Advancing safety in organizations - guidance and supporting material

S.H. Stroeve, J. Smeltink (NLR), B. Kirwan (ECTL)

Short abstract: Future Sky Safety is a Joint Research Programme (JRP) on Safety, initiated by EREA, the association of European Research Establishments in Aeronautics. The Programme contains two streams of activities: 1) coordination of the safety research programmes of the EREA institutes and 2) collaborative research projects on European safety priorities.

This deliverable is produced by the Project P5 “Resolving the organizational accident” of Future Sky Safety. The main objectives are to analyse the relations between the FSS P5 research streams and to provide guidelines to advance safety in organizations by relating the research streams to advanced safety management systems.

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Acronyms

Acronym	Definition
AMC	Acceptable Means of Compliance
ANSP	Air Navigation Service Provider
ARC	Agile Response Capability
ARC-COPE	ARC Crisis Operations and Plan Enhancement
ARC-MEX	ARC Method for EXercise Planning
ATM	Air Traffic Management
CANSO	Civil Air Navigation Services Organisation
CEO	Chief Executive Officer
COO	Chief Operating Officer
EASA	European Aviation Safety Agency
EREA	European Research Establishments in Aeronautics
FAA	Federal Aviation Administration
FSS P5	Future Sky Safety Project P5 “Resolving the organisational accident”
GM	Guidance Material
ICAO	International Civil Aviation Organization
JRP	Joint Research Programme
SARPs	Standards And Recommended Practices
SMAT	SMS Maturity Assessment Tool
SMICG	Safety Management International Collaboration Group
SMS	Safety Management System
SoE	Standard of Excellence
SRM	Safety Risk Management

EXECUTIVE SUMMARY

Problem area

The objective of project P5 "Resolving the organisational accident" (FSS P5) is to improve the safety of aviation organizations by improving relevant organizational processes and structures, and especially by supporting the ways that people at all levels in the organization understand, behave and interact in safety-relevant situations. FSS P5 answers to Future Sky Safety Theme 3, which aims at strengthening the resilience to deal with current and new risks of the humans and the organizations operating the air transport system. To this end, FSS P5 uses several research streams, addressing top management, middle management, safety dashboards, safety mindfulness, safety culture, agile response capability, and advanced safety management system. The objectives of the research presented in the current report are to analyse the relations between the FSS P5 research streams and to provide guidelines to advance safety in organizations by relating the research streams to advanced safety management systems.

Description of work

In air transport organizations, safety management systems (SMS) are traditionally used to achieve and maintain sufficient levels of safety in their operational conduct. As a starting point for the research we achieved an overview of air transport SMS standards and we developed a generic air transport SMS Maturity Assessment Tool (SMAT), which classifies the maturity of a range of SMS topics. The advances that the FSS P5 research streams can enable for the various SMS components, as well as the interrelations between the research streams were identified using discussions with researchers of the FSS P5 streams.

Results & conclusions

The research in FSS P5 mostly focused on improving human-related, soft aspects of organizational safety. The results of the research on top management support executives in improving their contributions and leadership in the safety performance and safety management of their organization. The middle management research has provided new insights and guidance that organizations can use to harness the role of middle management in organizational safety. The safety dashboard research supports organizations to develop and tune safety dashboards that lay an effective foundation for the information transfer in the organization's safety management system. The safety mindfulness research has provided new methods and techniques that support the flows of information in an organization to keep everyone mindful of their role in assuring safety and to provide them the knowledge to do so. The safety culture research has provided a broadened safety culture assessment and enhancement approach, and a safety culture stack approach, which supports improving the safety culture and safety interfaces of a stack of interrelated air transport organizations. The agile response capability research has provided new approaches for the development of exercises and preparedness plans for air transport crisis situations,

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which support organizations to advance their intra- and inter-organizational capability of detecting and flexibly responding to dynamic crisis scenarios. The advanced SMS research has provided guidance for the application of the FSS P5 research results in safety management, and it has developed a tool that supports air transport organizations to self-assess and improve their SMS.

The most important contributions of the FSS P5 research streams to topics in safety management systems are shown in the table below. These and other contributions are detailed in the report.

SMS Topic	FSS-P5 Research
Authorities, responsibilities, and accountabilities for safety management	Top Management
Emergency/contingency response procedures and plan	Agile Response Capability
Senior management visibility and involvement	Top Management
Integrated risk management and safety-related internal interfaces for key performance areas	Middle Management
Safety-related interfaces with external parties	Safety Culture (Stack)
Reporting and investigation of safety occurrences	Safety Mindfulness
Monitoring of safety indicators	Safety Dashboard
Auditing and improvement of SMS methods	Safety Management System
Safety culture measurement and an improvement programme	Safety Culture
Recording and dissemination of safety lessons learned	Safety Mindfulness
Sharing of safety information and knowledge with industry stakeholders	Safety Culture (Stack)
Sharing and learning best practices on operational safety and SMS practices	Safety Culture (Stack)

Applicability

Every organization is unique and has its own strong and weak elements in assuring the safety of its operations. As such there cannot be a one-size-fits-all for advancing safety in organizations, but this needs to be based on a careful analysis of the organization at hand, leading to tailored solutions. The FSS P5 research has provided two main approaches for such analysis. The safety culture assessment and enhancement approach uses questionnaires for all personnel to identify strengths and weaknesses in safety culture dimensions, and it applies workshops to understand their background and to arrive at ways to advance the safety culture. These solutions can be linked to the FSS P5 research streams. The SMS Maturity Assessment Tool (SMAT) uses questionnaires for management and safety management staff to identify strong and weak aspects in the SMS, and it applies workshops to discuss the safety management in practice and to identify ways to improve the SMS. The couplings of the FSS P5 research streams with the SMS components support their advancement. Following such analyses the results of the relevant FSS P5 research streams can be effectively used to advance safety in organizations.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1. The programme

Future Sky Safety[1] is an EU-funded transport research programme in the field of European aviation safety, with an estimated initial budget of about € 30 million, which brings together 33 European partners to develop new tools and new approaches to aeronautics safety, initially over a four-year period starting in January 2015.

Future Sky Safety contributes to the EC Work Programme Topic MG.1.4-2014 Coordinated research and innovation actions, targeting the highest levels of safety for European aviation in Call/Area Mobility for Growth – Aviation of Horizon 2020 Societal Challenge Smart, Green and Integrated Transport. Future Sky Safety addresses the Safety challenges of the ACARE Strategic Research and Innovation Agenda.

Future Sky Safety will also help coordinate the research and innovation agendas of several countries and institutions, as well as create synergies with other EU initiatives in the field (e.g. SESAR, Clean Sky 2). Future Sky Safety is set up with four years duration, and started on the 1st of January 2015.

Future Sky Safety, established under coordination of EREA, is built on European safety priorities around four main themes, each consisting of a small set of Projects:

- Theme 1 (New solutions for today's accidents) aims for breakthrough research with the purpose of enabling a direct, specific, significant risk reduction in the medium term.
- Theme 2 (Strengthening the capability to manage risk) conducts research on processes and technologies to enable the aviation system actors to achieve near-total control over the safety risk in the air transport system.
- Theme 3 (Building ultra-resilient systems and operators) conducts research on the improvement of Systems and the Human Operator with the specific aim to improve safety performance under unanticipated circumstances.
- Theme 4 (Building ultra-resilient vehicles) aims at reducing the effect of external hazards on the aerial vehicle integrity, as well as improving the safety of the cabin environment

1.2. Project context

The objective of project P5 "Resolving the organisational accident" (FSS P5) is to improve the safety of aviation organizations by improving relevant organizational processes and structures, and especially by supporting the ways that people at all levels in the organization understand, behave and interact in safety-relevant situations. P5 answers to Future Sky Safety Theme 3, which aims at strengthening the resilience to deal with current and new risks of the humans and the organizations operating the air transport system.

[1] See https://www.futuresky-safety.eu/.

In order to achieve this objective, research is done in the following work packages:

- WP1 - Safety intelligence. Researching the contributions to safety in aviation organizations by top and middle management, as well as ways to improve safety intelligence by best practices for the design and use of safety dashboards.
- WP2 - Safety mindfulness. Developing and implementing approaches for improving the organizational mindfulness – i.e. creating a flow of relevant and useful information that actively supports, from the one side, operational people's capability to remain mindful of safety when carrying out their activities, and from the other side, the managers to remain 'in the loop' and collect useful data to ensure continuity of improvement process.
- WP3 - Safety culture. Extending the safety culture analysis and improvement approach developed for ATM to other sectors in the air transport system.
- WP4 - Agile response capability. Developing an agile response capability that addresses events focusing on sudden crises.
- WP5 – Advanced SMS. The results of above four research directions form the basis for advancing the current safety arrangements within an organisation in relation with its safety management system (SMS).

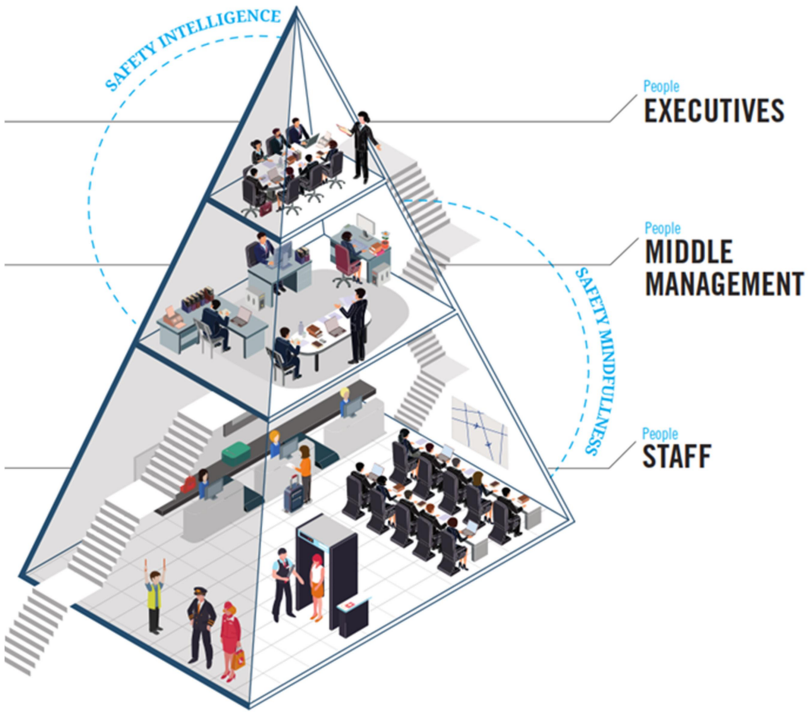

Figure 1. Layers in an organization and safety-related processes.

1.3. Research objectives

Results of the various FSS P5 research streams are presented in a range of reports, see a summary of this research in [1]. The objectives of the research presented in the current report are to analyse the relations between the FSS P5 research streams and to provide guidelines to advance safety in organizations by relating the research streams to advanced safety management systems.

1.4. Approach

In air transport organizations, safety management systems (SMS) are traditionally used to achieve and maintain sufficient levels of safety in their operational conduct. As a starting point for the research we achieved an overview of air transport SMS standards and we developed a generic air transport SMS Maturity Assessment Tool (SMAT), which classifies the maturity of a range of SMS topics. The advances that the FSS P5 research streams can enable for the various SMS components, as well as the interrelations between the research streams were identified using discussions with researchers of the FSS P5 streams.

1.5. Structure of the document

The remainder of this document is structured as follows.

- Chapter 2 provides an overview of standards and regulations for the traditional approach to control safety in an organization by a safety management system (SMS). It also describes the development of a generic air transport SMS Maturity Assessment Tool (SMAT), which supports a broad range of air transport organizations (airlines, ANSPs, airports, etc.) to self-assess and improve its SMS.
- Chapter 3 provides a high-level overview of the research streams in FSS P5, the interrelations between the research streams, and their couplings with safety management systems. It answers the question “What can it do for you?”
- Chapter 4 presents a detailed overview of the contributions of the FSS P5 research streams to the topics in a safety management system. Table 5 in this chapter helps the reader in quickly finding these safety management contributions by the FSS P5 research.
- Chapter 5 presents the conclusions.

In addition to the main text, various details are reported in the following appendices:

- Appendix A provides an overview of standards and recommended practices for SMS.
- Appendix B provides an overview of methods for SMS maturity assessment.
- Appendix C provides the questionnaire of the generic air transport SMS Maturity Assessment Tool (SMAT).

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2 SMS FOR SAFER ORGANIZATIONS

The traditional approach to achieve and control a sufficient level of safety in an organization is by a safety management system (SMS). Section 2.1 provides an introduction of the components in an SMS. Section 2.2 presents ways to assess the maturity of an organization's SMS.

2.1. Safety management systems

A safety management system (SMS) is the overall set of procedures, documentation and knowledge systems, as well as the processes using them, which are employed within an organization to control and improve its safety performance. The standards and recommended practices (SARPs) for SMS by ICAO [2-4] discerns four main components: (1) safety policy and objectives; (2) safety risk management; (3) safety assurance; and (4) safety promotion. These components interact and they relate with the people and processes at the various levels in an organization (Figure 2).

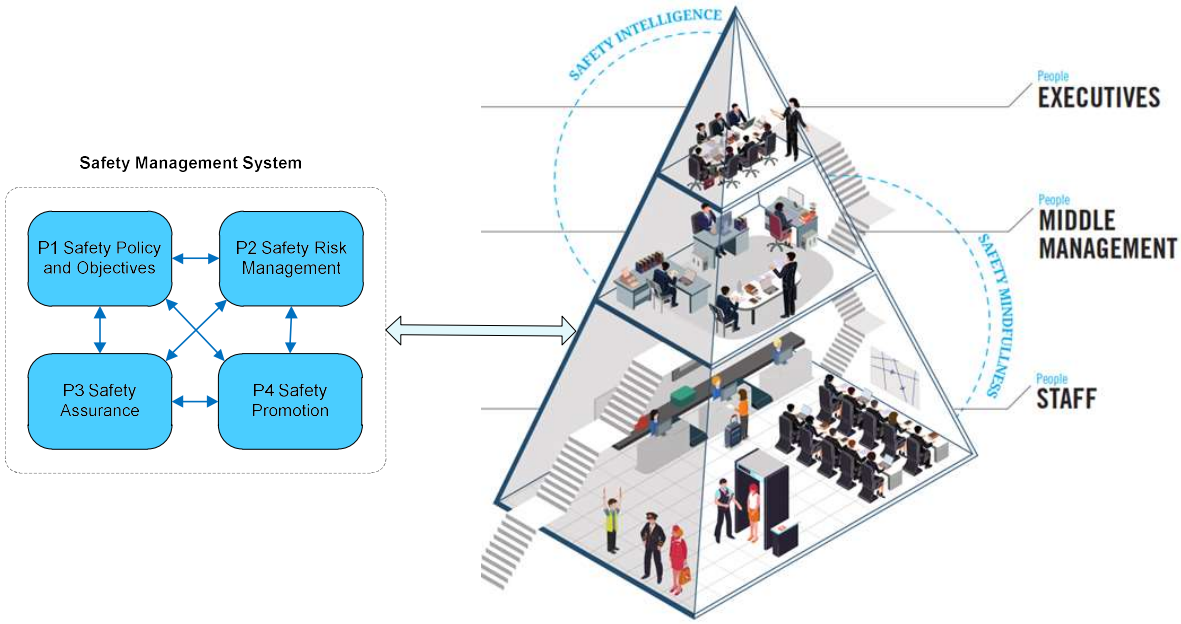

Figure 2. Safety management system and safe performance in an organization.

SMS component 1 of ICAO Annex 19 [2, 3] describes the safety objectives of an organization and the principles, processes and methods of the organization's SMS to achieve them. Component 2 describes the safety risk management processes to assure that the safety risks encountered in aviation activities are controlled to achieve an organization's safety performance targets. Component 3 describes the safety

assurance processes and activities undertaken by an organization to determine whether the SMS is operating according to expectations and requirements. It specifically concerns the continuous monitoring of its internal processes and operating environment to detect changes or deviations that may introduce new safety risks or the degradation of existing risk controls. Such changes or deviations then need to be addressed by the safety risk management process (component 2). Component 4 describes the training, education and communication in the SMS to achieve a positive safety culture with proper knowledge and awareness of all people in the organization. An overview of the elements in each of the components according to the ICAO standards is provided in Table 1; additional details are in Appendix A.1. As highlighted in Figure 2, there exist interrelations between each of the SMS components, and these are summarized in Table 2.

Table 1. SMS components according to ICAO Annex 19 [2, 3].

SMS component	Element	Description
P1. Safety Policy & Objectives	Management commitment	This includes the definition of a safety policy and safety objectives. The safety policy describes the organizational commitment regarding safety, the provision of resources for implementation of the safety policy, the safety reporting procedures, and the delineation between acceptable and unacceptable behaviour. The safety objectives form the basis for safety performance monitoring in reflection of the organization's commitment.
	Safety accountabilities and responsibilities	This includes the designation of an accountable executive for the implementation and maintenance of the SMS, the definition of lines of safety accountability in the organization, the definition of management levels with the authority to decide about safety risk tolerability, and the documentation and communication of the safety responsibilities, accountabilities and authorities in the organization.
	Appointment of key safety personnel	This concerns the appointment of a safety manager who is responsible for the implementation and maintenance of the SMS.
	Coordination of emergency response planning	This concerns the establishment and maintenance of an emergency response plan for accidents and incidents in aircraft operations and other aviation emergencies, which is well coordinated with the emergency response plans of related organizations.
	SMS documentation	This concerns the development and maintenance of an SMS manual which describes the safety policies and objectives, SMS requirements, SMS processes and procedures, and the related accountabilities, responsibilities and authorities. This documentation also includes SMS operational records.
P2. Safety Risk Management	Hazard identification	This concerns developing and maintaining a process for the identification of hazards associated with an organization's aviation products or services, including reactive and proactive methods.
	Safety risk assessment and mitigation	This concerns developing and maintaining a process that ensures analysis, assessment and control of the safety risks associated with identified hazards.
P3. Safety Assurance	Safety performance monitoring and measurement	This concerns developing and maintaining means to verify the organization's safety performance by relating safety performance indicators with safety performance targets, and to validate the effectiveness of safety risk control.
	The management of change	This concerns developing and maintaining a process to identify changes which may affect the level of safety risk associated with an organization's aviation products or services, and to identify and manage the safety risks that may arise from those changes.
	Continuous	This concerns monitoring and assessing the effectiveness of an organization's

	improvement of the SMS	SMS processes to enable continuous improvement of the overall performance of the SMS.
P4. Safety promotion	Training and education	This concerns developing and maintaining a safety training programme that ensures that the personnel is competent to perform their SMS duties.
	Safety communication	This concerns developing and maintaining formal means for safety communication regarding the SMS, safety-critical information, explanation of safety actions, and changes to safety procedures.

Table 2. Input/output relations between SMS components.

	P2. Safety risk management (SRM)		P3. Safety assurance		P4. Safety promotion	
P1. Safety Policy & Objectives	→	Methods for SRM. Safety objectives.	→	Methods for safety assurance.	→	SMS documentation for safety training and communication.
	←	Documentation of SRM results.	←	Documentation of safety assurance results.	←	Feedback to safety policy and objectives.
P2. Safety Risk Management			→	Requirements for operations and safety risk control.	→	SRM results for training and communication.
			←	Feedback about new hazards and ineffective safety risk control.	←	Facilitation of feedback in the organization to SRM.
P3. Safety Assurance					→	Safety assurance results for training and communication.
					←	Facilitation of feedback in the organization to safety assurance.

In addition to the world-wide standards and recommended practices for safety management by ICAO, there exist several others that are more regional or associated to specific organizations.

- In the European Union, organisational requirements for the conduct of air operations are specified in Annex III (Part-ORO) of EU Commission Regulation 965/2012 [5]. Details and explanations on the way that these requirements can be fulfilled have been formulated by EASA in their documentation on acceptable means of compliance (AMC) and guidance material (GM) to ANNEX III [6]. In particular, Section 2 of [6] provides AMC and GM for management, including the organizational structure (e.g. safety manager, safety review board, safety action group), accountabilities, safety policy, safety risk management, occurrence reporting, risk management for volcanic ash contamination, training and communication on safety, safety management manual, compliance monitoring, audits and inspections, contracted activities, and record-keeping.
- In the United States of America, order [7] provides the SMS policy and requirements for the Federal Aviation Administration (FAA). It describes the compliance of FAA with ICAO Annex 19, for the state safety program regarding FAA's regulatory role, as well as for the SMS of FAA's service provider organizations. The order provides a high-level description of the SMS components, being safety policy, safety risk management, safety assurance, and safety promotion. Detailed guidelines of

implementations of safety risk management and safety assurance are provided in [8] and [9]. A summary is provided in Appendix A.2.

- The Civil Air Navigation Services Organisation (CANSO) published a Standard of Excellence in Safety Management Systems (SoE in SMS) [10] and an associated implementation guide [11] to support ANSPs in their safety management. A summary of these CANSO SMS guidelines is provided in Appendix A.3.

