Civil Aviation Safety Authority
of Papua New Guinea

Advisory Circular
AC100-1B

Safety Management Systems (SMS) Component 2 - Safety Risk Management: A Practical Guide

Initial Issue

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GENERAL

Civil Aviation Authority Advisory Circulars (AC) contain information about standards, practices and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices or procedures are found to be acceptable, they will be added to the appropriate Advisory Circular.

This Advisory Circular also includes Explanatory Material (EM) where it has been shown that further explanation is required. Explanatory Material must not be regarded as an acceptable means of compliance.

PURPOSE

This Advisory Circular provides methods, acceptable to the Director, for showing compliance with the Safety Management System requirements of Part 100 and explanatory material to assist in showing compliance.

RELATED CAR

This AC relates specifically to Civil Aviation Rule 100 Subpart B – Safety Management Systems.

CHANGE NOTICE

There was no previous issue of this AC, consequently no change is in effect.

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1.1 EM 100.61 Introduction to Safety Risk Management (SRM)

1.1.1 Service providers should ensure they are managing their safety risks. This process is known as safety risk management (SRM), which includes hazard identification, safety risk assessment and safety risk mitigation.

1.1.2 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).

1.1.3 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. A 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.

1.1.4 The SRM process systematically identifies hazards that exist within the context of the delivery of its products or services. Hazards may be the result of systems that are deficient in their design, technical function, human interface or interactions with other processes and systems. They may also result from a failure of existing processes or systems to adapt to changes in the service provider's operating environment. Careful analysis of these factors can often identify potential hazards at any point in the operation or activity life cycle.

1.1.5 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.

1.1.6 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.

1.1.7 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	SMS Element
Safety Risk Management	1. Hazard Identification
	2. Safety Risk Assessment and Mitigation

1.1.8 Understanding the system and its operating environment is essential for the achievement of high safety performance. Having a detailed system description that defines the system and its interfaces will help. Hazards may be identified throughout the operational life cycle from internal and external sources. Safety risk assessments and safety risk mitigations will need to be continuously reviewed to ensure they remain effective.

2. EM100.59 HAZARD IDENTIFICATION

2.1 EM100.59 Hazard Identification

2.1.1 Identifying Hazards is the first step in the SRM process. The service provider should develop and maintain a formal process to identify hazards that could impact aviation safety in all areas of operation and activities. This includes equipment, facilities and systems. Any aviation safety-related hazard identified and controlled is beneficial for the safety of the operation. It is important to also consider hazards that may exist as a result of the SMS interfaces with external organizations.

2.1.2 ***Introduction to Hazard:*** 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.

In aviation, a hazard can be considered as a dormant potential for harm which is present in one form or another within the system or its environment. This potential for harm may appear in different forms, for example: as a natural condition (e.g. terrain) or technical status (e.g. runway markings).
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.

2.1.3 ***Understanding Hazards and their Consequences:*** Hazard identification focuses on conditions or objects that could cause or contribute to the unsafe operation of aircraft or aviation safety-related equipment, products and services (guidance on distinguishing hazards that are directly pertinent to aviation safety from other general/industrial hazards is addressed in subsequent paragraphs).

Consider, for example, a fifteen-knot wind. Fifteen-knots of wind is not necessarily a hazardous condition.

In fact, a fifteen-knot wind blowing directly down the runway improves aircraft take-off and landing performance. But if the fifteen-knot wind is blowing across the runway, a crosswind condition is created which may be hazardous to operations. This is due to its potential to contribute to aircraft instability. The reduction in control could lead to an occurrence, such as a lateral runway excursion.

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.

In the crosswind example above, an immediate outcome of the hazard could be loss of lateral control

followed by a consequent runway excursion. The ultimate consequence could be an accident. The damaging potential of a hazard can materialize through one or many consequences. It is important that safety risk assessments identify all of the possible consequences. The most extreme consequence - loss of human life - should be differentiated from those that involve lesser consequences, such as: aircraft incidents; increased flight crew workload; or passenger discomfort.

The description of the consequences will inform the risk assessment and subsequent development and implementation of mitigations through prioritization and allocation of resources. Detailed and thorough hazard identification will lead to more accurate assessment of safety risks.

2.1.4 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.

2.1.5 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.

2.1.6 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).

2.1.7 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.

2.1.8 The aviation organization shall develop and maintain a formal process that ensures that hazards in operations are identified. Hazard identification shall be based on a combination of reactive, proactive and predictive methods of safety data collection.

Hazard identification is based on a combination of reactive, proactive and predictive safety data collection methods.

The three methodologies for identifying hazards are:

(a) ***Reactive**.* This methodology involves analysis of past outcomes or events. Hazards are identified through investigation of safety occurrences. Incidents and accidents are clear indicators of system deficiencies and therefore can be used to determine the hazards that either contributed to the event or are latent.

(b) ***Proactive**.* This methodology involves analysis of existing or real-time situations, which is the primary job of the safety assurance function with its audits, evaluations, employee reporting, and associated analysis and assessment processes. This involves actively seeking hazards in the existing processes.

(c) ***Predictive**.* This methodology involves data gathering in order to identify possible negative future outcomes or events, analysing system processes and the environment to identify potential future hazards and initiating mitigating actions**.**

Hazard identification is the first step in the safety risk management process. The corresponding safety risks are then assessed within the context of the potentially damaging consequences related to the hazard. Where the safety risks are assessed to be unacceptable, additional safety risk controls must be built into the system.

A structured approach to the identification of hazards ensures that, as much as possible, most hazards in the system's operational environment are identified. Suitable techniques for ensuring such a structured approach might include:

(a) ***Checklists.*** Review experience and available data from similar systems and draw up a hazard checklist. Potentially hazardous areas will require further evaluation.

(b) ***Group review.*** Group sessions may be used to review the hazard checklist, to brainstorm hazards more broadly, or to conduct a detailed scenario analysis. Hazard identification sessions require a range of experienced operational and technical personnel and are managed by a facilitator. The same group may also be used to assess corresponding safety risks.

Once hazards have been identified, their consequences evaluated and the safety risks of such consequences assessed (i.e. once safety information has been extracted from the safety data), safety information is delivered to line managers for resolution and on-going management of underlying safety concerns.

Line managers are subject-matter experts in their respective areas and therefore best able to design effective and efficient solutions and implement them. The safety services office is fundamentally a safety data collection and analysis unit. Through a combination of predictive, proactive and reactive methods, the safety services office captures what takes place within the operational drift, by continuously and routinely collecting safety data on hazards during service delivery activities.

Furthermore, line managers can take the last step in the safety data analysis process, by turning safety information into safety intelligence and by providing a context for the information on hazards distilled by the safety services office.

In mature safety management systems, hazard identification is a continuous and is an integral part of the aviation document holder's processes. A number of conditions trigger more in-depth and far-reaching hazard identification activities and may include:-

- Instances where the organization experiences an unexplained increase in aviation safety related events or regulatory non-compliances;
- Significant operational changes, including operational changes to key personnel or other major components; and
- Significant organizational changes, including anticipated growth and contraction, corporate mergers or acquisitions

2.1.9 ***Safety Reporting systems*** **-** Hazards exist at all levels in the organization and are detectable through many sources including reporting systems, inspections, audits, brainstorming sessions and expert judgement. The goal is to proactively identify hazards before they lead to accidents, incidents or other safety-related occurrences. An important mechanism for proactive hazard identification is a voluntary safety reporting system. Voluntary safety reporting systems should be established to collect safety data and safety information not captured by the mandatory safety reporting system. These reports go beyond typical incident reporting. Voluntary reports tend to illuminate latent conditions, such as inappropriate safety procedures or regulations, human error, etc.

One way to identify hazards is through voluntary reporting. Information collected through such reporting systems may be supplemented by observations or findings recorded during routine site inspections or organizational audits.

Hazards can also be identified in the review or study of internal and external investigation reports. A consideration of hazards when reviewing accident or incident investigation reports is a good way to enhance the organization’s hazard identification system. This is particularly important when the organization’s safety culture is not yet mature enough to support effective voluntary safety reporting, or in small organizations with limited events or reports. An important source of specific hazards linked to operations and activities is from external sources such as ICAO, trade associations or other international bodies.

