following aircraft maintenance. After completing test flying, the remote pilot toggled the automatic mode switch to disengage the aircraft's automatic mode for taxi back to the hanger.

The remote pilot then increased throttle to provide sufficient momentum to taxi. As the aircraft turned toward the remote pilot, it failed to respond to commands to reduce engine thrust. The remote pilot toggled the automatic mode switch to regain control of the aircraft and turn it away from bystanders. The aircraft was directed across the airfield, coming to rest against the perimeter fence, resulting in minor damage to the aircraft's skin.

An investigation into the accident identified that following the autonomous flight phase, the remote pilot did not correctly disengage the automatic mode. Subsequently, when increasing throttle for taxiing the 'abort landing' function had been activated, increasing throttle to maximum and overriding the remote pilot's commands to decrease throttle. The remote pilot was able to deactivate the 'abort landing' function by toggling the automatic mode switch.

It was determined the remote pilot did not identify visual, audible, and tactile cues that indicate the aircraft had not exited the automatic mode prior to increasing throttle for taxiing.

The investigation identified four contributing factors to the accident:

1. When the throttle was advanced for taxi, the automatic mode, which had not been correctly deactivated, entered an 'abort landing' state. This overrode the remote pilot's commands to decrease throttle and the turbine thrust continued to increase, resulting in a loss of control.
2. The use of a 3-position switch (with two positive and one negative position), for a 2-position role, increased the likelihood that a remote pilot would inadvertently not deactivate the automatic mode prior to manoeuvring the aircraft.
3. The controller did not have a 'kill switch' to override the aircraft's automatic mode and shutdown the turbine in the event of an issue. As a result, the remote pilot was forced to toggle the aircraft's mode switches and direct it away from personnel rather than being able to override it.
4. The remote pilot was experiencing a level of fatigue known to impact performance. This likely led to a lack of reaction to multiple cues that the aircraft had not exited the automatic mode.

These findings reinforce the need for human factors and human performance limitations to be considered when operating RPAS. The design of the RPAs controller device resulted in a mismatch between the operator and the hardware, increasing the potential for human error. The fatigue impairment of the remote pilot is a human performance limitation that can affect all safety-critical roles across the aviation industry.

This incident has three key human performance learnings for RPA operators:

- Fatigue is a risk, particularly in high tempo commercial operations. Even when fatigue management is not mandated, operators should ensure that their fatigue management processes are robust, effective, and integrated into their SMS.
- All control devices for RPAs should be logical, human performance centred, and as reliable as possible. If a controller leaves room for human error, then it will increase the risk of this error occurring even if procedural controls are in place. Consideration should also be given to a system that allows the remote pilot to shut down the aircraft immediately in the event of an unexpected state or failure.
- Operators should be prepared for the RPA to do something unexpected, and frequently practice emergency procedures.

Source: ATSB Transport Safety Report AO-2020-035: 'Loss of control during taxi, involving RF Designs Mephisto, remotely piloted aircraft'.

Identification and analysis of HF issues

As a minimum, ReOC holders should be able to show that your organisation understands why human factors issues are important, and that human factors considerations are part of your reporting and investigation processes. Examples of some typical HF issues may include:

- communication breakdowns, leading to a lack of understanding, incomplete briefings, or lack of information sharing
- poor design of systems and equipment, not taking into consideration the human-machine interface with design can have a major impact on human performance and increase the risk of errors
- fatigue impairment
- stress
- time pressures
- environmental hazards (lighting, noise, weather etc).

These may all be a part of daily operations for your organisation, and your HF training should reflect this. Although these may not be completely avoidable you can assist in managing them through knowledge and development of HF risk controls.

Refer to **Book 6: Human factors and human performance** – casa.gov.au/sms for more detailed and in-depth information.

Safety management involves managing your aviation business activities in a systematic and coordinated way to minimise risks.

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