2.2. Assessing the maturity of SMS

2.2.1. SMS maturity assessment

The standards and recommended practices for SMS as explained in Section 2.1 provide a basis that is used by organizations to implement the various safety management aspects. Such implementation can be done to various extents. For instance, organizations may lack particular aspects of the SMS standards, they may fulfil the SMS standards as required but nothing more, or they may be doing their safety management well beyond the minimum requirements by using additional means and striving towards excellence in safety management. There are several means to assess the maturity of a safety management system, which include the following.

- *EASA questionnaire.* As part of the acceptable means of compliance and guidance material for the implementation and measurement of safety key performance indicators [12] EASA has published a questionnaire for measurement of the effectiveness of safety management. The questionnaire is based on a maturity survey in the ATM Safety Framework [13], which was developed by EUROCONTROL to support ANSPs in assessing the maturity of their SMS. This maturity survey is based on 11 study areas. The study areas are specified in more detail by one to four topics per study area and 26 topics in total. For each of these topics maturity levels are defined on a 5-point scale. The questionnaire on the basis of these study areas is provided in Appendix B.1.
- *CANSO maturity scheme.* The Civil Air navigation Services Organisation (CANSO) has published a Standard of Excellence in SMS [10]. It includes a definition of SMS maturity along five levels for its SMS objectives (36 in total). The development of the CANSO scheme used the above mentioned publications of EASA [12] and EUROCONTROL [13], but it has also added some items and it provides some better formulations. Description of the three highest maturity levels is provided in Appendix B.3.
- *Shell SMS assessment.* The SMS HSE MS self-assessment questionnaire of Shell [14] lists safety management topics and related current aviation practices, typical supporting evidence, and interpretation/guidance for aircraft operators. It consists of 32 topics distributed over eight groups, which are scored on a 4-point scale. The levels for each of the topics are provided in Appendix B.2.
- *SMICG SMS Evaluation Tool.* The Safety Management International Collaboration Group (SMICG) developed a Safety Management System Evaluation Tool [15]. This tool basically scores indicators for

the components of ICAO Annex 19 along four categories. Overall there are 129 indicators, distributed over 52 indicators for safety policy and objectives, 28 indicators for safety risk management, 30 indicators for safety assurance, and 19 indicators for safety promotion. Although the number of indicators is considerably more than the number of topics in the other three maturity assessment means, their content does not well surpass that of the other maturity assessment means. Rather the indicators consider detailed aspects, whereas the other maturity assessment means use more aggregated indicators.

2.2.2. Generic air transport SMS Maturity Assessment Tool (SMAT)

Most of the methods for SMS maturity assessment presented above in Section 2.2.1 are focused on particular air transport organizations, namely air navigation service providers (EASA questionnaire, CANSO maturity scheme) or aircraft operators (Shell SMS assessment). The SMICG SMS Evaluation Tool uses a very large set of 129 indicators, rather than a smaller set of more aggregated indicators such as used in the other SMS assessment methods. All approaches for SMS maturity assessment are mostly based on traditional perspectives on safety and safety management, and they lack insights from recent research in Safety-II [16], resilience engineering [17] and FSS P5.

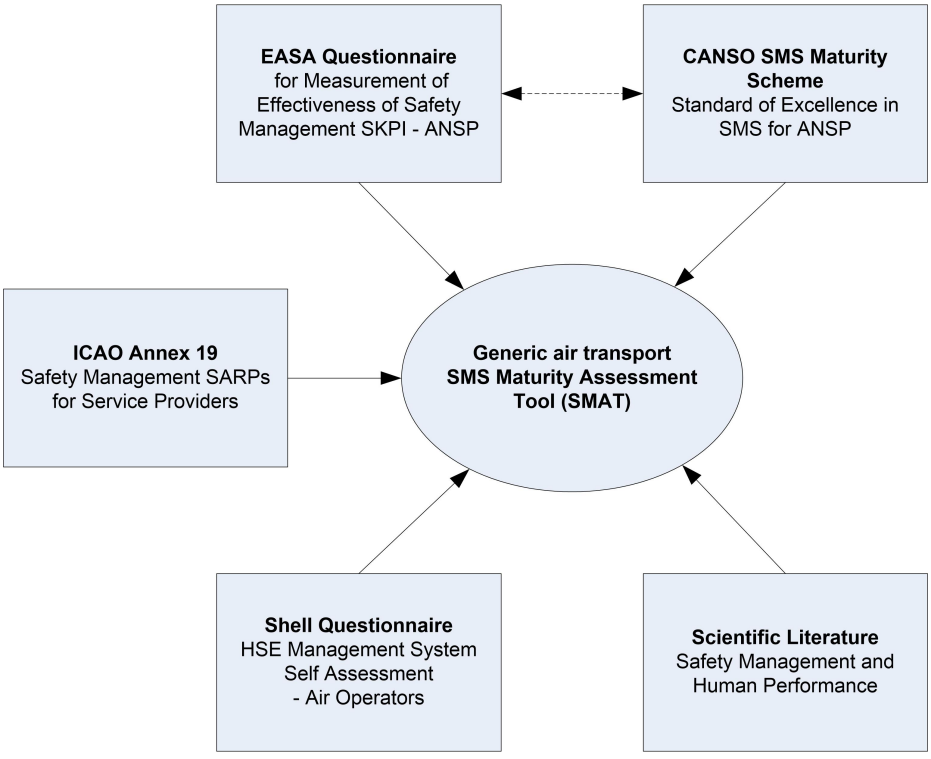

Figure 3. Development of the generic air transport SMS Maturity Assessment Tool

To overcome these limitations of existing SMS maturity assessment schemes, as part of this research a generic air transport SMS Maturity Assessment Tool (SMAT) was developed, as highlighted in Figure 3. For this development, the EASA questionnaire (Appendix B.1) and the CANSO SMS maturity scheme (Appendix B.3) were used as a basis. Their topics were generalized and reformulated where appropriate. Next it was analysed what questions from the Shell questionnaire (Appendix B.2) could add new aspects, leading to addition of some questions. Furthermore, insights from developments in research in FSS P5, Safety-II and resilience engineering were used as a basis for some topics. Finally, the topics in SMAT were structured following the SMS components of ICAO Annex 19.

Table 3 shows the topics for each of the SMS components, including 9 topics for Safety Policy and Objectives, 6 topics for Safety Risk Management, 9 topics for Safety Assurance, and 8 topics for Safety Promotion. For each of these 34 topics, five levels of maturity from A to E are defined in Appendix C. An answering table (Table 4) is used to indicate a selected level and to provide an explanation that justifies the selection.

Table 3. Topics of the generic air transport SMS Maturity Assessment Tool (SMAT). See Appendix C for definition of the associated levels.

SMS Component	Topics	
Safety Policy and Objectives	1.1	Authorities, responsibilities, and accountabilities for safety management
	1.2	Safety management function
	1.3	Implementation and management of the SMS
	1.4	Consistency with regional/international safety standards
	1.5	SMS documentation
	1.6	Emergency/Contingency response procedures and plan
	1.7	Safety policy
	1.8	Senior management visibility and involvement
	1.9	Sub-contractors
Safety Risk Management	2.1	Identification of hazards and disturbances
	2.2	Risk assessment for design and change
	2.3	Safety risk control
	2.4	Fatigue risk management
	2.5	Sufficiency of resources
	2.6	Maintenance
Safety Assurance	3.1	Integrated risk management and safety-related internal interfaces for key performance areas (such as finance, quality, security, and environment)
	3.2	Safety-related interfaces with external parties
	3.3	Reporting and investigation of safety occurrences
	3.4	Monitoring of safety indicators
	3.5	Operational safety surveys and audits
	3.6	Auditing and improvement of SMS methods
	3.7	Variations with respect to procedures and standards
	3.8	Auditor competency
	3.9	Management of change
Safety Promotion	4.1	Safety culture measurement and an improvement programme
	4.2	Promotion of a just and open culture for reporting and investigation of occurrences
	4.3	Knowledge transfer of safety management standards and practices
	4.4	Training and competency in safety and safety management
	4.5	Recording and dissemination of safety lessons learned
	4.6	Sharing of safety information and knowledge with industry stakeholders
	4.7	Publication of safety performance information to the general public
	4.8	Sharing and learning best practices on operational safety and SMS practices

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Table 4. Answering table of the generic air transport SMS Maturity Assessment Tool (SMAT).

Level	*A*	*B*	*C*	*D*	*E*
Explanation					

SMAT was designed to be used in several ways:

- Single user – single organization case
- Multiple users – single organization case
- Multiple users – multiple organizations case

The initial designs of these use cases are presented next.

Single user – single organization case design

The single user – single organization case is the most straightforward way for applying SMAT. The single user can for instance be a safety manager or staff from a safety department. The single user scores the topics and provides a justification. The SMAT results and the justification process helps him/her to understand the strong and weak points of the organization's SMS. This can support the identification of ways to improve weak points of the SMS.

Multiple users – single organization case design

The multiple users – single organization case uses SMAT in a more advanced way, as illustrated in Figure 4. It consists of the following three elements:

- *SMAT survey*. The SMAT questionnaire is completed by personnel from who it is expected that they have a reasonable overview over SMS topics, such as safety managers, staff of a safety department, other managers. The objective is to obtain a multitude of opinions about the SMS topics from different perspectives in the organization. People are asked to provide their opinions for the scores of the SMS topics as well as explanations of their findings.
- *SMAT analysis*. The results of the survey are collected and analysed by independent researchers with expertise in SMS. This analysis provides statistics of the scores on the various SMS topics, pointing to views on strong and weak points, and to differences in opinions on the SMS topics. The analysis of the explanations provided by the participants leads to initial insights in reasons for the scores.
- *SMAT workshop*. The results of the analysis are input for one or several workshops with participants of the survey, depending on the size and distribution of the survey group. Each workshop is facilitated by the researchers who performed the SMAT analysis. The objectives of the workshop are to achieve an improved understanding between the participants of the way that the SMS works in practice in the organization, and to arrive at ways to improve the organization's SMS and the ways that it can be effectively applied. Discussion of the differences in the views of the participants is key to arrive at these ends.

Multiple users – multiple organizations case design

The multiple users – multiple organizations case extends the application of SMAT from a single to multiple organizations. The objective is to improve the safety management systems of different organizations and to improve the interactions between the SMSs of interacting organizations. It is expected that a workshop-format involving participants from different organizations is a suitable way to achieve these objectives. A basis of such workshop could be results from single or multiple users cases per organization. The workshop is an opportunity for organizations to learn from the strong points of other organizations, and to improve the inter-organizational safety management relations.

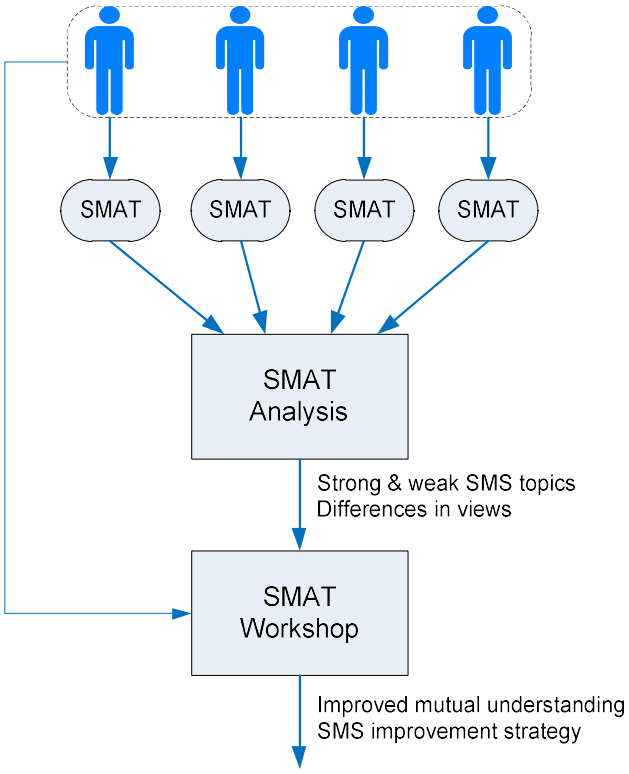

Figure 4. Design of multiple users – single organization application of SMAT.

In conclusion, SMAT is an approach that supports a variety of air transport organizations to assess and improve the maturity of their SMS. The design of the SMAT questionnaire generalized previous questionnaires for specific types of organizations (ANSPs, air operators) and included extensions based on safety management literature. The design of use cases of SMAT was based on general insights for the use of questionnaires and workshops. We see SMAT as an agile system, where both the questionnaire and the implementation of use cases can be adapted following feedback from their application and from developing views on effectively achieving safe performance in an organization.

3 ADVANCING SAFETY IN ORGANIZATIONS

The objective of FSS P5 research is to support aviation organizations in improving organizational processes and structures, and pre-dominantly the ways that people at all levels in the organization understand, behave and interact in safety-relevant situations. This chapter provides a high-level overview of the various research streams in FSS-P5 that were developed to this end, the interrelations between the research streams, and their couplings with formalized safety management systems:

- *WP1-TM*: Top Management as researched in WP1, see Section 3.1
- *WP1-MM*: Middle Management as researched in WP1, see Section 3.2
- *WP1-SD*: Safety Dashboard as researched in WP1, see Section 3.3
- *WP2-SM*: Safety Mindfulness as researched in WP2, see Section 3.4
- *WP3-SC*: Safety Culture as researched in WP3, see Section 3.5
- *WP4-ARC*: Agile Response Capability as researched in WP4, see Section 3.6
- *WP5-SMS*: Safety Management System as researched in WP5, see Section 3.7

3.1. Top management

Research stream

Interviews were held with 16 senior executives (e.g. CEOs, COOs, etc.) from key organisations across the European aviation industry about their perspectives on safety performance in their organizations. In particular it focused on how they led safety in their companies, and how they used various information sources to 'see around the corner' to the next safety threat. Obtained insights and recommendations are reported in [18] and summarized in Section 4.1 of [1].

Relations with other research streams

WP2-SM. The safety mindfulness concept concerns all levels of an organization, including the top management level. The top management needs to have proper oversight of the operations. This does not imply that they have full knowledge of operational details, rather the organization should be such that they can trust the expertise of the middle management and other staff. It is an important role of top management to control and retain oversight over the impact of organizational change processes on the totality of operations in the organization.

WP3-SC. For top management, a safety culture survey gives insights into the strengths and weaknesses of the safety perceptions within their organisation. It also provides feedback on their leadership and the perceived effectiveness of their performance.

WP4-ARC. Regarding exercises to improve an organization's agile response capability, the research in WP4 raises several questions that may be considered by top management to enhance their effectiveness. Are

your stress tests realistic? Do you impose constraints on stress tests? What are your success criteria for a stress test (when is a crisis exercise completed successfully)?

WP5-SMS. For top management, the results of a safety management maturity assessment provide insight into the strengths and weaknesses of the safety management in their organization, as well as ways to improve the safety management.

Relations with SMS

The strongest links of top management are with SMS component 1 (safety policy and objectives). This concerns the top management role in defining and keeping up-to-date the authorities, responsibilities, and accountabilities for the management of safety in the organisation. The highest organisational level recognises its role in the SMS and actively supports the development, implementation, maintenance, and promotion of the SMS throughout the organisation (including support departments). There is continuous monitoring of the effectiveness and efficiency of the various SMS processes, including the search for weak signals about safety, and management takes effective measures to control the performance of the SMS. Senior management visibility and involvement are important for effective safety management. A strong safety commitment is characterized by senior managers actively participating in safety-related activities such as training, reward and recognition schemes, safety workshops, safety conferences and audits. They jointly develop and discuss both safety results and activity improvement targets with staff and company contractors. They are fully aware of the high priority areas for improvement identified in the SMS and the status of the follow-up remedial programme. Senior managers drive the process for safety excellence and they are role models for safety. In relation to SMS component 3 concerning safety assurance, senior management support an integrated risk management system for all relevant key performance areas, such as finance, quality, security, and environment. This systematically addresses all types of risks and their relations, including assessment of costs associated with accidents and incidents, and of costs and benefits of risk mitigating measures.

Conclusion – What can it do for you?

The FSS P5 research on top management has provided a range of views by top managers of air transport organizations about their roles in safety management, such as maintaining safety under pressure, searching for evidence, seeing around the corner, and accountability and responsibility at the top. These results can inspire and support top managers in improving their contributions and leadership in the safety performance and safety management of their organization.

3.2. Middle management

Research stream

Interviews were held with 48 middle managers at ANSPs, aircraft manufacturers, airlines, and airports about their views on safety and their roles and ways of working in the organization [19] (see also the summary in Section 4.2 of [1]). Based on the interview results a descriptive model of safety-related practices and an explanatory model for the way that middle managers take safety into consideration were developed. This led to guidance on how best to harness the middle management role in organizational safety.

Relations with other research streams

WP2-SM. Middle managers are at the centre of horizontal as well as vertical escalation, and as such they play key roles in operationalizing standards and guidelines for staff, gathering and interpreting data from operations to upper management, and coordinating with other groups in an organization. The interviews with middle managers provide ample evidence of the multitude of their relations and responsibilities [19]. In these interviews, middle managers expressed that they mostly gather their information by direct face-to-face contact.

WP3-SC. For middle management, the output of the safety culture survey can be confrontational. As a group, middle managers often are quite competitive, striving towards growth in the organization, and criticism may be ill-received. Safety culture surveys reflect how they manage and if there are perceived weaknesses they often feel responsible for arriving at solutions. Workshops are the key instrument for achieving such improvements.

WP4-ARC. Regarding the role of management in crisis situations, it is recognized that agile organizational response and adaptive leadership is important to handle crises well. Middle managers are typically responsible for crisis exercise and training programmes and various processes and resources aimed at crisis preparedness and organizational learning from crises and exercises. A crisis manager often is a middle manager, e.g. a business continuity manager, who interacts with top management as well as relevant staff, and who gets together the right group of people for handling the situation, the crisis team. A crisis manager needs to manage how the crisis team does its work and interacts with other stakeholders to reflect the changing characteristics of dynamic and complex crises, as well as have the right capabilities in terms of leadership, in-depth knowledge of the operation and creativity.

Relations with SMS

There are various SMS topics that are relevant to the work by middle managers. It follows from the interviews in [19], that for many of these topics middle managers do not relate to the formalities of a SMS, but rather feel responsible for getting the work done while dealing with uncertainty and disturbances that may affect the operations. As such they serve multiple goals (including productivity,

finance, quality, security, environment) of which safety is only one. Doing so, they perform some kind of integrated risk management, although without explicitly assessing all risks. The management of information and knowledge transfer is focused on the overall practices for getting the work done appropriately, without special focus on safety. They recognized that it is important to have experts that have a good knowledge of the overall operations and the interactions between its human and technical elements, in order to get the work done effectively, efficiently, and safely. The interviewed middle managers indicated that for understanding the level of safety that they manage, they typically rely more on their own judgements, and those of key staff, than using formal safety indicators (such as in a safety dashboard). They considered safety management practices to be mostly relevant for safety management personnel, although some middle managers took safety management training to obtain a broader safety picture. An open reporting culture was considered important by the interviewed middle managers, as part of a management style where one listens to the field. Promotion of investigation of occurrences and a just culture were not indicated as important in the interviews though. The topic where the strongest connection with the formal SMS seems to exist is for management of change. The interviewed middle managers considered it important to involve all actors impacted by a particular change, and to recognize when a change would require a safety risk assessment.

Conclusion – What can it do for you?

The FSS P5 research has analysed ways that middle managers take safety into consideration in their work, including their information management, decision-making, and influencing of others. Middle managers have to balance multiple goals in getting the work done and their leadership role is crucial for the level of safety performance that is achieved in operations. The FSS P5 research results provide new insights and guidance that organizations can use to harness the role of middle management in organizational safety.

3.3. Safety dashboards

Research stream

The goal of this work is to determine how to improve Safety Intelligence (SI) by identifying best practices for the design and use of safety dashboards [20] (see also the summary in Section 4.3 of [1]). This work has resulted in the development of several safety dashboard prototypes for top management of ANSPs, as well as in practices for their use. In coordination with a case study for Luton Airport, a prototype safety dashboard has been developed for a group of organizations (known as a ‘stack’) at the airport.

Relations with other research streams

WP1-MM. In interviews, middle managers expressed that they mostly gather their information by direct face-to-face contact. Some added that they are not in a great need of dashboards.

WP2-SM. IT solutions/apps that support safety mindfulness by enabling staff to report on issues in operations have been developed. Moderation and processing of these data is needed to assure the effective integration in safety mindfulness. Such processing should not be owned by a safety department to avoid it becoming institutionalized in a safety silo.

WP3-SC. The results of a safety culture survey are not represented on a safety dashboard, because they are only obtained infrequently. However, if certain new topics are raised in a survey (e.g. fatigue, new hazards) they could be tracked in a safety dashboard. Also keeping track of improvement measures following a survey can be part of a safety dashboard.

WP4-ARC. Given the uniqueness of each crisis there are no crisis-specific dashboards. Some generic dashboards, such as the EUROCONTROL Network Operations Portal provide useful overviews that can support understanding of crisis situations.