Hazard identification may also consider hazards that are generated outside of the organization and

hazards that are outside the direct control of the organization, such as extreme weather or volcanic ash. Hazards related to emerging safety risks are also an important way for organizations to prepare for situations that may eventually occur.

The following should be considered when identifying hazards:

(a) system description;

(b) design factors, including equipment and task design;

(c) human performance limitations (e.g. physiological, psychological, physical and cognitive);

(d) procedures and operating practices, including documentation and checklists, and their validation under actual operating conditions;

(e) communication factors, including media, terminology and language;

(f) organizational factors, such as those related to the recruitment, training and retention of personnel, compatibility of production and safety goals, allocation of resources, operating pressures and corporate safety culture;

(g) factors related to the operational environment (e.g. weather, ambient noise and vibration, temperature and lighting);

(h) regulatory oversight factors, including the applicability and enforceability of regulations, and the certification of equipment, personnel and procedures;

(i) performance monitoring systems that can detect practical drift, operational deviations or a deterioration of product reliability;

(j) human-machine interface factors; and

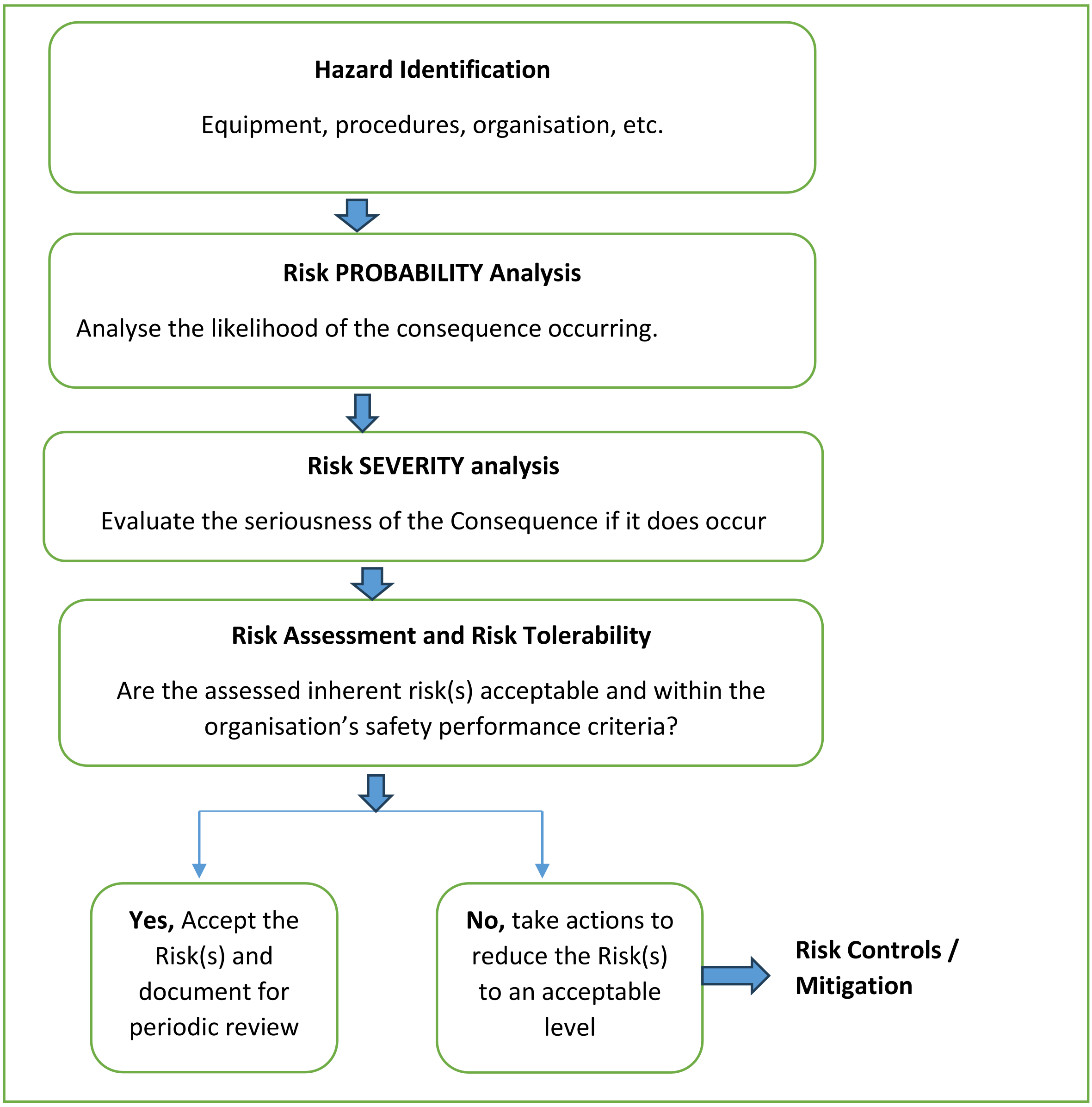
(k) factors related to the SSP/SMS interfaces with other organizations.

2.1.10 ***Hazards*** related to SMS Interfaces with external organisation:

Organizations should also identify hazards related to their safety management interfaces. This should, where possible, be carried out as a joint exercise with the interfacing organizations. The hazard identification should consider the operational environment and the various organizational capabilities (people, processes, technologies) which could contribute to the safe delivery of the service or product’s availability, functionality or performance.

As an example, an aircraft turnaround involves many organizations and operational personnel all working in and around the aircraft. There are likely to be hazards related to the interfaces between operational personnel, their equipment and the coordination of the turnaround activity.

The below figure provides an overview of the hazard identification and safety risk management process for a service provider.



2.2 EM 100.59 Sources of Hazard Identification

2.2.1 There are a variety of sources for hazard identification, internal or external to the organisation.

Some internal sources include:

(a) ***Normal operations monitoring*** – this uses observational techniques to monitor the day to day operations and activities such as line operations safety audit (LOSA);

(b) ***Automated monitoring systems*** – this uses automated monitoring recording systems to monitor parameters that can be analysed such as Flight Data Monitoring (FDM);

(c) ***Voluntary and mandatory reporting systems*** – this provides everyone including staff from external organisations, with opportunities to report hazards and other safety issues to the organisation.

(d) ***Audits*** – these can be used to identify hazards in the task or process being audited. These should be coordinated with organisational changes to identify hazards related to the implementation of the change.

(e) ***Feedback from training*** – that is interactive (two way) can facilitate identification of new hazards from participants.

(f) ***Service provider safety investigations*** – hazard identified in internal safety investigations and follow-up reports on accidents/incidents.

2.2.2 Some external sources include:

(a) ***Aviation accident reports -*** this may be related to accidents in PNG or other States or to a similar aircraft type, or operational environment.

(b) ***PNG confidential and mandatory reporting systems –*** PNG AIC provide reports of all accidents investigated on their website and some foreign design States provide summaries of the incident reports received from their service providers.

(c) ***State oversight audits and third-party audits –*** external audits can sometimes identify hazards. These may be documented as an unidentified hazard or captured less obviously witin an audit finding.

(d) ***Trade associations and information exchange systems –*** many trade associations and industry groups are able to share safety data that may include identified hazards.

2.3 AMC100.59 Hazard Taxonomy

2.3.1 Four (4) High Level Hazard Taxonomy Categories

In 2010, the SM ICG published *Development of a Common Taxonomy for Hazards*, which proposed a process for the development of a common taxonomy for hazards related to civil aviation. That document provided the rationale for developing a hazard taxonomy, proposed general definitions of a hazard, and also proposed a near term and far term approach to developing a taxonomy and categorizing hazards.

However, since the publication of that document ICAO had defined hazard in Annex 19 Edition 2 and the Commercial Aviation Safety Team (CAST)/ICAO Common Taxonomy Team (CICTT) has accepted the high level hazard categories established by SM ICG.