WP5-SMS. The results of a safety management maturity assessment are not represented on a safety dashboard, because of its infrequent results. Keeping track of measures for improving particular safety management topics can be part of a safety dashboard.

Relations with SMS

There exist various ways by which safety dashboards can support safety management. For the monitoring of the effectiveness of SMS (SMS component 1), interviewed safety managers indicated that it would be beneficial to complement the EU IR 390/2013 Safety KPIs with more fine-grained indicators of SMS effectiveness. In support of safety risk management (SMS component 2), an “operational risks” hotspot map in the prototyped safety dashboard, representing the feedback collected from surveys done inside operations units, supports the identification of threats to operations. The research has highlighted a need for integrating into safety dashboards a quantitative risk model capable of connecting multiple indicators, in order to deliver an overall risk picture. For integrated risk management (SMS component 3), the research has highlighted a need for integrating indicators for different KPAs, thus visualizing capacity, economic and safety indicators in a single dashboard. For safety-related interfaces with external parties, safety dashboards were prototyped including an indicator “external safety factors”, which highlights risk factors that are not under direct control of the organisation. In support of management of change, a prototype safety dashboard includes an indicator for the “Impact of Change”, which gives senior management an overview of all changes projects undergoing together with comments and impact on operations. In support of safety culture measurement and an improvement (SMS component 4), the prototyped safety dashboard includes indicators for monitoring the progress of safety culture actions, and the participation to safety initiatives. A safety dashboard can be a useful means for communication, especially if it is used in support of in-person communication about safety. This can also support the sharing of safety information and knowledge with industry stakeholders, for instance between parties interacting at an airport.

Conclusion – What can it do for you?

The core purpose of safety dashboards is to provide a structured overview of safety-relevant information that effectively supports decision-making processes that may affect safety in an organization. The research and development in FSS P5 identified best practices for the design and use of safety dashboards, and it developed several prototypes for air transport organizations. These results support organizations to develop and tune safety dashboards that provide the information that is suitable for their needs. As such, they can lay an effective foundation for the information transfer in the organization's safety management system.

3.4. Safety mindfulness

Research stream

The safety mindfulness concept describes flows of information that support mindfulness about safety in an organization, and decisions and actions to effectively mitigate risks, both directly within operations as well as in the management of system improvement [21-23] (see also the summary in Section 4.4 of [1]). As basis of the safety mindfulness concept it is argued, that if people are provided with relevant information and support, and made accountable for their actions, this creates a compelling obligation to act to solve the problems they face. This principle can be applied at all levels of an organization. The flow of information and the sharing and transformation of knowledge that is grounded in operational constraints represent the core activity. It requires nurturing by supportive social relations: both good co-ordination and leadership across relevant operational units, as well as amongst management groups and teams dedicated to improvement. Clear and effective operational and management processes provide an institutional governance structure enabling accountability for all this activity and its outcome across all the operational linkages between interdependent service processes. Horizontal escalation extends the gathering of information across the whole operational space, where risk-inducing interdependencies can be addressed. Vertical escalation extends accountability from the lowest operational level to the highest level of regulation and oversight.

Various metrics were developed to measure safety mindfulness [22]. IT applications were developed to support sharing of safety-relevant operational information in an organization, so as to improve safety mindfulness [23]. This includes the development of a prototype for a social media app, which allows operators to share safety-related experiences in their work, as well as an Improvement Manager app, which supports information transfer for change management in the organization. These safety mindfulness IT solutions/apps are being tested in use cases at MUAC and ALITALIA.

Relations with other research streams

WP1-MM. The role of middle management and its interaction with staff are at the core of the safety mindfulness concept. Middle managers are at the centre of horizontal as well as vertical escalation, and as

such they play key roles in operationalizing standards and guidelines for staff, gathering and interpreting data from operations to upper management, and coordinating with other groups in an organization. The interviews with middle managers provide ample evidence of the multitude of their relations and responsibilities [19]. In these interviews, middle managers expressed that they mostly gather their information by direct face-to-face contact.

WP1-TM. The safety mindfulness concept concerns all levels of an organization, including the top management level. The top management needs to have proper oversight of the operations, thereby relying on the expertise of middle management and other staff. Top management must control and retain oversight over the impact of organizational change processes on the totality of operations in the organization.

WP3-SC. There is a close relationship between safety mindfulness and safety culture. An open, just and reporting culture are conditions to achieve safety mindfulness in an organization, as staff needs to feel supported to share safety-related information and improve their performance. The safety mindfulness model [23] presents governance principles for acting by management and staff. This is believed to support safety culture in an organization. Regarding the results of safety culture surveys and workshops, it is key to keep supporting the information flow towards improving the organizational processes. If this is lacking and staff do not understand how the results are effectively used, this may weaken the safety culture survey approach and even the safety culture as such.

WP4-ARC. In order to have an effective Agile Response Capability, the right information needs to be at the right place and right time in crisis situations, such that a crisis team can argue about the risks and options in their decision-making. Such open communication, sharing of information, and understanding of risks are key aspects of safety mindfulness. Since there is a lot of pressure during a crisis, the flaws (or weak spots) of the safety mindfulness within an organization can become more prone and easier recognized than in regular operations.

Relations with SMS

Given the broad scope of the safety mindfulness concept, describing the flows of safety-related information, as well as the governance structure for accountability, decision-making and acting in support of safety, the safety mindfulness concept relates with all SMS components, regarding safety policy and objectives, safety risk assessment, safety assurance, and safety promotion. The safety mindfulness metrics are safety indicators in support of safety assurance (SMS component 3).

The development of the safety mindfulness IT applications, such as the prototype app that allows air traffic controllers to share experiences in their work, supports various SMS topics. They support the identification of hazards and disturbances for safety risk management (SMS component 2), as the apps can be used to report hazards, disturbances, and changing circumstances by staff. In support of safety assurance (SMS component 3), the apps can be used to report safety occurrences and to suggest corrective actions by staff. Also they can be used by staff to report variations with respect to procedures

and standards in operational conduct, and to suggest improvements. In particular, the qualitative narratives can be used by safety management staff to understand variations, and to leverage change in system procedures and standards. In support of management of change, the Improvement Manager app provides a structured way to control information flows for change processes. Recording and dissemination of safety lessons learned (SMS component 4) is directly supported by the safety mindfulness app.

Conclusion – What can it do for you?

The safety mindfulness concept stresses the importance of the flows of information in an organization to keep everyone mindful of their role in assuring safety and to provide them the knowledge to do so. In support of achieving suitable levels of safety mindfulness in air transport organizations, FSS P5 has developed several methods and techniques. Metrics developed in [22] can be used to measure safety mindfulness, ranging from metrics for safety mindfulness principles to metrics that focus on the risk perception and its adaptation of people in the organization. Questionnaires and workshops are the means to acquire such metrics. Two software applications [23] are available: (1) a social media app that allows operators to share and learn safety-related experiences in their work, and (2) an improvement manager app that supports information transfer for change management.

3.5. Safety culture

Research stream

An ATM safety culture survey approach was extended to other areas of the air transport system, including airlines, airport organisations and airframe manufacturers. A questionnaire-based analysis was done in a pan-European safety culture study of pilots [24]. Safety culture surveys, including questionnaires and workshops, were done for two airlines (easyJet and KLM), addressing large parts of their staff. These studies led to insights in safety culture statistics for European pilots and the airlines, as well as to insights to their background as attained in the workshops for the airlines. The studies also provided updated methods for safety culture assessment. Development of a ‘stack’ approach for measuring safety culture, whereby safety culture is measured for various organisations across the aviation system and these measurements set a basis for interaction and collaboration between these organisations, with the objective of making the total stack system safer. The approach was tested at Luton Airport in the UK, with six organisations undergoing independent safety culture surveys. The objectives of the stack approach and an application case for organisations at an airport are presented in [25].

Relations with other research streams

WP1-TM. For top management, a safety culture survey gives insights in the strengths and weaknesses of the safety perceptions within their organisation. It also provides feedback on their leadership and the

perceived effectiveness of their performance. Management commitment is considered to be a key driver for improving safety culture.

WP1-MM. For middle management, the output of a safety culture survey can sometimes be perceived as confrontational. If there are identified organisational weaknesses, they often feel responsible for arriving at solutions.

WP1-SD. The results of a safety culture survey are not represented on a safety dashboard, because they are only obtained infrequently (e.g. once every three to four years). However, if certain new topics are raised in a survey, they could be tracked in a safety dashboard. Also keeping track of improvement measures following a survey can be part of a safety dashboard.

WP2-SM. There is a close relationship between safety mindfulness and safety culture. An open, just and reporting culture are conditions to achieve safety mindfulness in an organization, as staff needs to feel supported to share safety-related information and improve their performance. The safety mindfulness model [23] presents governance principles for acting by management and staff. This is believed to support safety culture in an organization. Regarding the results of safety culture surveys and workshops, it is key to keep supporting the information flow as to how they are used to improve the organizational processes. If this is lacking and staff do not understand how the results are effectively used, this may weaken safety culture.

WP4-ARC.For an organization to respond effectively in a crisis situation, it is important to have a just and open culture. A crisis team needs to share all relevant information and it needs to be able to make decisions (with potential large consequences) fast. The crisis team should be able to deviate from procedures when they feel that it is necessary to cope with the situation. If there would be a blame culture and closed culture, the team could be hampered in dealing effectively with a crisis.

Relations with SMS

There are two types of relations of safety culture with safety management systems. The first type considers the intrinsic relation of safety culture with safety management. It stipulates that the effectiveness of safety management depends on the safety culture in the organization. If the level of safety culture is low, it is believed to be harder to achieve safety management objectives and to assure the level of safety in the operations. Also the safety management system has effect on the level of safety culture, in particular the actions and results of safety management influence the beliefs of the personnel and the way that the work is done in the organizations.

The second type considers the relations with SMS components. SMS component 4 of ICAO Annex 19 [2, 3] explicitly describes training, education and communication as part of safety management to achieve a positive safety culture with proper knowledge and awareness of all people in the organization. A key aspect is a safety culture measurement and improvement programme, where safety culture is assessed regularly, weaknesses are identified, and there is a continuing planning safety culture improvement. This

considers all safety culture dimensions, including the promotion of a just and open culture for reporting and investigation of occurrences, which is an important basis for effective safety management. The safety culture stack approach adds relations regarding the interactions with external parties. These concern the evaluation and support of the SMS of sub-contractors, the improvement safety-related interfaces with external parties (e.g. identification of newly developing risks), active sharing of safety data and information with other industry stakeholders, and sharing and learning best practices on operational safety and SMS practices with industry stakeholders.

Conclusion – What can it do for you?

The entirety of norms, values and practices with respect to safety and risk by people in an organization forms an important foundation for the effectiveness of its safety management and the level of safety that can be achieved in its operational conduct. As such safety culture is at the core of the human contributions to safety in any air transport organization. Understanding the weaknesses and strengths in an organization's safety culture, and effecting means to support weaker aspects are key contributions towards avoiding safety occurrences. The FSS safety culture assessment and enhancement approach, including well-validated questionnaires and tailored workshops, are fit for this purpose for a broad range of air transport organizations. The FSS safety culture stack approach effectively supports improving the safety culture and safety interfaces of a stack of interrelated air transport organizations. For single as well as multiple interacting organizations, safety culture analysis is a starting point for understanding and addressing human contributions, which can be effectively followed up by the other techniques developed in FSS P5.

3.6. Agile response capability

Research stream

Development of approaches for an agile response capability (ARC) that addresses events focusing on sudden crises [26, 27]. The ARC of actors in the air traffic system refers to their ability to anticipate/detect events, control them and bounce back after they have happened. Doing so, involves adapting their organisation and resource use, learning, and self-monitoring, as well as the ability to coordinate activities with other actors. Two approaches were developed: ARC-MEX (ARC Method for EXercise planning) and ACR-COPE (ARC Crisis Operations and Plan Enhancement). ARC-MEX provides methods that ensure scenarios will challenge the agility of the organisations that participate in the exercise. ARC-MEX is aimed to aid staff responsible for the planning, design, observation, analysis, and/or reporting of (series of) exercises. It provides guidance on the analysis of the phases before (planning), during (performing), and after (learning from) the crisis exercise. ARC-MEX can also be used to 'adjust the temperature' in real-time during crisis exercises and simulations, i.e. to appropriately challenge organisational resilience in relation to the ongoing performance of the crisis team(s). ARC-COPE aims to enhance preparedness through

supporting the requisite imagination that is necessary to develop a preparedness plan that covers many of the aspects of the variability that may occur during actual events, as well as support analyses to understand and learn from past events. These preparedness plans aim to improve the aviation stakeholders' response during the actual event, informing which events to monitor in order to recognize the onset of the event triggering the response plan, as well as the circumstances to monitor during the event that triggers parts of the response plan and its termination. ARC-COPE is aimed at staff responsible for developing preparedness or crisis plans, and for analysing and reporting on past incidents or crises. For both hypothetical scenarios and actual events, the ARC methodology may be used to analyse the course of events, and variations of what happened or may happen, and what agile response means, in 'what-if?' scenarios, in order to determine lessons to be learned for future events and exercises. The aim of ARC is to provide support to the imaginative as well as analytical process of running exercises, and to prepare for and learn from actual events.

Relations with other research streams

WP1-TM. Regarding exercises to improve an organization's agile response capability, the research in WP4 raises several questions that may be considered by (top) management to enhance their effectiveness. Are your stress tests realistic? Do you impose constraints on stress tests? What are your success criteria for a stress test (when is a crisis exercise completed successfully)?

WP1-MM. Regarding the role of management in crisis situations, it is recognized that agile organizational response and adaptive leadership is important to handle crises well. Middle managers are typically responsible for crisis exercise and training programmes and various processes and resources aimed at crisis preparedness and organizational learning from crises and exercises. A crisis manager often is a middle manager, e.g. a business continuity manager, who interacts with top management as well as relevant staff, and who gets together the right group of people for handling the situation, the crisis team. A crisis manager needs to manage how the crisis team does its work and interacts with other stakeholders to reflect the changing characteristics of dynamic and complex crises, as well as have the right capabilities in terms of leadership, in-depth knowledge of the operation and creativity.

WP1-SD. Given the uniqueness of each crisis there are no crisis-specific dashboards. Some generic dashboards, such as the EUROCONTROL Network Operations Portal provide useful overviews that can support understanding of crisis situations.

WP2-SM. In order to have an effective Agile Response Capability, the right information needs to be at the right place and right time in crisis situations, such that a crisis team can argue about the risks and options in their decision-making. Such open communication, sharing of information, and understanding of risks are key aspects of safety mindfulness. Since there is a lot of pressure during a crisis, the flaws (or weak spots) of the safety mindfulness within an organisation can become more prone and easier recognized than in regular operations.

WP3-SC. For an organization to respond effectively in a crisis situation, it is important to have a just and open culture. A crisis team needs to share all relevant information and it needs to be able to make decisions (with potential large consequences) fast. The crisis team should be able to deviate from procedures when they feel that it is necessary to cope with the situation. If there would be a blame culture and closed culture, the team could be hampered in dealing effectively with a crisis.

Relations with SMS

There are several relations of the ARC methods with SMS components. The strongest relation exists with the development of emergency/contingency response planning and exercises as part of SMS component 1. The ARC methodology provides approaches for development of guidance for analysing and aiding the intra- and inter-organizational capability of detecting and flexibly responding to dynamic crisis scenarios. As a core method ARC supports the development of scenarios for exercises and preparedness planning, including combinations of hazards and disturbances in crisis situations (SMS component 2). It is a key aspect of the ARC-MEX and ARC-COPE approaches to analyse and support the interactions between different organisations for their agile response capability. As such they improve safety-related interfaces and sharing of safety information with external parties as part of SMS components 3 and 4. Training in safety and safety management (SMS component 4) is supported by the ARC-MEX approach.

Conclusion – What can it do for you?

The FSS P5 research has provided new approaches for the development of exercises and preparedness plans for air transport crisis situations. These structured approaches support single organizations and multiple interacting organizations to augment their intra- and inter-organizational capability of detecting and flexibly responding to dynamic crisis scenarios. They support air transport organizations to be better prepared for crisis situations, and to be more resilient and creative when crises occur.

3.7. Advanced SMS

Research stream

This research stream has analysed the interactions between the P5 research streams and it has studied the couplings with safety management systems as used in the aviation industry. It has presented various cases for the various P5 research streams as examples how the knowledge gained can be actively employed for reducing the likelihood of accidents with organizational contributions [1]. In support of the research, it has developed a generic aviation safety management maturity questionnaire, which allows organisations across the aviation system to assess the maturity of their safety management system.

Relations with other research streams

This research stream provides an overview of the application of all P5 research streams in organizations, of the interactions of the P5 research streams, and provides the linkages to safety management systems.

Relations with SMS

There are two types of relations of this research stream with SMS. The first type regards the evaluation of the couplings of all P5 research streams to SMS. The second type regards the coupling of the generic air transport SMS Maturity Assessment Tool (SMAT), including its workshop-supported analysis. The prime coupling of SMAT is in support of the topic on auditing and improvement of SMS methods (SMS component 3). The tool is a way to audit current SMS methods and the associated workshops are means towards improvement of an organization's SMS. The tool can also support evaluation and improvement of the SMS of sub-contractors (SMS component 1).

Conclusion – What can it do for you?

The FSS P5 research on advanced SMS focused on the interrelations of the FSS P5 research streams and on their relations with SMS. As such it has provided guidance on their practical use. The development of SMAT provides air transport organizations (including airlines, ANSPs, airports, etc.) the opportunity to do a self-assessment of their SMS and to use the associated workshop to further improve their SMS. Such a self-assessment is a starting point for understanding limitation in the current SMS, which can be effectively followed up by the insights and methods arrived at in FSS P5.

4 INTEGRATION OF FSS P5 RESEARCH IN SMS

The customary way to achieve and control a sufficient level of safety in organizations is by an SMS, as explained in Chapter 2. The current chapter explains in detail how the FSS P5 research streams presented in Chapter 3 can effectively support an organization's SMS following the topics of SMAT (Section 2.2.2). Next, Section 4.1 gives an overview of the main contributions by the FSS P5 research streams and Sections 4.2 to 4.5 provide the details for each of the SMS components 1 to 4.

4.1. Overview of the contributions by FSS P5 research streams

As explained in Chapter 3, the FSS P5 research has been organized along the following streams:

- *WP1-TM*: Top Management as researched in WP1, see Section 3.1
- *WP1-MM*: Middle Management as researched in WP1, see Section 3.2
- *WP1-SD*: Safety Dashboard as researched in WP1, see Section 3.3
- *WP2-SM*: Safety Mindfulness as researched in WP2, see Section 3.4
- *WP3-SC*: Safety Culture as researched in WP3, see Section 3.5
- *WP4-ARC*: Agile Response Capability as researched in WP4, see Section 3.6
- *WP5-SMS*: Safety Management System as researched in WP5, see Section 3.7

The couplings of these research streams with SMS are based on the topics of the generic aviation Safety Management Maturity Tool (SMAT) as described in Section 2.2.2 and Appendix C. In coordination with the leaders of the research streams an assessment was made of the contribution of each research stream to the SMAT topics. For this assessment the following three categories are used:

- *None*: FSS P5 research has not addressed the topic.
- *Descriptive*: FSS P5 research has addressed the topic by description and analysis of current organizational practices. Organizations can use this information to learn and improve their safety performance.
- *Method*: FSS P5 research has addressed the topic by development of a method or tool. Organizations may can this method or tool to improve their safety performance.

A summary of the SMS couplings of the FSS P5 research streams, based on above overview, is presented in Table 5. It follows from the results in Table 5 that of the total of 32 topics in the SMS maturity assessment tool, 9 topics have not been addressed by the FSS P5 research, 14 topics have been addressed in a descriptive way, and for 16 topics a method has been developed. The most important contributions to the SMS topics are highlighted. Details of the assessment are presented next in Sections 4.2 to 4.5.

Table 5. Summary of relations between subjects in the SMS maturity tool and the FSS P5 research streams. The most important contributions are highlighted.