Furthermore, the Director has accepted the following high level hazard taxonomy categories established by SM-ICG as the baseline for use in PNG:

(a) **Category 1: Organizational** – Management or documentation, processes and procedures

(b) **Category 2: Environmental** – Weather or Wildlife

(c) **Category 3: Human** – Limitation of the human which in the system has the potential for causing harm

(d) **Category 4: Technical** – Aerodrome, Air Navigation, Operations, Maintenance, and Design and Manufacturing

Note: ICAO Annex 19 Edition 2 has defined hazard to be a condition or an object with the potential to cause or contribute to an aircraft incident or accident.

2.3.2 In this chapter, specific hazards have been described at a high level for each aviation sector. Additionally, SM-ICG determined that organizational, environmental, and human hazards are mostly generic, and apply to all aviation sectors at the high level. Human hazards are described as both hazards that have a direct safety effect in each aviation sector and hazards with latent effects that could later surface during aircraft manufacturing, operations and maintenance.

During the development of this document, aviation sector experts determined that specific aviation sector hazards may have descriptions of absence and/or judgmental adjectives since experience through accident/incident investigation and subsequent root cause analysis validates those types of specific hazards.

Due to the nature of the incident/accident causal chain, hazards are often described at various points in the causal chain.[1] Thus, risk mitigation strategies can also be applied at various points in the hazard causal chain. Therefore, it is important to understand this causal chain and contributing factors to identify the opportunities for potential risk mitigation options. For this reason, many of the technical category hazards are not necessarily independent and could stem from certain common organizational hazards.

For example, a runway incursion could be described as a hazard itself. However, one could also argue that the runway incursion is not the hazard, but rather the effect (consequence) of lower level

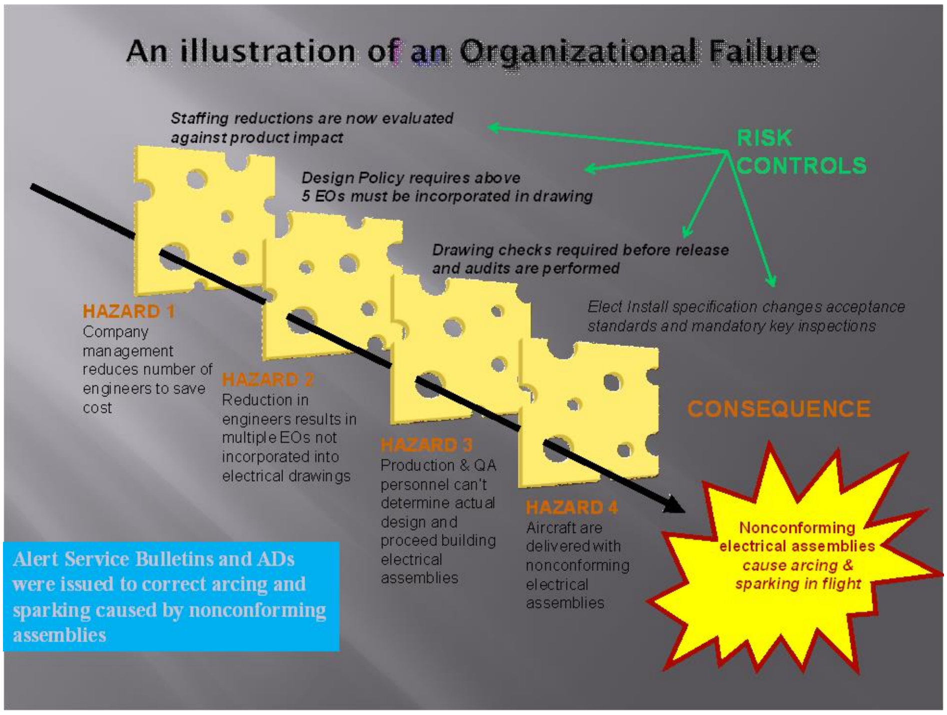
[1] Note that there are many more complex accident/incident models than the one cited here. Over the years, accident models have moved from linear cause-effect sequences to systemic descriptions of emergent phenomena (e.g., Functional Resonance Accident Model by Erik Hollnagel, which uses the principle of stochastic resonance in a system context).

hazards, such as lack of proper runway design and/or lack of runway signage.

It can further be argued that lack of proper runway design and signage is due to mismanagement stemming from an organizational hazard. Therefore, an organization should strive to develop risk controls to mitigate the runway incursion hazard risk in all hazard categories.

However, it is generally impossible to have risk mitigation strategies to address every possible point in the incident/accident causal chain, so an organization should strive to identify all hazards in its organization or activities and develop effective risk mitigation strategies for those hazards determined to have unacceptable risk.

The following illustration shows an example of this causal chain concept in the Design and Manufacturing sector:



Due to complexity in the aviation system, it would be very difficult to develop comprehensive hazard taxonomies for each aviation sector, unless all of the possible causal chains and contributing factors can be identified, described and documented, and continually updated based on potential future incidents/accidents, which is beyond the scope of this document. In addition, hazards may be different in service provider organizations based on their specific business processes.

Therefore, the specific hazard taxonomy elements in this document are only examples of some of the more basic understood hazards in each aviation sector based on expert opinion. It is anticipated that with more mature safety management processes in place, these example hazards will be developed further based on aggregate data from multiple service providers and analysis of systems under consideration to understand causal and contributing factors for interdependencies.

Finally, the aviation community has recently initiated activities to further develop a more systematic and comprehensive hazard taxonomy effort. This future development will enable the global aviation community to share and aggregate information related to hazards.

2.3.3 **Hazard Taxonomy Examples** are presented in more detail in **Appendix B.**

2.4 EM100.59 SMS Self-Evaluation Tool: Hazard Identification

2.4.1 To help service providers, self-check the maturity and effectiveness of their *Hazard Identification systems*, CASA has provided you with the below Guidance and Checklist using the PSOE acronym from guidance material developed by the Safety Management International Collaboration Group (SM-ICG) and summarized below:

Present (P)	There is evidence that the indicator is clearly visible at all levels of the organisation and is documented within the organisation's SMS manual.
Suitable (S)	There is evidence that the indicator is suitable based on the nature, size and complexity of the organisation and/or the inherent risk in the activity.
Operating (O)	There is evidence that the indicator is in use and an output is being produced
Effective (E)	There is evidence that the indicator is effective and is achieving the desired outcome
Best Practice	Organisations striving to continuously improve their SMS, <u>*may*</u> use the Best Practice indicators to achieve a higher level of safety performance.

2.4.2 Self-Evaluation Checklist for Hazard Identification (Required for CASA SMS Acceptance)

	Indicators of compliance and performance		**P**	**S**	**O**	**E**	**How it is achieved**	**Verification Evidence**
Evaluation	1.1.1	There is a confidential reporting system to capture errors, hazards, and near misses that is simple to use and accessible to all staff.						
	1.1.2	There is a confidential reporting system that provides appropriate feedback to the reporter and, where appropriate, to the rest of the organisation.						
	1.1.3	Personnel express confidence and trust in the organisation's reporting policy.						

Guidance

What to look for

- Review the reporting system for access and ease of use.
- Check staff's trust of and familiarity with the reporting system, and whether they know what should be reported.
- Review how data protection and confidentiality is achieved.
- Evidence of feedback to reporter, the organisation, and third parties.
- Assess volume and quality of reports, including whether personnel are reporting their own errors and mistakes.
- Review report closure rates.
- Check whether contracted organizations and customers are able to make reports.
- Review how reports in the system are analysed.
- Confirm that responsibilities with regards to occurrence analysis, storage, and follow-up are clearly defined.
- Check that relevant staff are aware of which occurrences should be mandatory.
- Assess how senior management engage with the outputs of the reporting system.