Topic in SMS maturity assessment tool		Type of related FSS P5 stream		
#	Description	None	Descriptive	Method
1.1	Authorities, responsibilities, and accountabilities for safety management		WP1-TM WP1-MM	
1.2	Safety management function		WP1-TM	
1.3	Implementation and management of the SMS		WP1-TM WP1-SD	
1.4	Consistency with regional/international safety standards	x		
1.5	SMS documentation	x		
1.6	Emergency/Contingency response procedures and plan			WP4-ARC
1.7	Safety policy	x		
1.8	Senior management visibility and involvement		WP1-TM	
1.9	Sub-contractors		WP1-MM	WP3-SC WP5-SMS
2.1	Identification of hazards and disturbances			WP1-SD WP2-SM WP4-ARC
2.2	Risk assessment for design and change	x		
2.3	Safety risk control		WP1-SD	
2.4	Fatigue risk management	x		
2.5	Sufficiency of resources		WP1-MM	
2.6	Maintenance	x		
3.1	Integrated risk management and safety-related internal interfaces for key performance areas (such as finance, quality, security, and environment)		WP1-TM WP1-MM WP1-SD	
3.2	Safety-related interfaces with external parties			WP1-SD WP3-SC WP4-ARC
3.3	Reporting and investigation of safety occurrences			WP2-SM
3.4	Monitoring of safety indicators		WP1-MM	WP1-SD
3.5	Operational safety surveys and audits	x		
3.6	Auditing and improvement of SMS methods			WP5-SMS
3.7	Variations with respect to procedures and standards			WP2-SM
3.8	Auditor competency	x		
3.9	Management of change		WP1-MM	WP1-SD WP2-SM
4.1	Safety culture measurement and an improvement programme			WP1-SD WP3-SC
4.2	Promotion of a just and open culture for reporting and investigation of occurrences		WP1-MM	WP3-SC
4.3	Knowledge transfer of safety management standards and practices		WP1-MM WP1-SD	WP2-SM
4.4	Training and competency in safety and safety management		WP1-MM	WP4-ARC
4.5	Recording and dissemination of safety lessons learned			WP2-SM
4.6	Sharing of safety information and knowledge with		WP1-MM	WP1-SD

	industry stakeholders			WP3-SC WP4-ARC
4.7	Publication of safety performance information to the general public	x		
4.8	Sharing and learning best practices on operational safety and SMS practices			WP3-SC WP5-SMS

4.2. SMS component 1: Safety policy and objectives

SMS component 1 of ICAO Annex 19 [2, 3] describes the safety objectives of an organization and the principles, processes and methods of the organization's SMS to achieve them. The SMAT questionnaire uses 9 topics to assess the maturity of SMS component 1 (see details in Appendix C.1). The contributions of the FSS P5 research streams to enhancing the SMS maturity for each of these topics are explained in the following tables.

1.1 Authorities, responsibilities, and accountabilities for safety management

Contents	Definition of authorities, responsibilities, and accountabilities for the management of safety in an organization. Review processes of these organizational roles.
Organisational aspects	• Staff: None. • Management: Involvement in the definitions. • Safety management: Leading the definitions and the review processes.
Contribution of P5 research	**WP1-TM *Descriptive*** In interviews with senior executives, as published in a White Paper [18], they stated their strong feelings of accountability and responsibility for safety. It is expected that these statements can inspire other senior executives in acting in accountable and responsible ways towards safety excellence. **WP1-MM *Descriptive*** It follows from interviews with middle managers, that they feel responsible for getting the work done in a proper way, thus serving multiple goals while dealing the various circumstances that may affect the operations. Herein, safety is (only) one of the goals.

1.2 Safety management function

Contents	Definition safety manager function. Role of top management in SMS development and promotion
Organisational aspects	• Staff: None. • Management: Involvement in SMS development and promotion. • Safety management: Leading SMS development and promotion.
Contribution of P5 research	**WP1-TM *Descriptive*** In interviews with senior executives [18], they stated their active leadership on safety in their organization. It is expected that these statements can inspire other senior executives in effectively contributing to safety management and supporting the work of safety managers.

1.3 Implementation and management of the SMS

Contents	Level of implementation of the SMS. Monitoring and control of the effectiveness of SMS.
Organisational	• Staff: None.

aspects	• Management: Involvement in implementation of the SMS • Safety management: Leading implementation and management of SMS.
Contribution of P5 research	**WP1-TM *Descriptive*** In interviews with senior executives [18], they stated their active leadership on safety in their organization, and their searching for evidence by weak signals about safety in their organization. It is expected that these statements can inspire other senior executives for active leadership in safety management. **WP1-SD *Descriptive*** Both the analysis of existing safety dashboards and envisioning of new ones identified a need for providing the information about EU IR 390/2013 Safety KPIs, which encompass a measure of the Effectiveness of Safety Management System. Safety managers agreed that it would be very beneficial to complement the European Indicator with more fine-grained indicators of SMS effectiveness. The safety dashboard would be very suitable for monitoring such SMS indicators.

1.4 Consistency with regional/international safety standards

Contents	Organisational mechanisms to assure compliance with regional or international safety standards. Contribution to development of such standards.
Organisational aspects	• Staff: None. • Management: None. • Safety management: Organisational processes for assuring consistency.
Contribution of P5 research	None.

1.5 SMS documentation

Contents	Completeness of SMS documentation. Excellence of SMS documentation. Availability of SMS documentation for all personnel. Organisational processes to continuously improve the SMS documentation.
Organisational aspects	• Staff: Availability of SMS documentation. • Management: Availability of SMS documentation. • Safety management: Development and improvement of SMS documentation.
Contribution of P5 research	None.

1.6 Emergency/Contingency response procedures and plan

Contents	Redundancy of primary systems. Development of emergency/contingency response plan. Distribution, rehearsal, exercises of plan by staff. Flexibility and adaptation of plans. Intra- and inter-organisational information exchange.
Organisational aspects	• Staff: Training and exercises of emergency/contingency response. • Management: Training and exercises of emergency/contingency response. Deciding on emergency/contingency systems and procedures. • Safety management: Development and adaptation of emergency/contingency response plans. Development of training. Analyses of past events.
Contribution of P5 research	**WP4-ARC *Method*** Development of guidance for analysing and aiding the intra- and inter-organizational capability of detecting and flexibly responding to dynamic crisis scenarios. ARC-MEX supports exercising agile response. ARC-COPE supports the development of preparedness plans and analysis of past actual events.

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1.7. Safety policy

Contents	Definition of safety policy. Periodic reviews of the safety policy. Comparing safety policies against other organisations.
Organisational aspects	• Staff: None. • Management: Involvement in definition of safety policy and formal responsibility. • Safety management: Definition and updating of safety policy.
Contribution of P5 research	None.

1.8 Senior management visibility and involvement

Contents	Involvement and visibility of senior management in a broad range of safety related activities in the organisation.
Organisational aspects	• Staff: Observe leading safety role of senior management. • Management: Senior management shows leading safety role. • Safety management: May support senior management in showing leading role.
Contribution of P5 research	**WP1-TM *Descriptive*** In interviews with senior executives [18], they stated their active leadership on safety in their organization. It is expected that these statements can inspire other senior executives in clearly expressing a leading safety role.

1.9 Sub-contractors

Contents	Evaluation, auditing, and support for improvement of the SMS of sub-contractors
Organisational aspects	• Staff: None. • Management: Are informed of actions. • Safety management: Lead actions for SMS of sub-contractors.
Contribution of P5 research	**WP1-MM *Descriptive*** In some interviews with middle managers they indicated their ways to interact with sub-contractors and to consider subcontractors' quality and safety. Although this has not been a systematic topic of the interviews, the used practices may be useful to consider by other middle managers. **WP3-SC *Method*** The Stack approach in WP3 supports discussion and improvement of the safety management of related organizations, including sub-contractors. **WP5 *Method*** The SMAT questionnaire can be used to assess the maturity of the SMS of a sub-contractor.

4.3. SMS Component 2: Safety risk management

SMS component 2 of ICAO Annex 19 [2, 3] describes the safety risk management processes to assure that the safety risks encountered in aviation activities are controlled to achieve an organization's safety performance targets. The SMAT questionnaire uses 6 topics to assess the maturity of SMS component 2 (see details in Appendix C.2). The contributions of the FSS P5 research streams to enhancing the SMS maturity for each of these topics are explained in the following tables.

2.1 Identification of hazards and disturbances

Contents	Identification of hazards and disturbances as part of safety risk assessment, feedback from operations, changes in circumstances.
Organisational aspects	• Staff: Involvement in identification/reporting of hazards, disturbances, changing circumstances. • Management: Involvement in identification/reporting of hazards, disturbances, changing circumstances. • Safety management: Lead identification of hazards and disturbances.
Contribution of P5 research	**WP1-SD *Method*** Development of an "operational risks" hotspot map in the prototyped safety dashboard. It represents the feedback collected from surveys done inside ops unit, in order to identify threats to operations. **WP2-SM *Method*** Development of IT solutions/applications for reporting of safety-related events and situations. These solutions/applications can be used to report hazards, disturbances, and changing circumstances by staff. **WP4-ARC *Method*** The ARC method supports the development of scenarios for exercises and preparedness planning, including combinations of hazards and disturbances in crisis situations.

2.2 Risk assessment for design and change

Contents	Assessment of safety risks by a variety of methods. Assessment of effects on a range of key performance areas: trade-offs of operators.
Organisational aspects	• Staff: Involvement in safety risk assessments and assessment of trade-offs by operators. • Management: Involvement in safety risk assessments and assessment of trade-offs. • Safety management: Leading of safety risk assessments and assessment of trade-offs.
Contribution of P5 research	None.

2.3 Safety risk control

Contents	Various methods for safety risk control: setting of requirements on human error; development of processes, training, staffing, systems; decision-making about as-low-as-reasonably practical risks, defining normal variability in work and performance indicators to check this.
Contribution of P5 research	• Staff: Involvement in training, and in the development of new processes and systems. Involvement in defining normal variability in work. • Management: Involvement in development of new processes and systems. • Safety management: Leading safety risk control activities: training, development of new systems / procedures, determining normal variability.
Contribution of P5 research	**WP1-SD *Descriptive*** The work done in WP1 has a highlighted a need for integrating into safety dashboards a quantitative risk model capable of connecting the various indicators, in order to deliver an overall risk picture which takes into account several sources of information.

2.4 Fatigue risk management

Contents	Various levels of fatigue risk management
Organisational aspects	• Staff: Involved in fatigue monitoring, effects of rostering, effects of mitigating measures. • Management: Deciding on rostering of staff, mitigating measures. • Safety management: Leading of fatigue risk assessment, fatigue monitoring, mitigating measures.
Contribution of P5 research	None.

2.5. Sufficiency of resources

Contents	Risk assessments concerning the numbers and functions of personnel are included in safety cases. Control in operations of under-resourcing situations.
Organisational aspects	• Staff: Involvement in the resources risk assessment. Effect on the human resources in the operations. • Management: Deciding on human resources. • Safety management: leading the risk assessment.
Contribution of P5 research	**WP1-MM *Descriptive*** In interviews with middle managers sufficiency of resources was not considered as part of risk assessments, but rather as part of managing operations. They indicated that often it is the quality of the resources that matters, rather than the quantity. In particular, it is important to have experts that have a good knowledge of the overall operations and the interactions between its human and technical elements, in order to get the work done effectively, efficiently, and safely.

2.6. Maintenance

Contents	Risk management of maintenance, including data-driven assurance of quality and integrity, improvement of maintenance management.
Organisational aspects	• Staff: Involvement in maintenance risk assessment. Effect on the maintenance policies in the operations • Management: Deciding on maintenance systems and procedures. • Safety management: leading the maintenance risk assessment.
Contribution of P5 research	None.

4.4. SMS component 3: Safety assurance

SMS component 3 of ICAO Annex 19 [2, 3] describes the safety assurance processes and activities undertaken by an organization to determine whether the SMS is operating according to expectations and requirements. The SMAT questionnaire uses 9 topics to assess the maturity of SMS component 3 (see details in Appendix C.3). The contributions of the FSS P5 research to enhancing the SMS maturity for each of these topics are explained in the following tables.

3.1 *Integrated risk management and safety-related internal interfaces for key performance areas (such as finance, quality, security, and environment)*

Contents	Integrated risk management for relevant key performance areas. Relations between various types of risks. Costs and benefits of risk mitigating measures. Continuous improvement of integrated risk management.
Organisational aspects	• Staff: Involvement in risk assessments for various key performance areas. • Management: Deciding on the strategies based on risk assessments. • Safety management: Leading integrated risk assessments.
Contribution of P5 research	**WP1-TM *Descriptive*** In interviews with senior executives [18], they stated that safety is a top priority, but also that there are economic and performance pressures that may affect safety. The views expressed may support other senior executives in balancing different goals. **WP1-MM *Descriptive*** In interviews with middle managers they indicated that a main part of their work is managing to get the work done and to deal with various (potentially conflicting) goals herein, and uncertainty and disturbances that complicate the work. Doing so, they perform some kind of integrated risk management, although without explicitly assessing all risks. **WP1-SD *Descriptive*** Work on Safety Intelligence has highlighted a need for integrating indicators coming from different KPA in a single "place". One of the most interesting links is the one between capacity and safety. Some ANSPs are making efforts in that sense, by visualising on the same tool both safety and economic indicators.

3.2 Safety-related interfaces with external parties

Contents	Risk management processes for relations with external parties, leading to safety requirements. Surveying / auditing of agreements with external parties, and of newly developing risks. Continuous improvement of safety-related interfaces with external parties.
Organisational aspects	• Staff: Involvement in risk assessments and auditing processes. • Management: Deciding on relations with external parties and involvement in risk assessments and auditing processes. • Safety management: Leading risk assessment and auditing processes.
Contribution of P5 research	**WP1-SI *Method*** Safety dashboards were prototyped including an indicator for so called "external safety factors", which aims at highlighting the risk factors not under direct control of the organisation. **WP3-SC *Method*** The safety culture stack supports discussion and improvement of the safety management of related organizations. **WP4-ARC *Method*** It is a key aspect of the ARC-MEX and ARC-COPE approaches to analyse and support the interactions between different organisations for their agile response capability.

3.3 Reporting and investigation of safety occurrences

Contents	System for reporting and investigation of safety occurrences. Corrective and preventive actions following investigation. Monitoring of identified risks. Feedback process to reporters. Reporters can suggest corrective actions.

Organisational aspects	Staff reporting occurrences. Involvement of staff in investigation. Staff suggesting corrective actions. Feedback of investigations to staff. • Staff: Reporting of occurrences, involvement in investigations, suggesting of corrective actions, feedback from investigators. • Management: Being informed about reports and investigations. • Safety management: Managing all elements of the reporting system and investigation processes.
Contribution of P5 research	**WP2-SM *Method*** Development of software IT solutions/applications for reporting of safety-related events and situations. These solutions/applications can be used to report occurrences and suggest corrective actions by staff.

3.4 Monitoring of safety indicators

Contents	Identification of safety indicators and targets. Monitoring system for safety indicators. Qualitative and quantitative indicators. Trend analysis, internal and external comparative analysis. Indicators for performance variability of work-as-done (normal behaviour).
Organisational aspects	• Staff: Performance of staff is being measures / monitored. Staff may be informed about outcomes of monitoring. • Management: Deciding on indicators and targets. Being informed about the monitoring results. • Safety management: Leading all processes for monitoring of safety indicators.
Contribution of P5 research	**WP1-SD *Method*** The safety intelligence research contributes by the development of top-class safety dashboards, which inform management of a range of leading and lagging safety indicators. Advanced safety dashboard would integrate data analysis and drilling capabilities, enabling their users to look for links and correlations between indicators, safety events and contributing causal factors. **WP1-MM *Descriptive*** In the interviews with middle managers, they rarely indicated that safety dashboards would be useful for their work. They would rather more rely on their own judgement of the level of safety in the work they manage. It was indicated though that safety indicators may be useful to influence others.

3.5 Operational safety surveys and audits

Contents	Internal and external (independent) operational safety surveys and audits. Development and implementation of improvement plans based on surveys/audits. Process to identify follow-up surveys/audits.
Organisational aspects	• Staff: Performance of staff is the subject of operational safety surveys / audits. • Management: Being informed about the outcomes of surveys / audits. • Safety management: Conducting / organizing the surveys / audits.
Contribution of P5 research	None.

3.6 Auditing and improvement of SMS methods

Contents	Internal and external audits of SMS methods. Processes for reviewing of SMS and keeping it up to date with industry practices, and with new insights for improving SMS in the scientific literature.
Organisational aspects	• Staff: None. • Management: Being informed of audits, deciding on changes.

	• Safety management: Conducting internal audits. Cooperating with external audits.
Contribution of P5 research	**WP5-SMS *Method*** The SMS Maturity Assessment Tool (SMAT) supports the assessment and improvement of an air transport organization's SMS.

3.7 Variations with respect to procedures and standards

Contents	Reporting of variances in work-as-done with respect to procedures. Analysis of reported variances, leading to training and/or changes in procedures. Reported variances compared with assumptions in safety risk assessment.
Organisational aspects	• Staff: Reporting of variances in work-as-done w.r.t. procedures. • Management: Being informed of analyses. Deciding on changes to procedures, extra training. • Safety management: Collecting and analysing data. Recommendations for changes in procedures, training.
Contribution of P5 research	**WP2-SM *Method*** Development of software IT solutions/applications for reporting of safety-related events and situations. These might be used to report variations/process improvements with respect to procedures and standards by staff.

3.8 Auditor competency

Contents	Audit training and competency development for safety and audit personnel. Use of external audits by peers.
Organisational aspects	• Staff: None. • Management: None. • Safety management: Doing audit training. Use external audit peers.
Contribution of P5 research	None.

3.9 Management of change

Contents	Various change management processes: involving stakeholders, risk assessment, impact analysis, quantitative and qualitative approaches. Improvement of the change management processes.
Organisational aspects	• Staff: Subject to the change. Involved in risk assessments. • Management: Leading the change management processes. • Safety management: Supporting some change management processes.
Contribution of P5 research	**WP1-MM *Descriptive*** In the interviews with middle managers, several aspects of change management were discussed. For instance, it is considered important to well involve all actors who may be impacted by a particular change. Also it is relevant to recognize when a change would require to do a safety risk assessment. These kinds of results from the interviews may be used as guidance for middle managers. **WP1-SD *Method*** A prototypes safety dashboard dedicates an indicator to the "Impact of Change", which gives an overview of all changes projects undergoing together with comments and impact on Ops. The aim is to support senior management in understanding the combined effect of change on staff. **WP2-SM *Method*** an Improvement Manager app has been developed, which

	supports information transfer for change management in an organization.

4.5. SMS component 4: Safety promotion

SMS component 4 of ICAO Annex 19 [2, 3] the training, education and communication in the SMS to achieve a positive safety culture with proper knowledge and awareness of all people in the organization. The SMAT questionnaire uses 8 topics to assess the maturity of SMS component 4 (see details in Appendix C.4). The contributions of the FSS P5 research to enhancing the SMS maturity for each of these topics are explained in the following tables.

4.1 Safety culture measurement and an improvement programme

Contents	Regular measurement of safety culture. Implementation of improvements for identified weaknesses. Continuously reflecting in the decision making on the impact on safety culture.
Organisational aspects	• Staff: Involvement in measurements and workshops. Effect of improvement actions. • Management: Being informed on safety culture results. Deciding on improvement actions. • Safety management: Leading safety culture measurement and improvement programme.
Contribution of P5 research	**WP1-SD *Method*** The prototyped safety dashboard includes indicators for monitoring the progress of safety culture actions, and the participation to safety initiatives. **WP3-SC *Method*** The safety culture analysis and improvement approach, using surveys and workshops, supports the measurement and analysis of safety culture in air transport organizations.

4.2 Promotion of a just and open culture for reporting and investigation of occurrences

Contents	Safety data-sharing and publication policies. Line between acceptable and unacceptable mistakes. Just reporting and investigation culture principles. Policy on how dialogue with judicial authorities and media is established.
Organisational aspects	• Staff: Knowing the just reporting and investigation culture. • Management: Assuring the just reporting and investigation culture. • Safety management: Developing policies for a just reporting and investigation culture.
Contribution of P5 research	**WP1-MM *Descriptive*** In the interviews with middle managers a reporting culture was considered important, as part of a management style where one listens to the field. Promotion of investigation of occurrences and a just culture were not indicated as important in these interviews. **WP3-SC *Method*** The safety culture survey includes just culture, reporting and occurrence investigation as subjects. Survey results in combination with workshops reveal opinions and ways to improve.

4.3 Knowledge transfer of safety management standards and practices

Contents	Effective communication to inform all staff about the safety management practices relevant for their work. Communication about changes, explanations about the background of procedures. Assessment and improvement of the effectiveness of communication mediums. Safety is a key focus of internal communication.
Organisational aspects	• Staff: Being informed with up-to-date information. • Management: Assuring effective communication and personal roles in achieving this. • Safety management: Leading the knowledge transfer strategies and assessment.
Contribution of P5 research	**WP1-MM *Descriptive*** In the interviews with middle managers, they indicated that management of information considered the overall practices for getting the work done appropriately, without special focus on safety. **WP1-SD *Descriptive*** Work on safety dashboard highlighted its importance as a tool for communication. It has been found out that a dashboard should not be "poured" over people, but rather used to support an in-person communication about safety. Therefore, in addition to safety monitoring, WP1 proposes to use the dashboard as an internal tool for safety communication between managers. **WP2-SM *Method*** Development of software IT solutions/applications for reporting of safety best practices/ recommendations coming from the direct users (e.g. the SM.App implemented in MUAC). These qualitative narratives might be used by the safety management staff to report variations/process improvements and leverage change in system procedures and standards, and this approach/methodology can be part/included in the safety process review.

4.4 Training and competency in safety and safety management

Contents	Regularly planned training processes for all staff and contractors for all relevant safety management practices. Feedback and improvement process of the training. High competency level of the instructors and uptake scientific developments in safety management.
Organisational aspects	• Staff: Receiving regular training and testing for all relevant safety practices. • Management: Receiving training and assuring that all staff follow the training programme. • Safety management: Leading of the training programme.
Contribution of P5 research	**WP1-MM *Descriptive*** In the interviews with middle managers training was discussed to a limited extent only. The middle managers considered safety management practices to be mostly relevant for safety management personnel. Some middle managers took some safety management training to obtain a broader safety picture. Some middle managers took operationally focused training to obtain a broader understanding of the work of their team. **WP4-ARC *Method*** The ARC-MEX approach supports the design of exercises that challenge the agile capability of the organisations.