Present	**Suitable**	**Operating**	**Effective**
There is a confidential reporting system to capture mandatory occurrences and voluntary reports that includes a feedback system and stored on a database. The process identifies how reports are actioned, and timescales are specified and addressed.	The reporting system is accessible and easy to use by all personnel. Responsibilities, timelines, and format for the feedback are meaningful and well defined. Data protection and confidentiality is ensured.	The reporting system is being used by all personnel. There is feedback to the reporter of any actions taken (or not taken) and, where appropriate, to the rest of the organisation. Reports are evaluated, processed, analysed, and stored. Staff are aware of and fulfil their responsibilities in respect to the reporting system. Reports are processed within the defined timescales.	There is a healthy reporting system based on the volume of reporting and the quality of reports received. Safety reports are acted on in a timely manner. Personnel express confidence and trust in the organisations' reporting policy and process. The reporting system is being used to make better management decisions and continuously improve. The reporting system is available for third parties to report (partners, suppliers, and contractors).

E	**Indicators of compliance and performance**	**P**	**S**	**O**	**E**	**How it is achieved**	**Verification Evidence**

Indicators of compliance and performance		P	S	O	E	How it is achieved	Verification Evidence
1.1.4	There is a process that defines how hazards are identified from multiple sources through reactive and proactive methods (internal and external).						
1.1.5	The hazard identification process identifies human performance related hazards.						
1.1.6	There is a process in place to analyse safety data and safety information to look for trends and gain useable management information.						
1.1.7	Safety investigations are carried out by appropriately trained personnel to identify root causes (why it happened, not just what happened).						

What to look for

- Review how hazards are identified, analysed, addressed, and recorded.
- Review structure and layout of hazard log.
- Consider hazards related to:
  - Possible accident scenarios;
  - Human and organisational factors;
  - Business decisions and processes;
  - Third party organisations; and
  - Regulatory factors.
- Review what internal and external sources of hazards are considered such as safety reports, audits, safety surveys, investigations, inspections, brainstorming, management of change activities, commercial and other external influences, etc.
- Review whether safety investigations identify human and organisational contributing factors.

Present	Suitable	Operating	Effective
There is a process that defines how hazards are identified though reactive and proactive methods. The triggers for safety investigations are identified.	Multiple sources of hazards (internal and external) are considered and reviewed, as appropriate. The data analysis process enables gaining useable safety information. Hazards are documented in an easy-to-understand format. The level of sign-off for safety investigations is defined and adequate to the level of risk.	The hazards are identified and documented. Human and organisational factors related to hazards are being identified. Safety investigations are carried out and recorded.	The organisation has a register of the hazards that is maintained and reviewed to ensure it remains up-to-date. It is continuously and proactively identifying hazards related to its activities and the operational environment and involves all key personnel and appropriate stakeholders including external organisations. Hazards are continuously assessed in a systematic and timely manner. Safety investigations identify causal/contributing factors that are acted upon.

3. EM100.61 SAFETY RISK ASSESSMENT AND MITIGATION

3.1 EM100.61 Safety Risk Analysis

3.1.1 ***Safety Risk Probability:*** Safety risk probability is the likelihood that a safety consequence or outcome will occur. It is important to envisage a variety of scenarios so that all potential consequences can be considered.

The following questions can assist in the determination of probability:

(a) Is there a history of occurrences similar to the one under consideration, or is this an isolated occurrence

(b) What other equipment or components of the same type might have similar issues?

(c) What is the number of personnel following, or subject to, the procedures in question?

(d) What is the exposure of the hazard under consideration? For example, during what percentage of the operation is the equipment or activity in use?

Taking into consideration any factors that might underlie these questions will help when assessing the probability of the hazard consequences in any foreseeable scenario.

An occurrence is considered foreseeable if any reasonable person could have expected the kind of occurrence to have happened under the same circumstances. Identification of every conceivable or theoretically possible hazard is not possible. Therefore, good judgment is required to determine an appropriate level of detail in hazard identification. Service providers should exercise due diligence when identifying significant and reasonably foreseeable hazards related to their product or service.

Table 1 below presents a typical safety risk probability classification table. It includes five categories to denote the probability related to an unsafe event or condition, the description of each category, and an assignment of a value to each category. This example uses qualitative terms; quantitative terms could be defined to provide a more accurate assessment. This will depend on the availability of appropriate safety data and the sophistication of the organization and operation.

Table 1. Safety risk probability table

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 the event will occur	1

Note.— This is an example only. The level of detail and complexity of tables and matrices should be adapted to the particular needs and complexities of each organization. It should also be noted that organizations might include both qualitative and quantitative criteria.

3.1.2 ***Safety Risk Severity:*** Once the probability assessment has been completed, the next step is to assess the severity, taking into account the potential consequences related to the hazard. Safety risk severity is defined as the extent of harm that might reasonably be expected to occur as a consequence or outcome of the identified hazard.

The **severity classification** should consider:

(a) fatalities or serious injury which would occur as a result of:

(1) being in the aircraft;
(2) having direct contact with any part of the aircraft, including parts which have become detached from the aircraft; or
(3) having direct exposure to jet blast; and

(b) damage:

(1) damage or structural failure sustained by the aircraft which:

i. adversely affects the structural strength, performance or flight characteristics of the aircraft;
ii. would normally require major repair or replacement of the affected component;

(2) damage sustained by ATS or aerodrome equipment which:

i. adversely affects the management of aircraft separation; or
ii. adversely affects landing capability.

The severity assessment should consider all possible consequences related to a hazard, taking into account the worst foreseeable situation.

Table 2 presents a typical safety risk severity table. It includes five categories to denote the level of severity, the description of each category, and the assignment of a value to each category. As with the safety risk probability table, this table is an example only.

Table 2. Example safety risk severity table

Severity	*Meaning*	*Value*
Catastrophic	• Aircraft / equipment destroyed • Multiple deaths	A
Hazardous	• A large reduction in safety margins, physical distress or a workload such that operational personnel cannot be relied upon to perform their tasks accurately or completely • Serious injury • Major equipment damage	B
Major	• A significant reduction in safety margins, a reduction in the ability of operational personnel 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	C
Minor	• Nuisance • Operating limitations • Use of emergency procedures • Minor incident	D
Negligible	• Few consequences	E

3.1.3 ***Safety Risk Tolerability:*** The safety risk index rating is created by combining the results of the probability and severity scores. In the example above, it is an alphanumeric designator. The respective severity/probability combinations are presented in the safety risk assessment matrix in Table 3. The safety risk assessment matrix is used to determine safety risk tolerability.

Consider, for example, a situation where the safety risk probability has been assessed as Occasional (4), and the safety risk severity has been assessed as Hazardous (B), resulting in a safety risk index of (4B).

Table 3. Example safety risk matrix

Safety Risk		*Severity*				
Probability		*Catastrophic A*	*Hazardous B*	*Major C*	*Minor D*	*Negligible E*
Frequent	5	5A	5B	5C	5D	5E
Occasional	4	4A	4B	4C	4D	4E
Remote	3	3A	3B	3C	3D	3E
Improbable	2	2A	2B	2C	2D	2E
Extremely improbable	1	1A	1B	1C	1D	1E

Note.— In determining the safety risk tolerability, the quality and reliability of the data used for the hazard identification and safety risk probability should be taken into consideration.

3.1.3 The index obtained from the safety risk assessment matrix should then be exported to a safety risk tolerability table that describes — in a narrative form — the tolerability criteria for the particular organization.

Table 4 presents an example of a safety risk tolerability table. Using the example above, the criterion for safety risk assessed as 4B falls in the “intolerable” category. In this case, the safety risk index of the consequence is unacceptable.

The organization should therefore take risk control action to reduce:

(a) the organization’s exposure to the particular risk, i.e., reduce the probability component of the risk to an acceptable level;

(b) the severity of consequences related to the hazard, i.e., reduce the severity component of the risk to an acceptable level; or

(c) both the severity and probability so that the risk is managed to an acceptable level.

Safety risks are conceptually assessed as acceptable, tolerable or intolerable. Safety risks assessed as initially falling in the intolerable region are unacceptable under any circumstances. The probability and/or severity 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.

Table 4. Example of safety risk tolerability

Safety Risk Index Range	*Safety Risk Description*	*Recommended Action*
5A, 5B, 5C, 4A, 4B, 3A	INTOLERABLE	Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventative controls are in place to bring down the safety risk index to tolerable.
5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	TOLERABLE	Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
3E, 2D, 2E, 1B, 1C, 1D, 1E	ACCEPTABLE	Acceptable as is. No further safety risk mitigation required.