4.5 Recording and dissemination of safety lessons learned

Contents	Systematic process for sharing safety lessons learned that is available for all staff at appropriate levels. Based on the lessons changes are made and well explained to staff. regular review of the recording and dissemination to assure its effectiveness.

Organisational aspects	• Staff: Contributing lessons learned and being well informed. • Management: Contributing lessons learned, being well informed, and assuring that changes are made. • Safety management: leading / organizing the recording and dissemination process.
Contribution of P5 research	**WP2-SM *Method*** Development of software IT solutions/applications for reporting and archiving of safety-related occurrences and lessons learned by staff.

4.6 Sharing of safety information and knowledge with industry stakeholders

Contents	Active sharing of safety data and information with recognised international bodies and other industry stakeholders. A learning process for safety data and information from external stakeholders.
Organisational aspects	• Staff: None. • Management: Facilitating of and participating in effective external communication. • Safety management: Leading the external communication.
Contribution of P5 research	**WP1-MM *Descriptive*** In the interviews with middle managers, some external sharing activities were considered, such as visiting of conferences. However, sharing of safety occurrences with external parties seems largely absent. **WP1-SD *Method*** Work on safety dashboard highlighted that there is already some sharing of safety data between ANSP and airlines. Data coming from external organisation can be part of some of the indicators featured in the prototyped safety dashboard, e.g. ”External safety factors”, “Top contributing causes” etc. **WP3-SC *Method*** The safety culture stack supports sharing of safety information and knowledge with industry stakeholders. **WP4-ARC *Method*** The ARC-MEX and ARC-COPE approaches support the interchange of safety information as part of multi-stakeholder exercises and preparedness planning.

4.7 Publication of safety performance information to the general public

Contents	Publishing appropriate and transparent safety performance information to the general public.
Organisational aspects	• Staff: None. • Management: Facilitating the publication of safety performance data. • Safety management: Leading the publication of safety performance data.
Contribution of P5 research	None.

4.8 Sharing and learning best practices on operational safety and SMS practices

Contents	Structured processes for sharing and learning of best practices for safe operations and for effective safety management, using cooperation with industry and academic partners.
Organisational aspects	• Staff: Indirectly only, by getting access to best practices. • Management: Facilitating the sharing and learning of best practices. • Safety management: Leading the sharing and learning of best practices.

Contribution of P5 research	**WP3-SC *Method*** The safety culture stack supports sharing and learning best practices on operational safety and SMS practices with industry stakeholders. **WP5-SMS *Method*** The SMS Maturity Assessment Tool (SMAT) supports organizations in learning from strong points in the SMS of other organizations and to improve inter-organizational safety management relations.

5 CONCLUSIONS

The objective of the research in FSS P5 is to advance safety in air transport organizations. The traditional approach to control and improve safety in organizations is by safety management using an SMS. The effort in maintaining and documenting an SMS can be considerable, as it includes a multitude of components and it relates in various ways to the design and conduct of operations in an organization. Notwithstanding the variety of components considered in SMS standards, including human factors and safety culture, safety management systems are often observed as being bureaucratic, distinct from actual operations, and being too much focused on the prevention of deviations from procedures rather than on the effective support of safety in the real operational context. The soft parts of advancing safety in organizations, such as the multitude of interrelations and the informal aspects in an organization that influence safety, are only considered to a limited extend in traditional safety management systems. A main challenge for an organization towards improving its safety lies in advancing the informal, human-related, soft elements.

The research in FSS P5 focused on improving these human-related, soft aspects, as follows from the overview in Section 3. The results of the research on top management support executives in improving their contributions and leadership in the safety performance and safety management of their organization. The middle management research has provided new insights and guidance that organizations can use to harness the role of middle management in organizational safety. The safety dashboard research supports organizations to develop and tune safety dashboards that lay an effective foundation for the information transfer in the organization's safety management system. The safety mindfulness research has provided new methods and techniques that support the flows of information in an organization to keep everyone mindful of their role in assuring safety and to provide them the knowledge to do so. The safety culture research has provided a broadened safety culture assessment and enhancement approach, and a safety culture stack approach, which supports improving the safety culture and safety interfaces of a stack of interrelated air transport organizations. The agile response capability research has provided new approaches for the development of exercises and preparedness plans for air transport crisis situations, which support organizations to advance their intra- and inter-organizational capability of detecting and flexibly responding to dynamic crisis scenarios. The advanced SMS research has provided guidance for the application of the FSS P5 research results in safety management, and it has developed a tool that supports air transport organizations to self-assess and improve their SMS.

Every organization is unique, in the operations it conducts, in the education of its personnel, in the relations it has with other organizations, in its history, in its organizational culture, in its relations with regulators, etc. As a result, every organization has its own strong and weak elements in assuring the safety of its operations. As such there cannot be a one-size-fits-all approach for advancing safety in organizations, but this needs to be based on a careful analysis of the organization at hand, leading to tailored solutions. The FSS P5 research has provided two main approaches for such analysis. The safety culture assessment and enhancement approach uses questionnaires for all personnel to identify strengths and weaknesses in safety culture dimensions, and it applies workshops to understand their background

and to arrive at ways to advance the safety culture. These solutions can be linked to the FSS P5 research streams. The SMS Maturity Assessment Tool (SMAT) uses questionnaires for management and safety management staff to identify strong and weak aspects in the SMS, and it applies workshops to discuss the safety management in practice and to identify ways to improve the SMS. The couplings of the FSS P5 research streams with the SMS components (Section 3) support their advancement. Following such analyses the results of the relevant FSS P5 research streams can be effectively used to advance safety in organizations.

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Appendix A STANDARDS AND RECOMMENDED PRACTICES FOR SMS

This appendix presents an overview of literature of standards and recommended practices (SARPs) for safety management. Appendix A.1 presents safety management SARPs of ICAO. Appendix A.2 presents SMS guidance material of the FAA. Appendix A.3 presents SMS guidelines by CANSO.

Appendix A.1 ICAO

The ICAO safety management manual [28] provides an overview of the standards and recommended practices (SARPs) related to safety management and it gives background and guidelines for applying them. These SARPs were initially adopted in a range of annexes to the Convention of International Civil Aviation (Annex 1, 6, 8, 11, 13, 14), but Annex 19 [2] now provides an overall overview of the safety management SARPs. A new (second) edition of Annex 19 has become available [3] and this edition will supersede the previous edition per 7 November 2019.

ICAO provides safety management related standards and recommended practices (SARPs) for service providers. Here the term 'service provider' refers to a range of organizations (excluding states), such as training organizations, airlines, maintenance providers, aircraft manufacturers, air traffic service providers, and aerodrome operators.

The ICAO framework includes four components and twelve elements, representing the minimum requirements for SMS implementation. The four components of an SMS are: (1) safety policy and objectives; (2) safety risk management; (3) safety assurance; and (4) safety promotion.

SMS component 1: Safety policy and objectives

Safety policy outlines the principles, processes and methods of the organization's SMS to achieve the desired safety outcomes. The policy establishes senior management's commitment to incorporate and continually improve safety in all aspects of its activities. Senior management develops measureable and attainable organization-wide safety objectives to be achieved.

It consists of the following elements: 1.1 Management commitment; 1.2 Safety accountabilities and responsibilities; 1.3 Appointment of key safety personnel; 1.4 Coordination of emergency response planning; 1.5 SMS documentation.

SMS Element 1.1: Management commitment

The service provider shall define its safety policy in accordance with international and national requirements The safety policy shall:

a) reflect organizational commitment regarding safety, including the promotion of a positive safety culture;
b) include a clear statement about the provision of the necessary resources for the implementation of the safety policy;
c) include safety reporting procedures;
d) clearly indicate which types of behaviours are unacceptable related to the service provider's aviation activities and include the circumstances under which disciplinary action would not apply;
e) be signed by the accountable executive of the organization;
f) be communicated, with visible endorsement, throughout the organization; and
g) be periodically reviewed to ensure it remains relevant and appropriate to the service provider.

Taking due account of its safety policy, the service provider shall define safety objectives. The safety objectives shall:

a) form the basis for safety performance monitoring and measurement;
b) reflect the service provider's commitment to maintain or continuously improve the overall effectiveness of the SMS;
c) be communicated throughout the organization; and
d) be periodically reviewed to ensure they remain relevant and appropriate to the service provider.

SMS Element 1.2: Safety accountabilities and responsibilities

The service provider shall:

a) identify the accountable executive who, irrespective of other functions, has ultimate responsibility and accountability, on behalf of the organization, for the implementation and maintenance of the SMS;
b) clearly define lines of safety accountability throughout the organization, including a direct accountability for safety on the part of senior management;
c) identify the accountabilities of all members of management, irrespective of other functions, as well as of employees, with respect to the safety performance of the SMS;
d) document and communicate safety responsibilities, accountabilities and authorities throughout the organization; and
e) define the levels of management with authority to make decisions regarding safety risk tolerability.

SMS Element 1.3: Appointment of key safety personnel

The service provider shall appoint a safety manager who is responsible for the implementation and maintenance of the SMS.

SMS Element 1.4: Coordination of emergency response planning

The service provider required to establish and maintain an emergency response plan for accidents and incidents in aircraft operations and other aviation emergencies shall ensure that the emergency response plan is properly coordinated with the emergency response plans of those organizations it must interface with during the provision of its products and services.

SMS Element 1.5: SMS documentation

The service provider shall develop and maintain an SMS manual that describes its:

a) the safety policy and objectives;
b) SMS requirements;
c) SMS processes and procedures;
d) accountabilities, responsibilities and authorities for SMS processes and procedures.

The service provider shall develop and maintain SMS operational records as part of its SMS documentation.

SMS component 2: Safety risk management

Safety risk management is the process whereby service providers ensure that the safety risks encountered in aviation activities are controlled in order to achieve their safety performance targets. It consists of the following elements: 2.1 Hazard identification, and 2.2 Safety risk assessment and mitigation.

SMS Element 2.1: Hazard identification

The service provider shall develop and maintain a process to identify hazards associated with its aviation products or services. Hazard identification shall be based on a combination of reactive and proactive methods.

SMS Element 2.2: Safety risk assessment and mitigation

The service provider shall develop and maintain a process that ensures analysis, assessment and control of the safety risks associated with identified hazards.

SMS component 3: Safety assurance

Safety assurance consists of processes and activities undertaken by the service provider to determine whether the SMS is operating according to expectations and requirements. The service provider continually monitors its internal processes as well as its operating environment to detect changes or deviations that may introduce emerging safety risks or the degradation of existing risk controls. Such

changes or deviations may then be addressed by the safety risk management process. It consists of the following elements: 3.1 Safety performance monitoring and measurement; 3.2 The management of change; 3.3 Continuous improvement of the SMS.

SMS Element 3.1: Safety performance monitoring and measurement

The service provider shall develop and maintain the means to verify the safety performance of the organization and to validate the effectiveness of safety risk controls. The service provider's safety performance shall be verified in reference to the safety performance indicators and safety performance targets of the SMS in support of the organization's safety objectives.

SMS Element 3.2: The management of change

The service provider shall develop and maintain a process to identify changes which may affect the level of safety risk associated with its aviation products or services and to identify and manage the safety risks that may arise from those changes.

SMS Element 3.3: Continuous improvement of SMS

The service provider shall monitor and assess the effectiveness of its SMS processes to enable continuous improvement of the overall performance of the SMS.

SMS component 4: Safety promotion

Safety promotion encourages a positive safety culture and creates an environment that is conducive to the achievement of the service provider's safety objectives. An organizational safety effort cannot succeed solely by mandate or strict adherence to policies. Safety promotion affects both individual and organizational behaviour and supplements the organization's policies, procedures and processes, providing a value system that supports safety efforts. It consists of the following elements: 4.1 Training and education; 4.2 Safety communication.

SMS Element 4.1: Training and education

The service provider shall develop and maintain a safety training programme that ensures that personnel are trained and competent to perform their SMS duties. The scope of the safety training programme shall be appropriate to each individual's involvement in the SMS.

SMS Element 4.2: Safety communication

The service provider shall develop and maintain formal means for safety communication that:

a) ensures personnel are aware of the SMS to a degree commensurate with their positions;
b) conveys safety-critical information;
c) explains why particular safety actions are taken; and
d) explains why safety procedures are introduced or changed.

Appendix A.2 FAA guidance material for SMS

In the United States, order [7] provides the SMS policy and requirements for the Federal Aviation Administration (FAA). It describes the compliance of FAA with ICAO Annex 19, for the state safety program regarding FAA's regulatory role, as well as for the SMS of FAA's service provider organizations. The order provides a high-level description of the SMS components, being safety policy, safety risk management, safety assurance, and safety promotion. In the light of the importance of safety risk management (SRM) in the FAA SMS, order [8] establishes a policy for safety risk management. SMS guidance material for Part 121 air carriers is provided by FAA in an advisory circular [9]. Next, some key aspects of this FAA documentation are provided.

Safety culture and safety management

Safety culture considers the aspects of an organization's culture that relate to safety performance [9]. It is recognized that safety culture and SMS are interdependent, and in particular that the management framework is crucial for shaping the environment in which employees work and affects the organizational performance in all aspects of the organization's business, including safety. If positive aspects of culture are to emerge, the organization's management must set up the policies and processes that create a working environment that fosters safe behavior. That is the purpose of the SMS processes.

Safety policy

As part of the safety policy component of the SMS, the following aspects are considered [9].

- The safety policy statement itself, including safety objectives, a commitment statement, information about resources for the SMS implementation, a safety reporting policy, a policy from delineating acceptable from unacceptable behaviour, and an emergency response plan.
- Definition of safety accountabilities in the organization and of the management levels that have the authority to make decisions regarding safety risk acceptance.
- Designation of the accountable executive for safety management, and definition of the responsibilities of the accountable executive.
- Designation of management personnel and definition of their responsibilities in safety management.

- Coordination of emergency response planning.

Safety risk management

The safety risk management component of FAA is consistent with that of ICAO Annex 19, but it is structured in more detail and it is more clearly coupled with the safety assurance component [7-9]. An overview of the steps in safety risk management and the relations with safety assurance is shown in Figure 5. In particular, the safety risk assessment is a formal approach for identifying and mitigating risk, which is started when new systems or changes to systems are considered, where systems considered in a broad sense and include people, hardware, software, information, procedures, facilities, services and other support facets.

Safety risk management (SRM) consists of the following steps [9].

a) *System description and analysis* – to gain an understanding of the components and elements of operational systems, processes, procedures and the operational environment. Systems analysis is the primary means of proactively identifying and addressing potential problems before the new or revised systems or procedures are put into place. The system analysis should explain the functions and interactions among the hardware, software, people, and environment that make up the system in sufficient detail to identify hazards and perform risk analyses.
b) *Hazard identification* – to examine operational systems, operations, processes, and the operational environment in order to identify conditions that could result in an aircraft accident. The key question in hazard identification is: “What could go wrong with your processes, under typical or abnormal operational conditions, that could cause an accident?” Operational experience and knowledge, (FAA) requirements, and manufacturers’ technical data can be input sources.
c) *Safety risk analysis* – to estimate the severity and likelihood of a potential accident due to exposure to an identified hazard. For each identified hazard, define the potential for injury and damage that may result from an accident related to operating while exposed to the hazard. In order to determine potential for injury and damage, you need to define the likelihood of occurrence of an accident and severity of the injury or damage that may result from the aircraft accident.
d) *Safety risk assessment* – to make a decision regarding the acceptability of operation in the presence of an identified hazard. A common tool used in risk assessment decisions is a risk matrix. A risk matrix provides you with a way to integrate the effect of severity of the outcome and the probability of occurrence, which enables you to assess risks, compare potential effectiveness of proposed risk controls, and prioritize risks where multiple risks are present. If all risks are acceptable the system design can go into operation (see link to safety assurance in Figure 5).

e) *Safety risk controls* – to develop a risk control that reduces risk to an acceptable level. Risk controls need to be developed to mitigate unacceptable risks, e.g. by new processes, equipment, training, systems, or staffing arrangements. It needs to be assessed whether the achieved level of risk is acceptable and that the proposed control does not introduce new hazards with unacceptable consequences by another iteration of the SRM cycle, as shown in Figure 5.

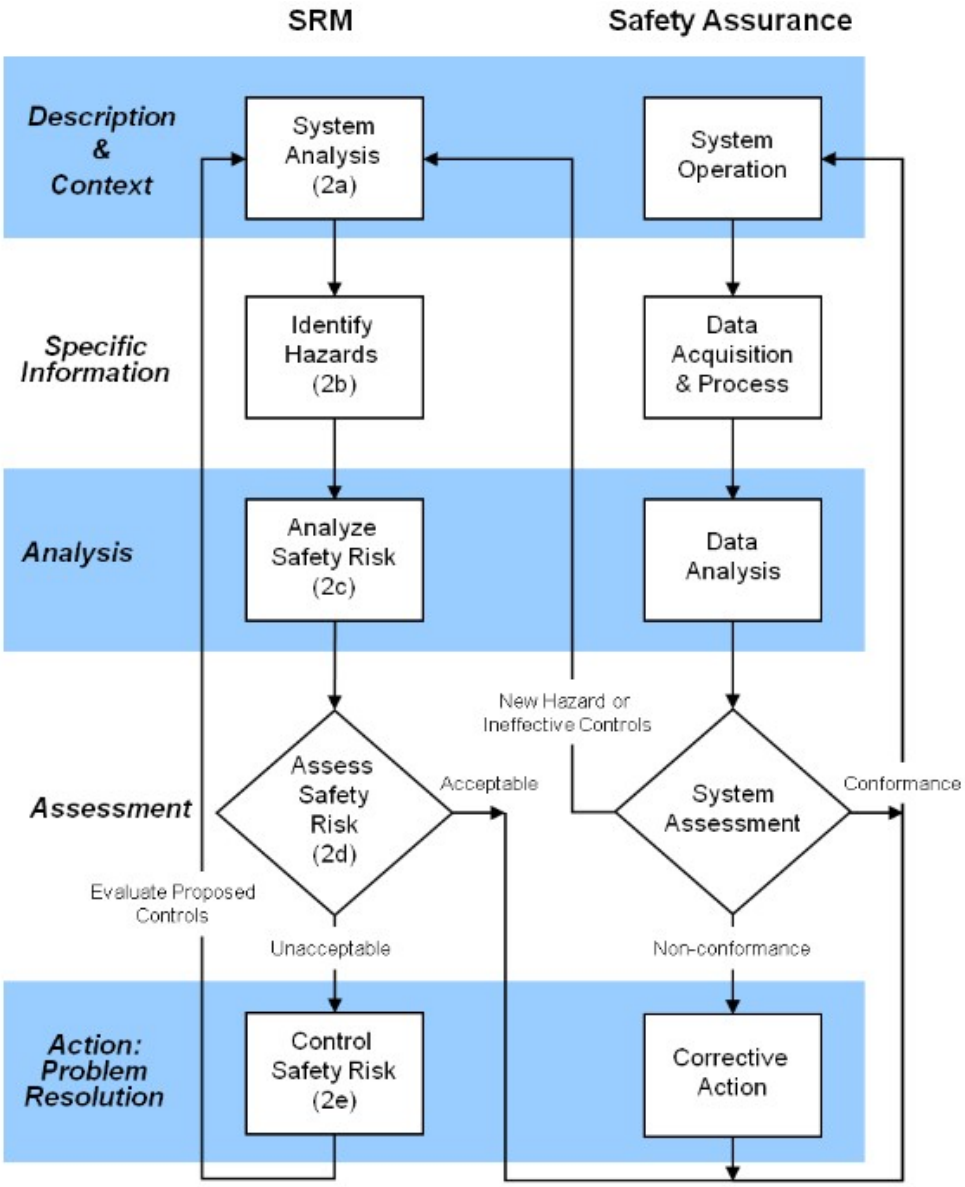

Figure 5. SRM and safety assurance processes, source [8].

Safety assurance

In [9] safety assurance is achieved by three types of processes:

a) Safety performance monitoring and measurement, which includes monitoring / data acquisition of system operations, and data analysis (i.e. the three top safety assurance processes in Figure 5);
b) Safety performance assessment; and
c) Continuous improvement (corrective action in Figure 5).

Safety performance monitoring and measurement

The safety performance monitoring and measurement process includes the following types of monitoring and data acquisition processes.