3.2 EM100.61 Assessing Human Factors related Risks

3.2.1 The consideration of human factors has particular importance in SRM as people can be both a source and a solution of safety risks by:

(a) contributing to an accident or incident through variable performance due to human limitations;

(b) anticipating and taking appropriate actions to avoid a hazardous situation: and

(c) solving problems, making decisions and taking actions to mitigate risks.

3.2.2 It is therefore important to involve people with appropriate human factors expertise in the identification, assessment and mitigation of risks.

SRM requires all aspects of safety risk to be addressed, including those related to humans. Assessing the risks associated with human performance is more complex than risk factors associated with technology and environment since:

(a) 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; and

(b) the consequences of variable human performance will differ according to the task being performed and the context.

This complicates how the probability and the severity of the risk is determined. Therefore, human factors expertise is valuable in the identification and assessment of safety risks. (The management of fatigue using SMS processes is addressed in the *Manual for the Oversight of Fatigue Management Approaches* (Doc 9966)).

3.3 EM100.61 Safety Risk Mitigation Strategies

3.3.1 Safety risk mitigation is often referred to as a safety risk control. Safety risks should be managed to an acceptable level by mitigating the safety risk through the application of appropriate safety risk controls.

This should be balanced against the time, cost and difficulty of taking action to reduce or eliminate the safety risk.

The level of safety risk can be lowered by reducing the severity of the potential consequences, reducing the likelihood of occurrence or by reducing exposure to that safety risk. It is easier and more common to reduce the likelihood than it is to reduce the severity.

3.3.2 Safety risk mitigations are actions that often result in changes to operating procedures, equipment or infrastructure.

Safety risk mitigation strategies fall into three categories:

(a) ***Avoidance*:** The operation or activity is cancelled or avoided because the safety risk exceeds the benefits of continuing the activity, thereby eliminating the safety risk entirely.

(b) ***Reduction*:** The frequency of the operation or activity is reduced, or action is taken to reduce the magnitude of the consequences of the safety risk.

(c) ***Segregation*:** Action is taken to isolate the effects of the consequences of the safety risk or build in redundancy to protect against them.

3.3.3 The consideration of human factors is an integral part of identifying effective mitigations because humans are required to apply, or contribute to, the mitigation or corrective actions. For example, mitigations may include the use of processes or procedures. Without input from those who will be using these in “real world” situations and/or individuals with human factors expertise, the processes or procedures developed may not be fit for their purpose and result in unintended consequences. Further, human performance limitations should be considered as part of any safety risk mitigation, building in error capturing strategies to address human performance variability. Ultimately, this important human factors perspective results in more comprehensive and effective mitigations.

3.3.4 A safety risk mitigation strategy may involve one of the approaches described above or may include multiple approaches. It is important to consider the full range of possible control measures to find an optimal solution.

The effectiveness of each alternative strategy must be evaluated before a decision is made. Each proposed safety risk mitigation alternative should be examined from the following perspectives:

(a) ***Effectiveness*.** The extent to which the alternatives reduce or eliminate the safety risks. Effectiveness can be determined in terms of the technical, training and regulatory defences that can reduce or eliminate safety risks.

(b) ***Cost/benefit*.** The extent to which the perceived benefits of the mitigation outweighs the costs.

(c) ***Practicality*.** The extent to which mitigation can be implemented and how appropriate it is in terms of available technology, financial and administrative resources, legislation, political will, operational realities, etc.

(d) ***Acceptability*.** The extent to which the alternative is acceptable to those people that will be expected to apply it.

(e) ***Enforceability***. The extent to which compliance with new rules, regulations or operating procedures can be monitored.

(f) ***Durability***. The extent to which the mitigation will be sustainable and effective.

(g) ***Residual safety risks*.** The degree of safety risk that remains subsequent to the implementation of the initial mitigation and which may necessitate additional safety risk control measures.

(h) ***Unintended consequences*.** The introduction of new hazards and related safety risks associated with the implementation of any mitigation alternative.

(i) ***Time*.** Time required for the implementation of the safety risk mitigation alternative.

3.3.5 Corrective action should take into account any existing defences and their (in)ability to achieve an acceptable level of safety risk. This may result in a review of previous safety risk assessments that may have been impacted by the corrective action. Safety risk mitigations and controls will need to be verified/audited to ensure that they are effective.

Another way to monitor the effectiveness of mitigations is through the use of SPIs. Further guidance on SPIs are provided in PNG AC 100-1C.

3.4 EM100.61 Safety Risk Management Documentation

3.4.1 Safety risk management activities should be documented, including any assumptions underlying the probability and severity assessment, decisions made, and any safety risk mitigation actions taken. This may be done using a spread sheet or table. Some organizations may use a database or other software where large amounts of safety data and safety information can be stored and analysed.

3.4.2 ***Hazard Register:*** Maintaining a register of identified hazards minimizes the likelihood that the organization will lose sight of its known hazards. When hazards are identified, they can be compared with the known hazards in the register to see if the hazard has already been registered, and what action(s) were taken to mitigate it. Hazard registers are usually in a table format and typically include: the hazard, potential consequences, assessment of associated risks, identification date, hazard category, short description, when or where it applies, who identified it and what measure have been put in place to mitigate the risks.

3.4.3 Safety risk decision-making tools and processes can be used to improve the repeatability and justification of decisions taken by organizational safety decision makers. An example of a safety risk decision aid is provided below in Figure 2-6.