1. *Monitoring of operational processes* – to observe the day to day, flight by flight, job by job performance of operational systems and their associated risk controls. Monitoring operational processes is what supervisors do on a day-to-day basis (e.g., direct supervision of employee activities, monitoring of pilot currency, and monitoring Minimum Equipment List (MEL) status). Monitoring also involves reviewing data that is collected for operational purposes to look for anything of safety significance (e.g., duty logs, crew reports, work cards, process sheets, and reports from the employee safety feedback system). This may include monitoring products and services from outside sources that are used in the certificate holder's operations.
2. *Monitoring of operational environment* – to monitor the operational environment to identify new or changed conditions. Monitoring of the operational environment involves practices that are similar to those of monitoring operational processes. The context for monitoring the operational environment of a system is developed from the system analysis that is conducted under SRM. Once the scope of the operational environment is defined under SRM, the operational environment must be monitored to assess impacts on aviation safety.
3. *Auditing of operational processes and systems* – to provide the process owners with a means to obtain information about the performance of systems in their area of responsibility. Audits are a means of collecting data to confirm whether or not actual practices are being followed within a department. Audits should typically involve the operational management responsible for the system(s) being audited. Procedures for auditing should describe your audit process, criteria, scope, frequency, method for selecting auditors, and methods of documentation and recordkeeping. Audit planning should take into account the safety criticality of the processes to be audited and the results of previous audits.
4. *Evaluation of SMS and operational processes and systems* – to provide a source of information to the organization regarding the safety performance of operational systems and the SMS. An evaluation is typically an independent review of the company's processes, procedures, and systems. The evaluation process builds on the concepts of audit and inspection. An evaluation is an internal oversight tool that provides the accountable executive with a snapshot of the safety performance of the carrier's

operational processes and systems, as well as SMS processes. The evaluation should include all available data about the organization, including information from the audits conducted by the operational management.

5. *Investigation of incidents and accidents* – to gather information on accidents and incidents to identify potential weaknesses in operational systems. Investigations should be treated as an opportunity for organizational learning to prevent a repeat of errors and/or change company processes so that mistakes do not recur. Investigations should focus on what went wrong rather than who caused the error and emphasize improvement of safety performance.
6. *Investigation of potential noncompliance* – to obtain information to determine compliance with regulations as well as underlying policies and procedures. Similar to the investigation of incidents and accidents, the focus should be on organizational learning to identify system deficiencies and improve system reliability.
7. *Confidential employee reporting system* – to provide a means for employees to communicate safety information to management. Front-line employees may observe aspects of the operation or environment that were not expected and were not included in audit or evaluation protocols. In this respect, the employee reporting system can fill in important gaps in the company's data collection process.

Based on data from above system monitoring and data acquisition processes, analysis is done to make inferences about the safety performance of the operational systems and the SMS. According to [9] such data analysis includes establishing the context of the data analysis, such as the safety performance objectives derived in the SRM, or the performance objectives set out for the SMS, the analysis of data by appropriate qualitative or quantitative methods, e.g. review by subject matter experts or trend analysis, and comparison with safety objectives, leading to the formulation of recommendations.

Safety performance assessment

As part of the safety performance assessment a certificate holder must conduct assessment of its safety performance against its safety objectives, including

1) Evaluation of compliance with the safety risk controls as established in the SRM;
2) Evaluation of the performance of the SMS;
3) Evaluation of the effectiveness of the safety risk controls established in the SRM and identification of ineffective controls;
4) Identification of changes in the operational environment that may introduce new hazards;
5) Identification of new hazards.

If it follows from 1) that performance if not compliant with safety risk controls, there is a need for a corrective action of the system operations. If it follows from 2) that the performance of the SMS is not in line with the safety policy, there is a need for a corrective action of the organization of the SMS. If it follows from 3) that the safety risk controls established in the SRM are not effective, the SRM cycle needs

to be done again using the feedback on ineffective risk controls. If it follows from 4) or 5) that there are new hazards, the SRM cycle needs to be revisited.

Continuous improvement

The continuous improvement step in the safety assurance process refers to the correction of substandard safety performance, following the safety performance assessment in the previous step.

Safety promotion

Safety promotion includes SMS training and safety communication.

SMS training

SMS training is needed to assure that employees are competent to perform their SMS-related duties. Determining the organization's training needs starts with a careful review of the safety policy, processes, and objectives. Everyone working within the scope of SMS should receive training commensurate with their position in the organization, leading to suitable competency of the employees. Competency is an observable, measurable set of skills, knowledge, abilities, behaviours, and other characteristics that individuals exhibit as they successfully perform work functions. Competencies are typically required at different levels of proficiency depending on the work roles or occupational function. Competence can be assessed at the completion of training by written, oral, or demonstration tests, and then measured periodically during the performance of that individual's work by way of periodic evaluations or supervisor/management observations. As part of safety assurance, organizations should periodically review their training program(s) to ensure that those programs meet the objectives set out in the safety policy.

Safety communication

Safety communication serves to assure that employees have current and pertinent safety information, which (a) ensures that employees are aware of the SMS policies, processes, and tools that are relevant to their responsibilities; (b) conveys hazard information relevant to the employee's responsibilities; (c) explains why safety actions have been taken; and (d) explains why safety procedures are introduced or changed. Effective communication involves adjusting the content of the communication and manner in which the information is delivered to match the target employee's role in the organization. The accountable executive must ensure that communication mechanisms are available and are effectively utilized. The delivery system should be appropriate according to the size and complexity of the organization.

SMS documentation and recordkeeping

The establishment of SMS documentation and SMS records is provided as a separate section in [9], whereas it is part of component 1.5 in ICAO Annex 19. It describes the requirement to establish and maintain SMS information, describing safety-related processes and procedures and interfaces between these, as well as requirements for maintenance of records of SMS information.

Phased SMS implementation strategy

A recommended approach towards implementation of an SMS is by the following four levels [9]:

Level 1) *Planning and Organization*. Level 1 begins when a management team commits to providing the resources necessary for full SMS implementation. Level 1 includes a thorough understanding of the organizational structure and a comparison (gap analysis) with the regulatory requirements. Next an implementation plan to bridge the identified gaps is developed and approved.

Level 2) *Basic Safety Management*. Level 2 is where basic Safety Risk Management (SRM) and Safety Assurance (SA) processes are developed and applied to existing systems. This is often called the "reactive phase" and the company is now able to identify hazards and address unacceptable risk.

Level 3) *Functional SMS*. Level 3 is where the SRM process is applied to the initial design of systems, processes, organizations, and services; development of new or changed operational procedures; and planned changes to operational processes. This is the "proactive/predictive" phase, where risks in future planned operations are addressed. Both the SRM and SA processes developed at Level 2 are now applied in a predictive manner. At the completion of Level 3, there is a fully implemented SMS.

Level 4) *Continuous Improvement*. At Level 4, the SMS and operational processes are monitored to attain and maintain continuous improvement for the life of the organization.

Integrating of safety programs into an SMS

Some guidelines are provided in [9] for integration of existing safety programs into an SMS, such as Aviation Safety Action Program (ASAP), Aviation Safety Reporting System (ASRS), Line Operations Safety Audit (LOSA), etc.

Appendix A.3 CANSO SMS guidelines

The Civil Air Navigation Services Organisation (CANSO) published a Standard of Excellence in Safety Management Systems (SoE in SMS) [10] and an associated implementation guide [11] to support ANSPs in their safety management. It is shown that the CANSO SoE in SMS is compliant with ICAO Annex 19 [2].

An overview of the structure of the CANSO SoE in SMS is provided in Figure 6. It considers safety culture as an SMS enabler and it consists of a framework of 5 components addressing 16 elements. Next the objectives associated with this SMS enabler and the SMS elements are presented.

Figure 6: Structure of the CANSO Standard of Excellence in Safety Management Systems [10].

Objectives for "Safety culture"

Development of a positive and proactive safety culture

- Objective 1.1. A positive and proactive, flexible, and informed safety culture (the shared beliefs, assumptions, and values regarding safety) that supports reporting and learning led by management.
- Objective 1.2. A just and open climate for reporting and investigation of occurrences. (Thorough reporting and investigation must include the complete process from notification, data gathering, reconstruction, analysis, safety recommendation and implementation of remedial actions, up to final reporting, exchange of lessons learned and effective monitoring.)
- Objective 1.3. Regular measurement of safety culture and an improvement programme.

Objectives for "Safety policy and objectives"

Safety policy

- Objective 2.1. The safety policy of the organisation presents the organisation's commitment to both safety and its resourcing. The priority of safety within the organisation is also articulated.

- Objective 2.2. The safety policy addresses key attributes of the organisation's approach to safety. These attributes will most likely include culture, visible endorsement, communication and safety reporting.

Organisational and individual safety responsibilities

- Objective 3.1. An approved, clearly documented, and recognised system for the management of safety. Management structure, responsibilities, accountabilities and authorities are clearly defined and documented.
- Objective 3.2. A clearly defined safety management function/safety manager that is independent of line management.
- Objective 3.3. Clear understanding and acceptance of safety management accountabilities and responsibilities by all relevant staff and contractors.

Coordination of emergency response plan

- Objective 4.1. Emergency response procedures and an emergency response plan that documents the orderly and efficient transition from normal to emergency operations and return to normal operations.

SMS documentation

- Objective 5.1. A formal SMS that meets all applicable safety and regulatory requirements.
- Objective 5.2. Clearly defined and documented safety standards and procedures.
- Objective 5.3. Safety management documents are regularly reviewed, assessed, and maintained.

Compliance with international obligations

- Objective 6.1. An organisation that takes into account the need to ensure, in a timely manner, that there are no inconsistencies with regional/international safety standards.

Objectives for "Safety risk management"

Risk management process

- Objective 7.1. Hazards to operations are reported and assessed.
- Objective 7.2. Assessed risks are mitigated or controlled.
- Objective 7.3. Risk controls are monitored for effectiveness, and remedial action taken if controls are not working effectively.

Objectives for "Safety achievement"

Safety by design

- Objective 8.1. Design addresses the whole system, people, procedures, airspace and equipment. Systems contain features to ensure they operate safely and support the operator's decision-making process. Equal weight is given to the success and failure case approaches.

Safety interfaces

- Objective 9.1. Effectively managed safety-related internal interfaces (e.g, quality management system, security, and environment).
- Objective 9.2. The effective management of external interfaces with a safety impact (e.g., military, airspace users, airports). Formalised processes and procedures dealing with external agreements, services, and supplies (e.g., cross-border letters of agreement).

Fatigue-related risk management

- Objective 10.1. A data-driven means by continuously monitoring and managing fatigue-related safety risk that aims to ensure relevant personnel are performing at adequate levels of alertness.

Objectives for "Safety assurance"

Safety reporting, investigation and improvement

- Objective 11.1. A continuing organisation-wide process to report and investigate safety occurrences and risks.

Operational safety surveys and SMS audits

- Objective 12.1. Internal and independent (external) operational safety surveys and SMS audits.

Safety performance monitoring and measurement

- Objective 13.1. An established and active monitoring system that uses and tracks suitable safety indicators and associated targets (e.g., lagging and leading indicators).
- Objective 13.2. Methods to measure safety performance, which is compared within and between ANSPs.

Management of change

- Objective 14.1. Documentation and reporting mechanisms are in place to assure that internal and external stakeholders are provided with assurance about the means by which safety risks which may be introduced during and/or following implementation of change are managed and mitigated.

Continual improvement of the SMS

- Objective 15.1. An integrated planning process drives the continual improvement of the SMS.
- Objective 15.2. A structured approach to gather and share information on operational safety and SMS best practices from the industry.

Objectives for "Safety promotion"

Training and education

- Objective 16.1. Staff, and contractors where appropriate, that are educated and trained, in safety and safety management, and where required, licensed. This objective is primarily focused on ATC, Engineering and Senior staff who have the ability to affect the safety of the operational service.
- Objective 16.2. Staff are competent to conduct their obligations under the SMS.

Safety communication

- Objective 17.1. Staff are informed about safety and safety management standards which are relevant to their position.
- Objective 17.2. An organisation-wide means to record and disseminate lessons learned and safety critical information.
- Objective 17.3. Appropriate safety information and knowledge is shared with industry stakeholders. Information disclosure is compliant with agreed publication and confidentiality policies/agreements.
- Objective 17.4. A general public knowledgeable of the ANSP's performance through routine publication of achieved safety levels and trends. (Information disclosure complies with the requirements of ICAO Annex 13, Attachment E).

It is noted in [10] that these last two objectives go beyond the requirements of ICAO Annex 19 [2].

CANSO Implementation guide

The CANSO SMS implementation guide [11] provides guidance to support ANPSs in setting up their SMS. The guidance supports SMS maturity levels A, B and C, but it is explained that it does not provide detailed guidance for levels D and E. Next, highlights of the approaches for each of the elements are given.

Safety culture

A safety culture enhancement process is proposed that consists of the following five steps.

1. *Define a safety culture model*. The work of James Reason [29] is presented, which describes an informed culture based on reporting culture, learning culture, just culture and flexible culture. The safety culture framework of [30] is presented, which describes three interrelated aspects of safety culture: psychological aspects (how people feel), behavioural aspects (what people do), and situational aspects (what the organisation has).
2. *Identify safety culture drivers*. Two main groups of safety culture drivers are distinguished: organisation (management systems, national culture) and key individuals (employees, professional groups, labour unions, senior management).
3. *Measure safety climate*. Several tools are presented to measure the psychological, behavioural and situational aspects of safety culture, including questionnaires, interviews, workshops, observations, and audits.
4. *Evaluate the measures to identify strengths and weaknesses*. It is indicated that the interpretation of measurement data can be difficult and the use of multiple measurement tools is advised.
5. *Enhance safety culture*. A safety culture action plan should focus on identified weaknesses. Such action plan should be realistic, understandable for employees, be linked to the organisation's mission, and it should be well and timely communicated.

Safety policy

Generic elements of a safety policy are described, such as policy statements with regard to safety priority, safety objectives, safety responsibilities, safety leadership, and safety resourcing. Examples of safety policy statements are provided

Safety accountabilities

Detailed guidelines are provided for safety responsibilities and accountabilities in an ANSP. Accountability refers to the individual being answerable for the satisfactory completion of a task or activity, regardless of whether this person directly caries it out. Responsibility refers to the individual directly carrying out the task or activity. The guidelines consider documentation and discharging of safety accountabilities and responsibilities; the accountabilities and responsibilities of a safety manager; delegation of safety responsibilities; an Independent Safety Function who reports directly to the head of the organisation; delineation of responsibilities for development, oversight and implementation of a SMS; and safety manager resources.

Coordination of emergency response planning

Guidance is provided on emergency procedures, and creating and maintaining emergency response plans. Emergency/contingency procedures should be developed for operations during system failures or other abnormal or unexpected situations. ANPSs should develop such procedures using risk-based assessments of emergency scenarios. Emergency response plans are aimed at preserving the availability of major air routes within the air transportation system where ANSPs are designated to provide services, as well as to ensure access to designated aerodromes for humanitarian reasons. They are generally required for aircraft emergencies (e.g. emergency descent, hijack) and disruption of air traffic services (e.g. evacuation of operations room, closure of an adjacent air traffic centre). Emergency response plans should be well coordinated with related agencies (e.g. airlines, airport operators, police, security services). As part is the emergency response planning the organisational structure / hierarchy with for the occurrence response should be well defined.

SMS documentation

Guidelines are provided for producing a formal SMS that is in line with regulatory requirements (such as in ICAO Annex 19 and of the State), to clearly document safety standards and procedures, and to manage document reviewing and maintenance processes.

Compliance with international obligations

Guidelines for achieving compliance with international obligations use a business cycle consisting of identification of regulatory requirements (issued by ICAO, EASA, State); comparison of the requirements with current operations; the preparation of a regulatory compliance matrix; the identification of gaps; filling of the gaps or explicit acknowledgement of the difference in coordination with the State; monitoring and recording of internal compliance by ways such as internal audits, air safety investigations, ICAO safety oversight programmes, or EASA standardisation inspections. Organisations should provide training to assure that employees understand the importance of compliance with organisational and legislative requirements.

Safety risk management

The core requirements of implementing an organisation-wide risk management process are commitment to and objectives for risk management; designing a framework for managing risk; implementing risk management; and monitoring and continuous improvement of the risk management framework. The framework for managing risk consists of the following processes: establish the context, hazard identification, risk analysis (determine severities and probabilities), risk evaluation (determine risk acceptability), and risk treatment.

Safety by design

A safety by design philosophy is presented in order to drive risk levels down to compensate for increased operational demands; view changes in a total system context, recognising that controls and mitigations can come from a number of sources (both ground and airborne); build safety attributes in every system,

process and equipment implemented or altered; and address known and anticipated human performance issues more effectively in the design process. The safety by design philosophy considers both a failure case, evaluating the impact of potential system failures, as well as a success case, which is focused on evolving the functionality of the design to ensure maximum safety benefit. This is studied by a total system approach, examining the technical equipment, airspace, people, procedural elements involved and the changing environment within which services are delivered. Several techniques for safety by design are highlighted, such as fault trees, barrier models, bow tie models, safety assessment phases in design and implementation, and goal structured notation.

Safety interfaces

An organisational focus on safety-related interfaces assures that 1) new hazards are not introduced into the ATM system; 2) gaps in systems, process or procedure do not exist; 3) there is common intent and understanding between parties; and 4) efforts are not duplicated (which may introduce confusion or increase resource demands). Safety interfaces consider internal and external interfaces.

- *Internal safety interfaces.* Internal interfaces exist within the ANSP between departments that work together and have some reliance upon each other for the safe execution of their responsibilities (e.g., safety, security, operations, engineering). An effective safety-related internal interface generally assumes that the organisation has the necessary processes in place to effectively communicate safety risks and associated mitigations across departments. Safety-related interfaces should be established in operating procedures. They are formalised and managed through items such as Letters of Agreement (LOAs), Memoranda of Understanding (MOUs) and Service-level Agreements (SLAs), covering aspects such as services to be delivered, performance, tracking and reporting, problem management, etc.
- *External safety interfaces.* External safety-related interfaces are those between the ANSP and other entities on which the ANSP may rely to provide services (e.g. energy, equipment, meteorology, aeronautical information), or between the ANSP and stakeholders in safety risks (e.g. airlines, airports, military, regulator, adjoining ANSP). Even if such entities are certified, it is necessary to have formalised agreements in place (e.g., contracts, LOAs, MOUs, SLAs, joint committees/boards).

Fatigue risk management

Guidance is provided for the development of a fatigue risk management system (FRMS). A FRMS consists of a policy, a fatigue risk management process (typically revolving around work schedules), education and promotion, assurance, and documentation. Development of a FRMS follows a general risk management approach, including identification of fatigue hazards, their assessment, control or mitigation of these hazards, implementation of controls/mitigations, and monitoring of the effectiveness of the management interventions.

Safety reporting, investigation and improvement

Safety occurrence reporting and investigation aims to improve the safety of ANSP operations by ensuring timely detection and mitigation of operational hazards and system deficiencies. Safety occurrences

include accidents, incidents, hazardous events and safety concerns. What is reported within an ANPS is influenced by domestic requirements and by mandatory versus voluntary reporting requirements. The reporting depends on the reporting culture in the organisation, which depends on its just culture. Investigation should focus more on the 'why' and 'how' of a safety occurrence rather than its 'what', 'who' and 'when'; the Swiss Cheese model of Reason may help in such analysis. A reporting system should be developed based on an appropriate analysis of the way that it will be used in the safety reporting, investigation and improvement cycle. The safety reporting and investigation process includes incident notification, decision on the need for investigation, data collection in case of an investigation (recorded data, interviews), analysis of the occurrence, reporting & recommendations, communication of outcomes. In order to detect systemic deficiencies ANPS are advised to evaluate groups of incidents and use trend analysis.

Operational safety surveys and SMS audits

Operational safety surveys seek feedback from frontline personnel about areas of dissatisfaction and potentially hazardous conditions. They are usually open-ended and seek to find problems that may not be completely known or understood. Surveys are also an ideal tool to identify what is working well, and positive findings should be part of the survey output. SMS audits are performed to verify compliance with SMS requirements that have been established by the ANSP in order to meet the requirements of ICAO and of the ANSP's regulator. Guidelines are provided for establishing systematic audit and survey programs.

Safety performance monitoring

Safety performance monitoring uses performance indicators to judge whether levels of operational safety performance are consistent with agreed-upon levels, to assess levels of compliance with internal and external requirements, and to verify whether practice is consistent with the organisation's safety policy and safety objectives. Good indicators should be specific, measurable, actionable, relevant, and timely. Safety indicators can be distinguished between lagging indicators, related to occurred accident and incidents, and leading indicators, related to behaviours or characteristics which may lead to future safety occurrences, e.g. failures to comply with regulations, safety culture measures, workload measures, normal operating safety surveys, staff turnover. Safety performance monitoring may be required by ICAO or State regulations. Benchmarking of the safety performance data can be done internally in the ANSP, in a region (e.g. Europe), or word-wide. Safety performance targets may be set by the management, the owner, or the State. Safety performance should be communicated regularly to internal stakeholders.

Management of change

The management of change in a SMS refers to the identification, analysis and evaluation of risks during change. The safety risk management approaches discussed earlier can well be used for risk management during change. A formal safety risk assessment is done when the change is judged to be safety significant. Some criteria are provided for such judging the significance of a change, such as failure consequences, novelty of the change, complexity of the change, monitoring of the change, reversibility to the system before the change, and additionality of recent changes.