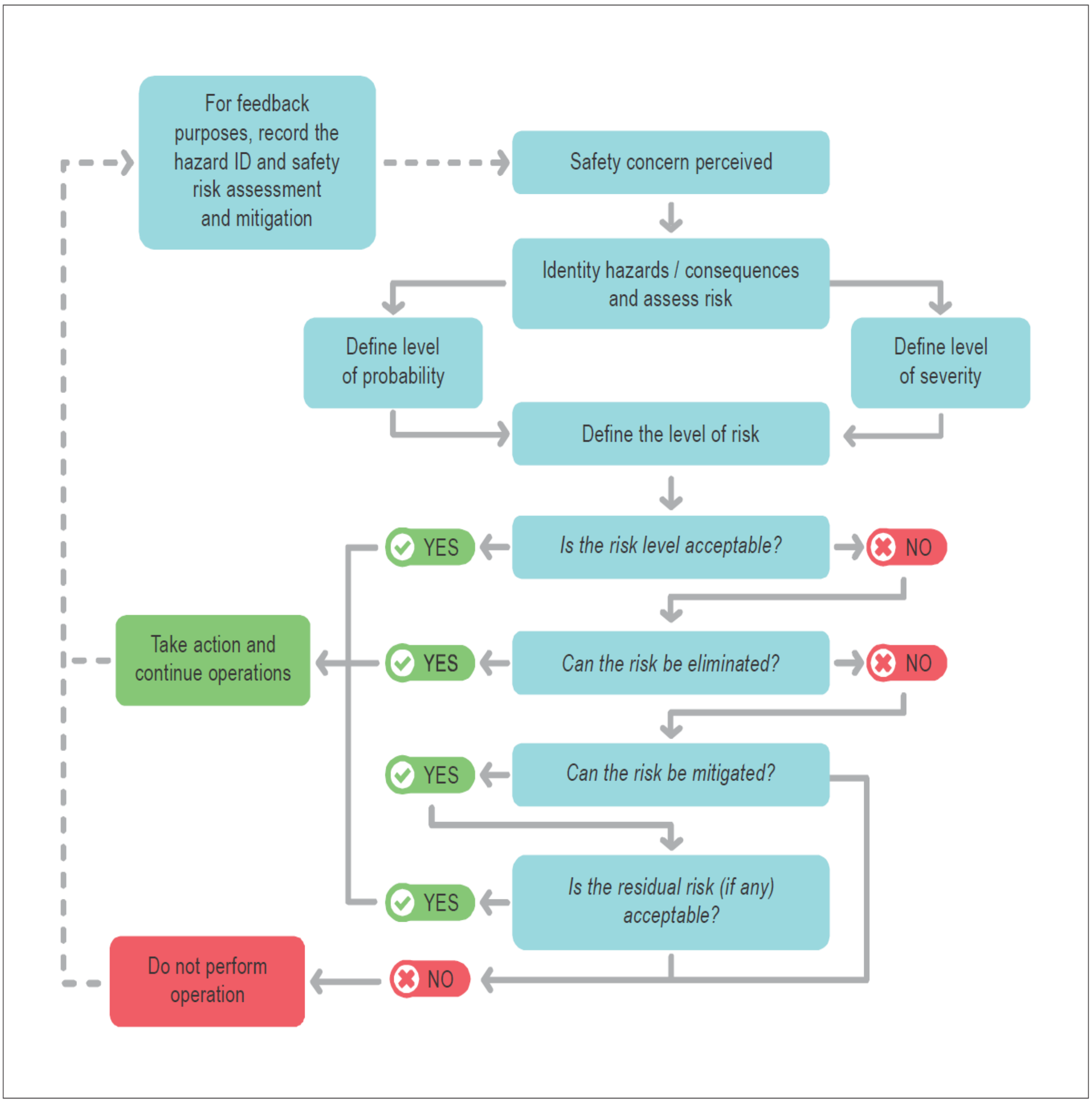


Figure 2-6. Safety risk management decision aid

3.5 EM100.61 Cost-Benefit Analysis

3.5.1 Cost-benefit or cost-effectiveness analysis is normally carried out during the safety risk mitigation activities. It is commonly associated with business management, such as a regulatory impact assessment or project management processes.

However, there may be situations where a safety risk assessment may have a significant financial impact. In such situations, a supplementary cost-benefit analysis or cost-effectiveness process to support the safety risk assessment may be warranted.

This will ensure cost-effectiveness analysis or justification of recommended safety risk control actions has been taken into consideration, with the associated financial implications.

APPENDIX A – SAMPLE SAFETY RISK ASSESSMENT TEMPLATE

CASA PNG Risk Assessment & Change Management (RACM) ***(PNG rule reference : CAR 100.59, 100.61, 100. 65)***	**Date Initial Assement:** 22 August 20XX **Date of Review:**	**RACM No:**

Applicability: ☒ All Personnel ☐ Aircrew ☐ Engineering ☐ Ground Operations ☐ Cargo ☐ Cabin Crew ☐ Other ____________

Project: Title

Work Location:

Task Description:

Risk Rating Calculator Tool

Likelihood	Severity: A. Catastrophic	B. Major	C. Moderate	D. Minor	E. Negligible
5. Almost Certain	Extreme	Extreme	Extreme	High	High
4. Likely	Extreme	Extreme	High	Medium	Medium
3. Possible	Extreme	High	High	Medium	Low
2. Unlikely	High	High	Medium	Low	Low
1. Rare	Medium	Medium	Low	Low	Low

Definitions

Likelihood:
- **Rare** – Extremely Improbable / Nil Events
- **Unlikely** – Improbable / Few events
- **Possible** – Remote
- **Likely** – Occasional / Regular recorded incidents
- **Almost Certain** – Frequent / Almost certain incident

Severity:
- **Negligible** – minor injury
- **Minor** – Serious injury
- **Moderate** – multiple injuries
- **Major** – Hazardous / Disabling injury or death
- **Catastrophic** – Multiple disabling injuries or deaths

Risk Score
- **Low** – Acceptable – monitoring only
- **Medium** – Acceptable based on Risk Mitigation
- **High** – Tolerable for limited period only (requiring risk mitigation)
- **Extreme** – Unacceptable under existing conditions

☒**NOT Applicable**

ASK

In case of injury is a member of the team First Aid Qualified? ☐YES ☐NO
Am I Fit and ready for the task? ☐YES ☐NO
Are ambient conditions suitable? ☐YES ☐NO
What Communications are required? ____________________

☒**NOT Applicable**

Check Location of:
☐Fire extinguisher
☐ Exits
☐Emergency Contact Numbers

☒**NOT Applicable**

Check PPE
☐gloves ☐goggles/visors
☐ear plugs ☐safety helmets
☐respirators ☐safety boots
clothing_______ other_________

Developed By:

1			
2			

1			
2			
3			

Approved By:

1			
2			
3			

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No.	Work Activity *List the Basic steps required to carry out the task*	Hazard / Risk *Identify and list the hazards that are possible in each step*	Risk Rating	Changes required to Mitigate Risk to 'Low' *List the actions or changes required to eliminate or reduce the hazards*	New Risk Rating	Action By	Status
1	uninstalled switch with exposed electrical in Part 145 Hangar	staff may get electrocuted	5A	1. Licensed Electrician to install proper electrical switch	1E	145 AMO - Chief Engineer	
2							
3							

APPENDIX B – HAZARD TAXONOMY EXAMPLES

BACKGROUND

In 2010, the SM ICG published *Development of a Common Taxonomy for Hazards*, which proposed a process for the development of a common taxonomy for hazards related to civil aviation. That document provided the rationale for developing a hazard taxonomy, proposed general definitions of a hazard, and also proposed a near term and far term approach to developing a taxonomy and categorizing hazards. However, since the publication of that document ICAO had defined hazard in Annex 19 Edition 2 and ICAO Common Taxonomy Team (CICTT) has accepted the high level hazard categories established by SM ICG. Thus, this document supersedes the SM ICG “Development of a common Taxonomy for Hazards” document.

In coordination with the CICTT, the following four(4) high level hazard taxonomy categories have been established:

- **Category 1**: **Organizational** – Management or documentation, processes and procedures
- **Category 2: Environmental** – Weather or Wildlife
- **Category 3: Human** – Limitation of the human which in the system has the potential for causing harm
- **Category 4: Technical** – Aerodrome, Air Navigation, Operations, Maintenance, and Design and Manufacturing

Note: ICAO Annex 19 Edition 2 has defined hazard to be a condition or an object with the potential to cause or contribute to an aircraft incident or accident.

Due to complexity in the aviation system, it would be very difficult to develop comprehensive hazard taxonomies for each aviation sector, unless all of the possible causal chains and contributing factors can be identified, described and documented, and continually updated based on potential future incidents/accidents, which is beyond the scope of this document. In addition, hazards may be different in service provider organizations based on their specific business processes. Therefore, the specific hazard taxonomy elements in this document are only examples of some of the more basic understood hazards in each aviation sector based on expert opinion. It is anticipated that with more mature safety management processes in place, these example hazards will be developed further based on aggregate data from multiple service providers and analysis of systems under consideration to understand causal and contributing factors for interdependencies.

Finally, the aviation community has recently initiated activities to further develop a more systematic and comprehensive hazard taxonomy effort. This future development will enable the global aviation community to share and aggregate information related to hazards.

HAZARD TAXONOMY EXAMPLES[2]

CATEGORY 1: ORGANISATIONAL

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
Aerodrome, Air Navigation Service Provider, Air Operation, Maintenance Organization, Design & Manufacturing Organization	Regulator	Lack of, poor or ineffective legislation and/or regulations
		Lack of or ineffective accident investigation capability
		Inadequate oversight capability
	Management	Limited or lack of management commitment – Management do not demonstrate support for the activity
		Lack of or incomplete description of roles, accountabilities and responsibilities
		Limited or lack of resource availability or planning, including staffing
		Lack of or ineffective policies
		Incorrect or incomplete procedures including instructions
		Lack of or poor management and labor relationships
		Lack of or ineffective organizational structure
		Poor organizational safety culture
		Lack of or ineffective safety management processes (including risk management, safety assurance, auditing, training and resource allocation)
		Lack or ineffective audit procedures
		Lack of or limited resource allocation
Aerodrome, Air Navigation Service Provider, Air Operation, Maintenance Organization, Design & Manufacturing Organization (continued)	Management (continued)	Incorrect or incomplete or lack of training and knowledge transfer. *Note: Training should reflect the needs of the organization. Accidents have shown that inadequate training is a hazard and may lead to accidents.*
		Unofficial organizational structures *Note: These structures may be of a benefit but also may lead to a hazard.*
		Growth, strikes, recession or organizational financial distress
		Mergers or acquisition
		Changes, upgrades or new tools, equipment, processes or facilities
		Incorrect or ineffective shift/crew member change over procedures
		Changes or turnover in management or employees
		Informal processes (Standard Operating Procedures)

[2] Security issues can certainly effect safety; however, the SM ICG has intentionally left out potential security hazards since this group does not possess the expertise to address this topic.