Continuous improvement of the SMS

An ANSP must continually refine its approach to safety and safety management. An integrated safety planning process aims to identify and reduce safety risk in an ANSP. As such, it must determine the current risk situation; develop safety goals and objectives to reduce these risks; identify and gain commitment for resources; and monitor the success of interventions. Such interventions may lead to a direct change in process or procedure within the SMS; inclusion of additional elements within the SMS (i.e., beyond those specified in the CANSO SoE); changes to the way services are delivered; or additional operational safety nets. Additionally, a SMS can be improved by the implementation and sharing of best practices from within the ANSP as well as outside the own ANSP (other ANSPs, other stakeholders, industry standards). These include international standards and acceptable means of compliance to regulations.

Safety communication

Safety communication guidelines are provided to assure that staff has proper knowledge of the SMS and its processes; to build a lessons learned capability; to share safety information and knowledge with industry stakeholders; and to disseminate safety performance information to the general public. Proper knowledge of the SMS by the staff can be achieved by assuring easy accessibility of the SMS, by creating awareness of the SMS, by education and training on the SMS in line with the roles of the staff, and by assuring currency and competency of the training courses in line with changes of SMS practices. Guidelines for building a lessons learned capability include reviews to achieve lessons learned, implementation of best practices following lessons learned, and staff awareness and training campaigns. Sharing safety information with industry stakeholders, such as airlines, airports and adjoining ANPSs can have significant benefits for all stakeholders, given that confidentiality agreements between the parties are used. It is advocated to disseminate safety performance data to the general public, since this can increase the public confidence in the ANSP, as long as both the information and dissemination process are carefully managed and a narrative is provided to enable the public to understand the relevance and meaning of the data.

Training and education

It is essential that ANSPs have a process to assure that relevant employees are trained and competent in safety and safety management. Guidelines are provided for definition of safety professional functions; establishment of the core competencies required to perform the safety functions; determination of the training required; development of a training strategy and course material; and conducting initial and recurrent training. Such training an education refers to all kinds of roles and functions within the organisation, including controllers, technicians, middle management and upper management.

Appendix B SMS MATURITY ASSESSMENT

This appendix lists a number of SMS maturity assessment schemes. Appendix B.1 presents a questionnaire by EASA for the measurement of safety management of ANSPs. Appendix B.2 presents a questionnaire by Shell for SMS assessment. Appendix B.3 presents SMS maturity levels for ANSPs as formulated by CANSO.

Appendix B.1 EASA questionnaire

As part of the acceptable means of compliance and guidance material for the implementation and measurement of safety key performance indicators [12] EASA has published a questionnaire for measurement of the effectiveness of safety management. This appendix shows the questionnaire for measurement of effectiveness of safety management SKPI – ANSP level (source: Appendix 1 to AMC3 of [12]) along 11 study areas:

- SA1: Development of a Positive and Proactive Safety Culture
- SA2: Organisational and Individual Safety Responsibilities
- SA3: Timely compliance with international obligations
- SA4: Safety standards and procedures
- SA5: Competency
- SA6: Risk Management
- SA7: Safety interfaces
- SA8: Safety reporting, investigation and improvement
- SA9: Safety Performance Monitoring
- SA10: Operational Safety Surveys and SMS Audits
- SA11: Adoption and Sharing of Best (good) Practices

For each of these study areas, one to several questions are used.

SA1: Development of a Positive and Proactive Safety Culture

SA1.1 *A positive and pro-active, flexible, and informed safety culture (the shared beliefs, assumptions, and values regarding safety) that supports reporting and learning led by management.*

A. Within the organisation, there are significant differences between what is said, what is done, and what is believed. The competent authority may be regarded as being responsible for safety. The organisation determines what safety means and generates some awareness of this throughout the organisation. Individuals may have a different understanding of how their activities contribute to safety.
B. Individuals within the organisation have a good level of systematic safety management awareness. The organisation is starting to put processes in place for systematic safety management.
C. The fundamentals of a positive safety culture exist and are operating. Individuals may be involved in systematic safety management.

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D. **All of Level C plus:** Staff are proactively involved in planning for and implementing systematic safety management. The organisation operates informed learning and reporting cultures, as well as a just culture with respect to errors in operations.
E. **All of level D plus:** Individuals across the organisation are proactively and constantly striving to improve their approach to systematic safety management. They are supported by measurement and review processes and organisational management. Experiences are openly exchanged internally and externally. Within the organisation, there is a complete alignment between what is said, what is done, and what is believed.

SA1.2 *Regular measurement of safety culture and an improvement programme.*

A. The organisation does not see the need to have a safety culture measuring mechanism in place.
B. The organisation is aware of the need to have periodic measurements of safety culture in place, as well as an improvement plan. However, what will be measured, and when, is still being defined.
C. Safety culture is measured and results are available. An improvement plan addresses the need for individuals to be aware of, and support, the organisation's shared beliefs, assumptions and values regarding safety.
D. **All of Level C plus:** The organisation assesses its safety culture on a regular basis and implements improvements to any identified weaknesses. Safety Culture enablers and barriers are identified, and solutions to reduce barriers are being implemented.
E. **All of Level D plus:** All personnel are pro-active and committed to improving safety. Safety Culture Surveys confirm that, within the organisation, there is a high level of alignment between what is said, what is done, and what is believed. Organisational management approves a continuous improvement plan.

SA1.3 *A just and open climate for reporting and investigation of occurrences.*

A. Management believes there are no issues regarding the existing reporting and investigation culture and therefore does not see the need for any activity or dialogue with the staff in this area.
B. Discussions between staff and management to define an open reporting and investigation climate are underway. However, there is no agreed policy in place yet.
C. Safety data-sharing and publication policies are supported by the staff. Safety data are sufficiently protected from external interference within legal limits.
D. **All of Level C plus:** Within the organisation, the line between acceptable and unacceptable mistakes is established and known by the staff. Just reporting and investigation culture principles are in place and systematically applied within the organisation.
E. **All of Level D plus:** There is a clear and published policy on how dialogue with judicial authorities and media is established and followed.

SA2: Organisational and Individual Safety Responsibilities

SA2.1 *An approved, clearly documented, and recognised system for the management of safety. Management structure, responsibilities, accountabilities and authorities are clearly defined and documented.*

A. No formal designation of authorities, responsibilities or accountabilities for the management of safety exists.
B. Safety authorities, responsibilities, and accountabilities have been identified but not yet formalised. Line managers assume responsibility for safety.
C. The process to maintain all national regulations up to date and in line with the EU regulatory framework is formalised and systematic. Procedures are kept up to date and changes are notified to staff.

D. **All of Level C plus:** Procedures are in place to address the need to review safety authorities, responsibilities, and accountabilities after any significant organisational change.
E. **All of Level D plus:** Safety authorities, responsibilities, and accountabilities are periodically reviewed to determine whether they are suitable and effective (i.e., continuous improvement of safety management).

SA2.2 *A clearly defined safety management function/safety manager that is independent of line management.*

A. A safety management function has not yet been appointed to develop the SMS.
B. A safety management function has been appointed to develop and maintain the SMS.
C. The safety management function is independent of line management and develops and maintains an effective SMS. The safety manager has access to the resources required for the proper development and maintenance of the SMS.
D. **All of Level C plus:** The highest organisational level recognises its role in the SMS and actively supports the development, implementation, maintenance, and promotion of the SMS throughout the organisation (including support departments).
E. **All of Level D plus:** There is clear evidence that the highest organisational level plays a pro-active role in the continuous improvement of the SMS.

SA2.3 *An integrated safety planning process is adopted by the organisation with published and measurable safety goals and objectives for which the executive is accountable.*

A. An ad hoc or non existent safety planning process is utilised by the organisation. Safety goals and objectives have not been identified or documented for the implementation of a safety management system.
B. Identification of an appropriate SMS has been identified. A compliance gap analysis has been performed and a SMS Implementation Plan developed to meet the applicable safety regulatory requirements.
C. The requirements expressed in the SMS Implementation Plan have been completed. The SMS meets the regulatory requirements.
D. **All of Level C plus:** An Organisation Safety Plan is published on a periodic basis with specific accountable and measurable safety management goals and targets.
E. **All of Level D plus:** The Organisation Safety Plan goals and objectives are developed and prioritised based on organisation safety risks which have been identified through trend analysis, risk assessment processes and identified system safety deficiencies. Where appropriate (considering ANSP size and complexity), the organisation is committed to share and implement ATM safety management international Best (good) practice.

SA2.4 *Clear understanding and acceptance of safety management accountabilities and responsibilities by all relevant staff and contractors.*

A. Knowledge of the principles underpinning SMS amongst all staff and contractors is negligible.
B. All staff and contractors apply rules and procedures to their tasks in the knowledge that some of the rules and procedures need improvement. All staff and contractors are only partially aware of their roles in the SMS.
C. All staff and contractors are aware of how their actions impact the safety of the wider operation and how the actions of others impact safety.
D. **All of Level C plus:** All staff and contractors across the organisation are actively promoting and improving safety. All staff and contractors take pro-active day-to-day action to have rules and procedures changed where they identify a safety benefit by the change.
E. **All of Level D plus:** The organisation regularly reviews and assesses documented safety management responsibilities.

SA3 Timely compliance with international obligations

SA3.1 *A formal SMS that meets all applicable safety requirements.*

A. There is no SMS in place. There may be deviations from safety requirements.
B. The SMS is partially implemented, but it is not yet effective; it does not yet meet the safety requirements.
C. The essential parts of the SMS are implemented, and the organisation meets the safety requirements.
D. **All of Level C plus:** The SMS is fully implemented and effective.
E. **All of Level D plus:** The organisation is committed to going beyond compliance and operating at the highest international safety standard.

SA3.2 *An organisation that strives to go beyond compliance, takes into account the need to ensure, in a timely manner, that there are no inconsistencies with European or national requirements or international safety standards.*

A. There is little awareness of the regional or international safety standards.
B. There is an awareness of the European or national requirements or international safety standards. Work has started in some areas.
C. European or national requirements or international safety standards are known and met as required.
D. **All of Level C plus:** There is a process in place to address the need for timely and consistent compliance with European or national requirements or international safety standards.
E. **All of Level D plus:** The organisation has a structured mechanism to address the need for on-going and consistent compliance with European or national requirements or international safety standards. It contributes to a European, national or international dialogue to improve these requirements or standards.

SA4: Safety standards and procedures

SA4.1 *Clearly defined and documented safety standards and procedures.*

A. Some safety and safety management procedures exist, but they are not complete. Operations manuals do not contain any specific safety management procedures.
B. The documentation of SMS processes and procedures has started and is progressing as planned.
C. The documentation of the essential parts of the SMS processes and procedures is complete. The processes and procedures ensure that the organisation is compliant with all applicable safety and regulatory requirements.
D. **All of Level C plus:** There is clear evidence that the safety and safety management documentation is readily available to all personnel in the organisation. This documentation details safety and safety management processes and procedures that meet or exceed the applicable safety and regulatory requirements.
E. **All of Level D plus:** Processes are in place and are being applied to give effect to the organisation's commitment to continuously improve safety and safety management processes and procedures.

SA4.2 *Staff know about the safety and safety management requirements and standards, which are regularly reviewed, assessed, and maintained.*

A. Staff have limited knowledge of SMS processes and procedures. There is no formal process that maintains the SMS, nor is there an identified authority (or authorities) responsible for the updates.

B. A process to maintain all safety and safety management procedures exists, but its initial implementation is ad hoc and not fully effective. The authority (or authorities) responsible for the updates are partially identified.
C. The process to maintain all safety and safety management procedures is documented and practised. Procedures are kept up to date on an ad hoc basis as a minimum.
D. **All of Level C plus:** There is a formal process in place to periodically review safety and safety management procedures and ensure that they remain relevant, up to date, and effective. The authority (or authorities) responsible for the updates are completely identified. All safety-related procedures are documented and are known by the staff.
E. **All of Level D plus:** Changes within the organisation that could affect safety and/or the safety management framework are subjected to formal review.

SA4.3 *Emergency/Contingency response procedures and an emergency/contingency response plan that documents the orderly and efficient transition from normal to emergency operations and return to normal operations.*

A. The organisation has sound primary Air Traffic Management systems but does not have redundant capabilities or back-up systems.
B. There are procedures and some redundant capabilities and resources to cope with abnormal and unexpected situations.
C. All primary systems have redundant capabilities, and emergency/contingency response procedures have been developed, documented, and distributed to appropriate staff. The emergency/contingency response plan is properly coordinated with the emergency/contingency response plans of those organisations it must interface with during the provision of its services.
D. **All of Level C plus:** Primary Air Traffic Management systems are reliable and have redundant capabilities and back-up systems. The emergency/contingency response plan and procedures have been rehearsed through desktop or operational exercises.
E. **All of Level D plus:** The Emergency/Contingency Response planning processes and Emergency/Contingency Procedures and Plans are regularly exercised and revised to keep them up-to-date.

SA5 Competency

SA5.1 *Staff, and contractors (where appropriate) are trained, competent in safety and safety management, and where required, licensed.*

A. Competent staff and contractors (where appropriate) are provided on an ad hoc basis for safety and safety management activities. There are no formal competency methods (including proficiency, licensing, and training).
B. Competent staff, and contractors (where appropriate) are provided and allocated based on limited planning and only for a limited number of positions related to operations and safety management activities. Competency methods are being developed.
C. Competency methods have been designed and are applied. An annual planning process for training is in place.
D. **All of Level C plus:** There is a process for the training providers(s) to receive feedback on the effectiveness of training programmes; based on feedback, the training programmes are revised to improve effectiveness.
E. **All of Level D plus:** Competency methods (including proficiency, licensing, and training) are periodically reviewed and improved with industry Best (good) practice adopted. Training plans cover safety and SMS activities and allow for the improvement of staff skills and competency.

SA6 Risk Management

SA6.1 *A continuing risk management process that identifies, assesses, classifies, and controls all identified safety risks within the organisation, including potential future risks.*

A. There is no formal risk management process in place.
B. The principles of risk management are documented and understood. There is an approved plan in place to implement the risk management process.
C. The fundamentals of an approved and structured process is in place for the assessment of current and potential safety risks. Training in risk assessment is on-going.
D. **All of Level C plus:** There is clear evidence that safety risk management is embedded within the organisation and identified safety risks are managed and controlled.
E. **All of Level D plus:** Methods are in place to predict future safety risks and to mitigate these risks. The risk management processes are reviewed and improved on a periodic basis. The organisation develops best practice guidelines that it shares with other ANSPs.

SA7 Safety interfaces

SA7.1 *Effectively managed safety-related internal interfaces (e.g. quality management system, security, and environment).*

A. The relationships between various different internal interfaces are defined; however, the interfaces operate in isolation.
B. Internal safety-related interfaces are managed on an informal or ad hoc basis.
C. Internal safety-related interfaces are managed with a solid understanding of the boundaries and relationships between the interfaces.
D. **All of Level C plus:** Safety-related internal interfaces are coordinated, and relationships are managed through interface agreements (e.g., Letters of Agreement (LoAs), Memoranda of Understanding (MoUs), Service-Level Agreements (SLAs)).
E. **All of Level D plus:** A process is in place to regularly review agreed interface arrangements (LoAs/MoUs/SLAs etc.), identify weaknesses and act on rectification .

SA7.2 *The effective management of external interfaces with a safety impact (e.g., MIL, airspace users, airports). Formalised processes and procedures dealing with external agreements, services, and supplies (e.g., cross-border Letters of Agreement). (NB: for certain organisations MET, CNS and/or AIS are internal interfaces of the Organisation).*

A. There is a limited number of agreements in place.
B. Safety-related external interfaces are managed on an informal or ad hoc basis. Draft contractual arrangements are being prepared and negotiated for all safety-related external interfaces. Some elements are already formalised and implemented.
C. Safety requirements are specified and documented in appropriate agreements.
D. **All of Level C plus:** Activities with safety-related external interfaces are coordinated and relationships are managed through documented agreements. Safety requirements within contractual agreements are systematically reviewed and revised as necessary..
E. **All of Level D plus:** External services and suppliers are surveyed/audited and systematically monitored to identify deviations from the documented arrangements.

SA8 Safety reporting, investigation and improvement

SA 8.1 *A continuing organisation-wide process to report and investigate safety occurrences and risks.*

A. There is an informal system in place for reporting safety occurrences and risks, but reports are not reviewed systematically. The reporting system is not organisation-wide. Investigation is done on an ad hoc basis and with little or no feedback.
B. There is a plan to formalise the existing reporting and investigation system. There is commitment from management to allocate resources to implement this system. The reporting system is wide-spread but does not yet cover the whole organisation. Feedback is given on an ad hoc basis.
C. The system in place is commensurate with the size of the organisation. The organisation has a complete and formal system that records all reported information relevant to the SMS, including incidents and accidents. Corrective and preventive actions are taken in response to event analysis.
D. **All of Level C plus:** Identified safety-related risks and deficiencies are actively and continuously monitored and reviewed for improvement.
E. **All of Level D plus:** Personnel who report safety occurrences, risks and problems are empowered to suggest corrective actions, and there is a feedback process in place.

SA 8.2 *An organisation-wide means to record and disseminate lessons learned.*
A. Safety lessons learned are known only to those who experience them.
B. There is an intention to develop a means to record and share lessons learned. This may already happen, but only on an adhoc basis
C. The process for sharing safety lessons learned is systematic and operational and the majority of data is shared with appropriate personnel.
D. **All of Level C plus:** All safety lessons learned are systematically shared across the organisation at all appropriate levels. Corrective actions are taken to address lessons learned.
E. **All of Level D plus:** There is clear evidence that the internal lessons learned dissemination process is embedded across the organisation at all levels and is periodically reviewed.

SA8.3 *Appropriate safety information and knowledge is shared with Industry stakeholders. Information disclosure is compliant with agreed publication and confidentiality policies/agreements.*
A. Safety data and information are treated as confidential. There are no plans to release it in any way to any industry stakeholders.
B. Safety data and information are shared internally, but the organisation is reluctant or unwilling to share data with industry stakeholders.
C. Safety data and information is shared internally, nationally, and with international bodies when it is required by regulation.
D. **All of Level C plus:** There is a clear and published policy that encourages the proactive sharing of safety-related information with other parties.
E. **All of Level D plus:** Safety data and information are actively shared internally, nationally, with recognised international bodies, and with other industry stakeholders. The organisation has a process in place to receive and act on safety data and information from external stakeholders.

SA9: Safety Performance Monitoring

SA9.1 *An established and active monitoring system that uses and tracks suitable safety indicators and associated targets (e.g., lagging and leading indicators).*
A. There are no indicators, thresholds, or formal monitoring system in place to measure safety achievements and trends.
B. There is a plan to implement a monitoring system. A limited set of indicators has been implemented.
C. The safety monitoring system has been implemented and documented. Indicators and targets have been set.

D. **All of Level C plus:** Additional indicators are also defined and monitored to meet both organisational and local safety objectives. All indicators are tracked against thresholds/targets on a regular basis. Trends are analysed for safety improvement purposes.
E. **All of Level D plus:** Safety indicators covering all aspects of the system/operations are mature and used to measure safety improvement. There are comprehensive metrics in place to measure and monitor indicators and thresholds throughout the system.

SA9.2 *Methods to measure safety performance, which is compared within and between ANSPs.*

A. Ad hoc safety performance data related to individual incidents is available, but there is no systematic approach for measuring safety performance.
B. The implementation of some qualitative and quantitative techniques in certain parts of the organisation has started. However, there is insufficient data to analyse.
C. Qualitative techniques are in place, and the implementation of quantitative techniques has started.
D. **All of Level C plus:** Safety performance is measured using statistical and other quantitative techniques. Internal comparative analysis is done, and external comparative analysis has begun.
E. **All of Level D plus:** The reporting, operational safety survey and SMS auditing programmes are integral parts of the management and operational processes. Results are used to drive further safety improvements across the organisation. Internal and external comparative analysis is well-established.

SA9.3 *A general public knowledgeable of the ANSP's performance through routine publication of achieved safety levels and trends.*

A. Safety-related performance information is not made available to the public under any circumstances.
B. A limited amount of safety-related performance information is made available, but only to selected authorities.
C. High-level safety-related performance information is made available according to applicable requirements.
D. **All of Level C plus:** Safety performance information not governed by applicable requirements is also made available to the public.
E. **All of Level D plus:** The organisation voluntarily makes available appropriate safety-related performance information to the general public. The achieved safety levels and trends are transparent to the general public.

SA10: Operational Safety Surveys and SMS Audits

SA10.1 *Internal and independent (external) operational safety surveys and SMS audits.*

A. There is no plan to conduct systematic operational safety surveys and SMS audits. Operational safety surveys, SMS audits, and gap assessments are conducted on an ad hoc basis (e.g., when deficiencies in the system or in working arrangements are found).
B. There is a plan in place to formalise the conduct of systematic operational safety surveys and SMS audits. A limited number of operational safety surveys and SMS audits have been carried out.
C. Internal operational safety surveys and SMS audits are conducted on a periodic basis. Based on the output of operational safety surveys and SMS audits, a process is in place that requires the development and implementation of appropriate improvement plans.
D. **All of Level C plus:** Internal or external operational safety surveys and SMS audits are carried out in a systematic way. There is a process in place to monitor, analyse trends, and identify areas that require follow-up operational safety surveys or SMS audits. Follow-up operational safety surveys, SMS audits, and gap assessments are conducted in all areas affecting operational safety and the

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SMS. Operational safety surveys and SMS audits are actively reviewed to assess opportunities for system improvement.