CATEGORY 1: ORGANISATIONAL

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Lack of or poor or inappropriate materials/equipment acquisition decisions
		Lack of, poor staffing recruitment/assignment *Note: Staff should be hired or assigned according to organizational needs but also according to their skills, qualifications and abilities. An employee with the wrong skill set can be a hazard. This includes management.*
	Documentation, Processes and Procedures	Incorrect, poor or lack of internal and external communication including language barriers
		Lack of, incorrect or incomplete manuals, or operating procedures (including maintenance)
		Lack of, incorrect or incomplete employee duty descriptions
		Lack of, incorrect, incomplete or complicated document update processes
		Lack of, incorrect or incomplete reports and records
		Lack of, incorrect or incomplete control of necessary documents for personnel (licenses, ratings, and certificates)

CATEGORY 2 - ENVIRONMENTAL

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
Aerodrome, Air Navigation Service Provider, Air Operation, Maintenance Organization (Effects may not be all encompassing)	Weather/Natural Disasters	Thunderstorms and lightning
		Hail
		Heavy rain
		Fog (reduced visibility)
		Wind shear
		Sand storm
		Snow or ice storms
		Excessive or cross winds
		Hurricane, Tsunami, or tornado
		Floods
		Ash (including volcanic or forest fire)
		Earthquake
		Extreme temperatures
		Icing conditions (Impact on aircraft surfaces)
	Geography	Mountains or bodies of water
		Altitude at the aerodrome
	Wildlife	Wildlife on airfield
		Flying wildlife

*CATEGORY 3 - HUMAN**

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
Aerodrome, Air Navigation Service Provider, Air Operation, Maintenance Organization, Design & Manufacturing Organization	Sudden Incapacitation	Heart attack, Stroke, Kidney stone, Seizure
	Subtle Incapacitation/ Impairment	Nausea, Diarrhea, Carbon monoxide, Medication, Fatigue
	Illness	Influenza, Upper Respiratory Tract Infection (TI), Urinary TI
	Static Limitations	Color vision, Visual field limitations, Mobility limitations, Colostomy bag, Hearing loss
	Self-Imposed Stresses	Fatigue (lack of sleep), Alcohol and substance abuse, Medications, Complacency
Aerodrome	Psycho-Social Stresses	Financial, Birth of child, Divorce, Bereavement, Challenging timelines, Inadequate resources

***CATEGORY 3 - HUMAN**

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
Air Navigation Service Provide, Air Operation, Maintenance Organization, Design & Manufacturing Organization (continued)	Trauma	Inflight turbulence cabin crew injury, injury caused to personnel during ground aircraft operations or luggage handling
	Environmental/ Occupational	Jet lag, Paint shop, Solvents, Chemical/Biological exposures, Noise, Vibrations, Distractions
	Latent Failures Related to Man/ Machine/ Process Interface	Human factors related to design, manufacturing, maintenance and operations.
	Cognitive Capacity	Excessive number of aircraft in a controller's area; Varying multi-tasking actions; Over saturation of digital information

CATEGORY 4 TECHNICAL - AERODROME

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
Aerodrome	Runway Operations	Construction, vehicles and people on movement area
		Poor aerodrome design (Intersecting runways; Obstacle clearance; Taxiway crossing runways)
		Distracting lights
		Lack of coordination with Air Traffic Control (ATC)
		Improper, inadequate, or lack of Notices to Airmen (NOTAMs) issuance
		Laser beams
	Runway Condition	Poor condition or improper runway surface
		Inadequate runway length
		Lack of, or inadequate runway protected areas
Aerodrome (continued)	Airfield Apron Operation Airfield Apron Operation (continued)	Jet blast
		Lack of, limited or incorrect type of aircraft parking
		Improper marshaling
		Lack of, or insufficient protective pylons around aircraft
		Lack of, or inadequate chalks when aircraft parks
		Lack of, or improper foreign object debris (FOD) control
		Lack of, or improper ramp control tie down procedures
		Improper fuel or hazardous material spill containment and cleanup

CATEGORY 4 TECHNICAL - AERODROME

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Poor refueling procedures
	Airside Vehicle Operations	Vehicle failure during aerodrome services
		Poor mechanical condition
		Poor radio or communication equipment condition
		Oil spills on apron and/or in passenger areas
		Lack of vehicle maintenance
		Poor Emergency Reponses Planning
		Erratic driving or not complying with flight line driving regulations
		Driving too fast
		Improper parking
		Failure to chalk vehicles
		Leaving engine running while vehicle is unattended
		Lack of coordination between vehicles during aircraft servicing
	Action of Individuals	Pedestrians on apron areas
		Ignoring aircraft hazard beacons
		Improper checking around aircraft during departure marshaling
		Misinterpreting apron markings
		Smoking on the apron
		Passenger failure to follow guidance
Aerodrome (continued)	Action of Individuals (continued)	Use of cell phone within 15 meters of a refueling operation
		Littering on ramp
		Running on apron
	Facilities	Faulty electrical power supply systems on airport or navigational aids (radars, satellites, very high frequency (VHF) omni-directional radio range (VOR), Automatic Dependent Surveillance - Broadcast (ADS-B), etc.)
		Faulty, incorrect or incomplete airfield markings (especially in movement areas)
		Faulty, incorrect, or incomplete airfield lighting (especially in movement areas)
		Faulty, incorrect, or incomplete approach lighting
		Poor condition or inappropriate runway surface
		Poor condition or inappropriate apron surface
		Taxiway and runway system complexity
		Inadequate airfield or terrain drainage
		Insufficient equipment, radios, infrastructure, or personnel

CATEGORY 4 TECHNICAL - AERODROME

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Issues that attract wildlife (high grass, proximity of landfills, nearby water bodies)
		Inadequate or inappropriate firefighting equipment
		Lack of or limited parking areas
		Lack of safety protective equipment

CATEGORY 4 TECHNICAL – AIR NAVIGATION SERVICE PROVIDER (ANSP)

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
ANSP	Traffic Pattern	Traffic complexity (mixture of aircraft type)
		Excessive aircraft in pattern or given airspace
		Ineffective design and flow of traffic pattern
		Runway incursions by aircraft or vehicles
		Unauthorized flights entering into traffic pattern
		Unauthorized procedures by aircraft
		Similar sounding or confusing call signs
		Lack of or poor procedures for aircraft in distress.
	Airspace	Insufficient airspace for typical traffic
		Improperly distributed airspace
		Airspace combined during excessive traffic
		Confusing labeling of fixes or way points
		Improperly developed instrument procedures
		Aircraft incorrectly performing missed approach procedures
		Intermingling of ICAO and national instrument procedure criteria
	Controller Actions	Incomplete clearances
		Misidentification of aircraft or targets (radar)
		Improper reading of clearance instructions
		Loss of separation between aircraft
		Loss of separation between aircraft and terrain or obstacles
		Misinterpretation of pilot desires
		Incorrect judgment of aircraft characteristics
	Communications	Incorrect, confusing, or incomplete communications between ATC and aerodrome personnel
		Incorrect, confusing, or incomplete communications between ATC and aircraft
		Incorrect, confusing, or incomplete coordination between or within ATC facilities

CATEGORY 4 TECHNICAL – AIR NAVIGATION SERVICE PROVIDER (ANSP)

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Radio/Frequency failures or anomalies
		Navigational aid (radars, satellites, VOR, ADS-B, etc) failures or anomalies
ANSP (continued)	Communications (continued)	Differences in ICAO and national Air Traffic Control phraseology
		Not using the standard international aviation language
		Language barriers (Multiple languages)
		Lack of, or wrong aeronautical information
	Facilities	Faulty electrical power supply systems on airport or navigational aids (radars, satellites, VOR, ADS-B, etc)
		Faulty, incorrect or incomplete airfield markings or lighting
		Faulty, incorrect, or incomplete approach lighting
		Taxiway and runway system complexity
		Inadequate airfield or terrain drainage
		Insufficient equipment, radios, infrastructure, or personnel

CATEGORY 4 TECHNICAL – AIR OPERATION AND MAINTENANCE

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
Air Operation	Facilities	Faulty electrical power supply systems on airport or navigational aids (radars, satellites, VOR, ADS-B, etc)
		Faulty, incorrect or incomplete airfield markings and lighting
		Faulty, incorrect, or incomplete approach lighting
		Taxiway and runway system complexity
		Inadequate airfield drainage
		Insufficient equipment, radios, infrastructure, or personnel
		Lack of, limited or incorrect type of aircraft parking
		Poor HVAC (heating, ventilation, and air conditioning)
		Noisy environment
		Lack of or poor Lighting
		Poor facilities (inadequate space)
	Preflight Preparation	Lack of or poor airworthiness verification
		Lack of or poor verification of equipment and instruments necessary to a particular flight or operation
Air Operation (continued)	Preflight Preparation (continued)	Lack of, incorrect or incomplete aircraft performance limitations verification
		Lack of, incorrect or incomplete flight planning
		Poor fueling processes

CATEGORY 4 TECHNICAL – AIR OPERATION AND MAINTENANCE

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Lack of or poor aircraft dispatch or release
		Lack of or poor maintenance release
	Aircraft Loading	Incorrect cargo loading and distribution
		Improper or unauthorized hazardous materials carriage
		Poor cargo and baggage stowage
		Incorrect information on cargo or baggage loaded
		Improper stowage of carry-on baggage
		Improper weight and balance calculations
	Flight Operation	Use of obsolete documents
		Absence of or incorrect flight and cabin crew manuals or charts on board
		Improper response to flight route changes
		Lack of, or poor crew resource management
		Lack of or poor flight following
		Improper execution of procedures in all flight phases (including taxiing and parking)
		Inadequate or complicated procedures
		Equipment and instruments necessary for a particular flight or operation not available or malfunctioning
		Lack of, or poor communication (ATC, ramp, maintenance, flight Ops, cabin, dispatch, etc)
		Language barriers (Multiple languages)
Maintenance	Facilities	Poor HVAC (heating, ventilation, and air conditioning)
		Noisy work environment
		Lack of, or poor Lighting
		Poor facilities (inadequate space, equipment or infrastructure)
	Maintenance Activity	Lack of, or poor maintenance release
		Lack of, or poor maintenance programs (Including imprecise maintenance data or transcription errors when creating job-cards)
Maintenance (continued)	Maintenance activity (continued)	SUPS (Suspected Unapproved Parts)
		Maintenance movement of aircraft/run-ups
		Lack of, or poor communication (ATC, ramp, flight Ops, cabin, dispatch, etc)
		Language barriers in maintenance teams (Multiple languages)
		Poor control of outsourced maintenance (any maintenance completed outside the maintenance facility or organization including third party maintenance)
		Lack of or, inappropriate specialized processes (including NDT, plating, welding, composite repairs etc…)
		Lack of or, improper Airworthiness Directive Control

CATEGORY 4 TECHNICAL – AIR OPERATION AND MAINTENANCE

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Ineffective or lack of procedures to ensure materials, parts, or assemblies are worked or fabricated through a series of precisely controlled steps, and that undergo physical, chemical, or metallurgical transformation (some examples are heat-treating, brazing, welding, and processing of composite materials).
		Lack of or, inadequate reliability program
	Tooling	Lack of, or poor tool accountability (Including traceability or registration)
		Lack of or unsafe or unreliable equipment, tools, and safety equipment;
		Inappropriate layout of controls or displays
		Mis-calibrated tools
		Inappropriate or incorrect use of tools for the task
		Lack of, or inadequate instructions for equipment, tools, and safety equipment
	Maintainability	Complex design (Difficult fault isolation, multiple similar connections, etc)
		Inaccessible component/area
		Aircraft configuration variability (Similar parts on different models)

CATEGORY 4 TECHNICAL DESIGN – DESIGN AND MANUFACTURING

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
Aircraft Design	Safety Requirements Capture	Noncompliance with applicable regulations (For example FAA 14 CFR part 23, 25, 27, 29, 33).
		Inadequate Functional Hazard Assessment.
		Inadequate structural static and dynamic loads analysis.
		Inadequate Preliminary System Safety Assessment.
		Inadequate common cause analysis.
	Safety Requirements Validation	Incomplete or ineffective design reviews, analysis, simulator, wind tunnel, and flight testing.
		Ineffective or incomplete structural external, internal, and elemental loads analysis.
	Safety Requirement Verification	Incomplete structures loads verification, such as static load tests, ground vibration tests, and flight tests.
		Inadequate System Safety Assessments (SSA) process including lack of, or improper verifying of, failure effects using failure performance testing.
		Inadequate verification of software and complex hardware
	Aircraft Integration	Inadequate requirements traceability.
		Inadequate design requirements control.

CATEGORY 4 TECHNICAL DESIGN – DESIGN AND MANUFACTURING

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Inadequate verification of system/system and system/structure unintended functions and physical interference, such as lack of Bench/Sim/Airplane Testing and inadequate zonal inspections
	Continued Operational Safety	Ineffective in-service monitoring methods such as lack of failure reporting and tracking.
		Inadequate or no root cause analysis, risk analysis, corrective action development, corrective action validation, and incorporation of corrective action and lessons learned into Design Process
	Design Control	Lack of methods for approving, controlling, and documenting initial designs and design changes.
		Inadequate planning and integration of the facility's procedures for continuously maintaining the integrity of design data, drawings, part lists, and specifications necessary to define the configuration and the design features of the product.
Aircraft Manufacturing	Manufacturing Processes	Lack of processes for the control of materials, parts, or assemblies, how they are accepted, worked or fabricated, tested, inspected, stored, and prepared for shipment.
Aircraft Manufacturing (continued)	Manufacturing Processes (continued)	Problems with special manufacturing processes and specific functions and operations necessary for the fabrication and inspection of parts and assemblies (some examples are machining, riveting, and assembling).
		Ineffective or lack of procedures to ensure materials, parts, or assemblies are worked or fabricated through a series of precisely controlled steps, and that undergo physical, chemical, or metallurgical transformation (some examples are heat-treating, brazing, welding, and processing of composite materials).
		Inadequate methods used to accept and protect raw materials, parts, subassemblies, assemblies, and completed products during receipt, manufacture, inspection, test, storage, and preparation for shipment.
		Inadequate Airworthiness Determination, which is the function that provides for evaluation of completed products/parts thereof, and related documentation, to determine conformity to approved design data and their condition for safe operation.
	Manufacturing Controls	Ineffective methods that are used by the Production Approval Holder to control product quality by statistical methods, and that may be used for continuous improvement and/or product acceptance. Statistical Quality Control includes techniques such as statistical sampling, PRE-control, and statistical process control.
		Ineffective control of precision measuring devices (for example, tools, scales, gauges, fixtures, instruments, and automated measuring machines) used in fabrication, special processing, inspection, test of detail parts, assemblies, and completed products to determine conformity to approved design.
		Lack of functions that provide for static, destructive, and functional tests of production products/parts thereof to ensure conformity to approved design.

CATEGORY 4 TECHNICAL DESIGN – DESIGN AND MANUFACTURING

Type of operation	Type of activity/ infrastructure/ system	Examples of Hazards
		Ineffective methods of controlling, evaluating, and dispositioning of any product/part thereof that does not conform to approved design.
	Supplier Control	Ineffective methods by which the production facility ensures supplier materials, parts, and services conform to approved design. The term “supplier” includes distributors.

APPENDIX C – SAMPLE RISK REGISTER

Risk register example

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