E. **All of Level D plus:** Independent (external) operational safety surveys and SMS audits are periodically conducted. The outputs from operational safety surveys and SMS audits are incorporated as appropriate into operations or the SMS. There is a process in place that requires external data (e.g. pilot performance trend information) to be considered when selecting areas to be subject to operational safety surveys and SMS audits.

SA11: Adoption and Sharing of Best (good) Practices

SA11.1 *A structured approach exists to promote safety, its standing within the organisation and lessons learnt through application of the SMS.*

A. There is no structured approach to promote safety and its management within the organisation. The organisation has the capability to identify lessons learnt and promote them but on an ad hoc basis.
B. Ad hoc processes are in place to gather and then promote information on safety, lessons learnt and the SMS. Some initial implementation has begun. Some internal best best (good) practices practises are spread across units within the organisation, but there is no systematic structure for internal safety promotion.
C. An organisational approach has been established to promote safety, lessons learnt and the SMS.
D. **All of Level C plus:** Formal methods are in place to capture safety knowledge and promote it internally. The standing of safety and its management is a consistent and expected feature in internal communication.
E. **All of Level D plus:** Staff are encouraged to share lessons learnt in order that the lessons can be promoted across the organisation. Strategies to promote safety and its management are developed by senior levels in the organisation and are being implemented. Other industries' initiatives in relation to internal safety promotion are periodically reviewed with the approach being modified on the basis of the information gathered.

SA11.2 *A structured approach to gather information on operational safety and SMS best (good) practices from the industry.*

A. There is no structured approach to gather best (good) practices from the industry. The organisation has the capability to identify and adopt industry best (good) practices on an ad hoc basis.
B. There is an ad hoc structure in place to gather information on operational safety and SMS best (good) practices. Some initial implementation has begun. Some internal best (good) practices are spread across units within the organisation, but there is no systematic structure for the adoption of best (good) practices.
C. A structure has been established to identify applicable operational safety and SMS best (good) practices from the industry.
D. **All of Level C plus:** Industry best (good) practices are periodically reviewed to provide the most current information, which is then assessed for applicability, and adopted as appropriate.
E. **All of Level D plus:** All relevant best (good) practices are readily accessible to appropriate personnel. The organisation actively participates in developing industry best (good) practices.

SA11.3 *Sharing of safety and SMS-related best (good) practices with industry stakeholders.*

A. There are no plans to release and share best (good) practices with industry stakeholders.
B. Sharing of best (good) practice is ad hoc and takes place in response to requests for assistance from industry stakeholders.
C. A formalised process is in place to share Best (good) practice with industry.

D. **All of Level C plus:** Best (good) practices are actively shared with industry stakeholders. Sharing of safety-related best (good) practices with industry has demonstrated improved safety performance.
E. **All of Level D plus:** SMS-related best (good) practices are pro-actively shared with industry stakeholders with the aim of improving SMS standards.

Appendix B.2 Shell SMS assessment questionnaire

This appendix lists the questionnaire of the Shell SMS assessment approach [14]. It consists of 32 subjects distributed over eight groups. Each subject is described by four levels.

1 Leadership & Commitment

1.1 Leadership visibility

Level 1) Company Leaders communicate their flight safety, ground/industrial safety and, where appropriate, environmental protection expectations to staff reporting to them, but are not involved in the HSE-MS process and do not refer to it.
Level 2) Leaders discuss and review with staff and subcontractors progress against meeting specific 'results' and 'activity' safety targets, usually during appraisals
Level 3) Leaders actively participate in safety-related activities such as training, reward and recognition schemes, safety workshops, safety conferences and audits.
Level 4) Leaders drive the process for safety excellence and in terms of personal behaviour, are role models for safety. All levels 'own' the safety management process.

1.2 Proactive in target setting

Level 1) Company Leaders participate in the review of 'reactive' indicators such as incidents, accidents, damage or loss through maintenance error.
Level 2) Company Leaders participate in the development of objectives and target setting for safety management 'activities' (proactive indicators) as well as 'result' indicators.
Level 3) Set and Communicate Targets - Company Leaders jointly develop and discuss both safety 'results' and 'activity' improvement targets with staff and company contractors.
Level 4) Appraisal on Target Setting and Achievement - Company Leaders ensure that all staff have safety 'results' and 'activity' targets in their appraisals and are rewarded accordingly.

1.3 Informed involvement

Level 1) Leaders are unconvinced that the systematic management of safety and measurement of the effectiveness of such a system are as important as the reactive measurements such as LTIs.
Level 2) Leaders review the progress both in the development and the content of the SMS and Safety Cases and make available the resources and expertise to meet the targets.
Level 3) Leaders are fully aware of the high priority areas for improvement identified in the HSE MS and the status of the follow up remedial programme.
Level 4) Leaders are personally involved in the improvement efforts arising from formal senior management 'Reviews'.

2 Policy and strategic objectives

2.1 Policy content

Level 1) There is a working safety policy, dated and endorsed by CEO.

Level 2) The Company's safety policy complies with the Shell Group HSE policy as a minimum.
Level 3) All sub-contractors have safety policies consistent with those of the company as described in level 2. The policies are endorsed by the CEO. A statement on Joint ventures is available.
Level 4) The HSE Policy is reviewed as part of the formal HSE management system Review. Comments are sought from all stakeholders on the content of the company HSE Policy during the revision process.

2.2 Policy dissemination

Level 1) Staff and sub-contractors know where to find a copy of the company safety policy.
Level 2) ·The safety policy is prominently displayed in a language understood by all staff and contractors. All staff have a personal copy of the safety policy.
Level 3) ·The personal relevance of the safety policy is communicated to all new staff by their immediate supervisors or as appropriate. Supervisors discuss revised safety policies with line staff.
Level 4) ·All staff /sub-contractors are able to explain what responsibilities they have to and what they have to do in their work to fulfil the requirements of the Company safety policy. Where applicable, company safety policy is available to neighbouring communities.

2.3 Strategic objectives

Level 1) There is an HSE MS under development which includes a Safety Plan to meet the Company's strategic objectives.
Level 2) The targets described in the Safety Plan are consistent with Shell minimum HSE expectations.
Level 3) Audits confirm that the Safety Plan is functioning and there is a process in place to effectively monitor progress against the Safety Plan and verify the results. The company audit process/program monitors the extent to which the Safety Plan is achieving strategic objectives.
Level 4) Senior managers are measured on performance in setting challenging targets for continuous improvement. Personnel at all levels in the company are assessed on performance in achieving these targets which are included in the Safety plan.

3 Organization, Responsibilities, Resources, Standards and Documents

3.1 Roles & responsibilities

Level 1) There is a definition / description of both the current organisational structure and current safety/quality structure, plus the relationships of all the parties/positions/departments involved in the operation.
Level 2) The HSE MS includes a description of all safety-critical activities and the safety responsibilities of employees and sub-contractors in undertaking these activities and it can be demonstrated that Supervisors, employees and sub-contractors have knowledge thereof.
Level 3) The safety-critical activities of each job (pilot, engineer etc) are clearly defined, documented and understood by the relevant staff in terms of inputs, outputs, performance standards, verification and competency requirements.
Level 4) Individual safety responsibilities are known and understood by all employees (company and contractor) and are maintained by updating and revision in conjunction with the employees.

3.2 Safety Advisors & Management Representatives

Level 1) Quality specialist advice is readily available to line personnel of all safety issues. Safety advisors' professional profiles must meet regulatory requirements.
Level 2) The role and reporting relationship of the safety advisor(s) is fully defined in the HSE MS. · This also includes for direct access to the chief executive of the company.
Level 3) Safety is fully understood and implemented in the line and only specialist advice is required from safety advisors. This advice is sought and acted upon.

Level 4) Safety advisors can demonstrate that they are regularly supporting the drive for continuous improvement in HSE MS across the operation by proactive challenge, comparison and promotion of best practice.

3.3 Resources

Level 1) Risks inherent in the operation or facility, the emergency procedures, shifts, leave and competency levels are taken into account in determining the resource levels.
Level 2) The level of resources required to assure safety in terms of numbers and function of personnel are described or referred to in the SMS or Safety Case (i.e. to ensure 'adequate' personnel and resources).
Level 3) The actual resourcing meets the requirements described in the HSE MS or Safety Case in number and competency.
Level 4) Changes to resourcing levels and competencies and associated risks are assessed as part of the change control procedure within the company· Symptoms of under-resourcing are recognised, acknowledged and addressed.

3.4 Competence (Safety competencies)

Level 1) All staff and employees are made aware of their safety responsibilities when joining the company. Staff be made aware of safety responsibilities when joining the company.
Level 2) A competency assurance process is in place for company personnel with responsibility for safety-critical activities. Required and actual competencies of incumbents are documented.
Level 3) A competency assurance process as described in Level 2 is also in place for the employees of sub-contractors in positions with responsibility for safety-critical activities.
Level 4) The competency requirements of all positions involving safety-critical activities are periodically reviewed and improved and the competency of staff reassessed and gaps addressed.

3.5 Sub-contractors

Level 1) Sub-contractor safety competence is assessed in the light of the risks to be managed during the contract prior to the invitation to tender and award of contract.
Level 2) Sub-contractor acceptance is conditional upon receiving a description of how safety risks will be systematically managed to ALARP and interfaces managed on that particular activity.
Level 3) Compliance with the sub-contractors own HSE MS is audited within an audit programme defined in the contract. Actions to be taken in the event of different levels of non-compliance are defined in the contract.
Level 4) The HSE MS of sub-contractors are subject to continuous improvement during the course of projects and contracts in consultation with the Company and OU.

3.6 Communication

Level 1) An effective hierarchy of safety meetings within the company is described.
Level 2) There is an effective system in place for the timely transfer of safety information and feedback across all levels in the company and sub-contractors. All employees are aware of key safety information and expectations.
Level 3) There is a formal process to address safety matters raised by employees, sub-contractors, customers, government agencies and the public.
Level 4) Where relevant, consultation programmes are in place to identify and act upon the safety concerns of communities and other stakeholders. The Safety Policy, targets and verified performance of the company are provided in a clear format with a process for feedback.

3.7 Documentation & Control of the HSE-MS

Level 1) There are documented safety procedures available in the company.

Level 2) An HSE MS Manual is available for the company as a whole. Legislative requirements are known but compliance cannot be demonstrated. Shortfalls in the HSE-MS are identified and a rectification plan is in place.
Level 3) The HSE MS is substantially complete. The environmental part of the HSE MS meets the requirements of ISO 14001. There is a system for tracking, anticipating and disseminating and ensuring compliance with relevant H&S legislation.
Level 4) The HSE Manual is complete, maintained up-to-date and subjected to continuous improvement and upgrade.

3.8 Documentation & Control of the Safety Case

Level 1) All sites and operations requiring Safety Cases have been identified and there is a resourced plan in place for their development.
Level 2) Safety Cases are complete for locations and specific operations / activities, documenting hazards and effects, demonstrating ALARP and endorsed by the Management.
Level 3) Sub-contractors document how all hazards and effects on their contract are managed to ALARP. Interfaces between Shell OU, company and sub-contractor systems are defined.
Level 4) Each HSE Case including those of sub-contractors and the interface documents are up to date and reflect current practice on the location or activity. Safety Cases are reviewed as per cycle specified in the Case.

4 Hazards & Effects Management

4.1 Identification of Hazards & Effects

Level 1) Techniques for hazard and effects identification adopted by the company are documented and known by those employees responsible for their use.
Level 2) Appropriate techniques such as Health Risk Assessment, Environmental Assessment and HAZOP are used on all facilities and operations and the results documented in the inventory of hazards and effects.
Level 3) A comprehensive inventory of safety hazards and effects has been documented for all departments/operations within the company.
Level 4) There is a procedure for updating the hazard and effects listing as a result of changes to operations or findings; e.g., job hazard analyses, inspections or incident analyses.

4.2. Assessment

Level 1) Hazard and effects assessments are carried out as part of new projects, acquisitions, divestments, and major modifications.
Level 2) Hazards and effects assessments have been carried out for all operations and assets, (includes workplace hazards). The risk or significance of these has been classified using the risk matrix or equivalent and endorsed by management. .
Level 3) The assessments include health, safety and the environment including impact on third parties. The assessment for environmental effects satisfy ISO 14001 requirements.
Level 4) The hazard and effects assessments are kept up to date and modified as circumstances change as part of change control procedure.

4.3. Recording of Hazards and Effects

Level 1) The HSE MS describes the procedures used in the analyses of hazard and effects in the company.
Level 2) All hazards and effects analyses are described or referenced in the Safety Case demonstration that the selected option is ALARP and that the controls are in place to reduce risks to ALARP. All shortfalls are identified in the remedial action plan.
Level 3) Documents exist which describe all those activities, which must be discontinued or restricted in given circumstances (e.g. ,wave state, wind strength, icing conditions etc.). These documents, based

on health, safety, and environmental risk, are understood by all supervisors responsible for operational decisions.

Level 4) HEMP documentation is updated to reflect the actual situation. All controls described in the analysis reflect existing practice and any identified shortfalls.

4.4. Objectives and Performance Criteria Controls

Level 1) The means of measuring performance in the maintenance of critical safety controls are defined and documented.

Level 2) Performance indicators are available for all safety-critical activities (e.g., for testing systems, emergency response times, procedures, training effectiveness). These are included or referenced in the HSE Case and assigned to individuals.

Level 3) The actual performance of safety critical tasks is documented and trended against performance criteria.

Level 4) Performance against activity indicators are used in staff appraisal and rewarded accordingly.

4.5 Risk Reduction Measures (Controls Pre-Release of Hazard)

Level 1) Controls and persons responsible for managing the controls have been identified for known risks.

Level 2) Each 'significant' risk (including those in the workplace) can be demonstrably linked to a set of controls either preventative and/or recovery. The quality of the controls is commensurate with the risks.

Level 3) All controls with respect to risk are assigned to responsible parties and performance measurements for the maintenance of the controls defined.

Level 4) Controls have been revised as a result of changes, improvements and more demanding targets; e.g., in terms of incidents, waste, conservation and as appropriate, establishment of community development projects.

4.6. Risk Reduction Measures (Recovery from Release of hazard)

Level 1) Recovery procedures are available in the company for general emergency and contingency planning and for managing the consequences of any failure to control hazards and effects.

Level 2) Procedures in Level 1 are referenced in the HSE MS and or Safety Case(s) together with those responsible for updating, implementing and checking implementation of the procedures.

Level 3) All personnel are familiar with their roles in control and recovery procedures. Procedures are regularly tested. Records are available to demonstrate that these procedures are in place and performing satisfactorily under test.

Level 4) The control and recovery procedures are updated and their implementation improved as a result of exercises, safety cases and practical experience from both inside and outside the company.

5. Planning & Procedures

5.1. General – Safety Planning

Level 1) There is a company HSE Plan which includes one and five year performance targets.

Level 2) An overall company HSE Plan has been developed to meet continuous improvement targets and a strategy has been developed to close the gaps in the HSE MS.

Level 3) Safety improvement plans have been developed in the different units with resources, accountable parties and target dates. These align with the overall documented Safety Plan and Business Plan which reflects the resources required.

Level 4) Strategies to improve company HSE performance in the longer term form part of the overall business plan. Targets are published annually.

5.2. Asset Integrity

Level 1) Asset management does not conform to National Regulations

Level 2) Primary assets (aircraft, equipment, facilities) be managed in accordance with national regulations. Properly engineered facilities and equipment are provided and maintained. There is assurance of quality and integrity of aircraft, facilities and equipment; effective operation and maintenance of critical equipment; and thorough records of inspection, maintenance, repair and alteration.
Level 3) Primary assets (aircraft, equipment, facilities) are managed in accordance with enhanced standards (Shell, industry best practices, elevated standards). There are well developed maintenance worksheets and procedures exist ranging from control of bogus parts to ramp operations.
Level 4) There are mature reliability programs in place and well-developed, customized maintenance program. Facilities are pristine.

5.3. Procedures & Work Instructions

Level 1) HSE standards and procedures exist and are known to supervisors. These are inconsistently applied and enforced. The documents are written primarily by safety personnel or consultants with little or no employee involvement.
Level 2) Safety or consultant personnel develop HSE standards and SOP with employee input. These HSE standards and SOP are consistently applied, but they are not critically reviewed and there is no documented process for updating these standards and SOP.
Level 3) A defined process exists for the development and review of safety standards and procedures and includes employee involvement. HSE standards and standard operating procedures (SOP) are consistently applied and variances are subject to a control procedure.
Level 4) There is evidence that in addition to Level 3 requirements outside the formal review cycle, modifications to standards and procedures have been initiated by operations personnel.

5.4. Management of change

Level 1) Changes to approved plans (cost time, resources) are approved 'one level up', and only formally documented and approved when required by financial controls.
Level 2) There is a change control procedure, but its scope is not clearly described and application is not consistent.
Level 3) There are several change control procedures (e.g., corporate, local, project) with clearly defined scope. The procedures document evaluation, approval and the responsibilities and competencies of those involved.
Level 4) Comparative analysis and documentation of the safety impact of IMPLEMENTING the change as well as the safety impact of the IMPLEMENTED change are an integral part of all change control procedures.

5.5. Contingency and Emergency Planning

Level 1) Relevant external emergency organisations are unfamiliar with the operational hazards in the company. The company emergency plan does not define the incident command structure and the relationship with these external agencies.
Level 2) The incident command structure is identified. Regulatory emergency response requirements are met. A comprehensive emergency response plan is under development. External emergency agencies are familiar with operational hazards in the company.
Level 3) There is a comprehensive tiered emergency response plan which is integrated with individual site plans as appropriate. Competencies are defined in the plan and assured. Drills include for testing the co-ordination between sites.
Level 4) Drills are conducted with third parties and agencies according to a plan. Improvements are incorporated and checked. External agencies and communities are familiar with site hazards and emergency response plans.

6. Implementation & Monitoring

6.1. Monitoring – Performance Monitoring

Level 1) The HSE MS is being introduced but measurements which show that activities are being performed satisfactorily are not yet available.
Level 2) Performance measurements relating to 'results' (incidents, accidents, etc.) are collected but not for HSE MS activities. The local operator has completed the first review assessment of the implementation of their HSE MS.
Level 3) Locations are beginning to develop performance indicators to measure the elements and procedures of the HSE MS.
Level 4) Numerical performance indicators and targets are used to measure the implementation of the elements and procedures of the HSE MS and are included in employee appraisal.

6.2. Records

Level 1) The monitoring system for health, environmental and safety performance is not fully described and is driven by legislation. Health programs are developing.
Level 2) Tasks have been identified where exposure assessments should be made. Significant effects have been identified where environmental measurements should be taken.
Level 3) Records for most health, environmental and safety measurements are held and made available in the company.
Level 4) Records for health (confidentiality requirements permitting), environmental and safety data/measurements are available on locations and trends are openly discussed as part of improvement plans.

6.3. Non-Compliance and Corrective Actions

Level 1) Procedures which describe what must be done in the event of non compliance with legislation, procedures and standards are known but not documented.
Level 2) Few variances are recorded and the procedure for approving variance is ill defined or impractical.
Level 3) There is a documented system for variance control of safety-critical procedures and standards known by those responsible for following procedures and standards. There are records for variances at all locations and projects.
Level 4) Employees anticipate any potential need to deviate from standards and procedures allowing sufficient time to consider alternatives and, if necessary obtain the appropriate authorisations for the variance.

6.4. Incident Reporting and Follow-Up

Level 1) Only significant high profile incidents and investigated. These investigations are undertaken directly by HSE personnel. Investigation findings and only disseminated locally and remedial action poorly tracked.
Level 2) There are procedures for reporting and investigating incidents, HSE personnel and supervisors undertake investigations with limited employee involvement. A process is documented for tracking recommendations but many are outstanding.
Level 3) Reporting and investigation process is well understood and also applied to high potential near misses. Supervisors are trained in incident investigation and direct investigations which include employee participation. Lessons are disseminated.
Level 4) Investigation findings are documented and addressed in a timely manner, accountabilities assigned and tracked to closure. All information is stored and retrievable. Employees suggest improvements to the process.

7. Audit

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

7.1. Audit Plan

Level 1) Auditing plan or process is not documented, follow up system not in place. Audits are focused on hardware and housekeeping and conducted mostly by HSE personnel. Some regulatory audits are conducted.
Level 2) Audit plan and process under development. Audit tracking system not functioning effectively. Some checklist and compliance auditing being performed. Some involvement of supervisors in auditing.
Level 3) Audit process is defined and implemented. Supervisors take ownership of audit process which involves employees and independent parties. Audit recommendations documented and tracked to closure.
Level 4) Audit programme fully implemented. Skilled auditor base includes HSE personnel, supervisors and employees. Conformance with ISO 14001 externally certified. All past audit recommendations arising from "serious" findings have been resolved.

7.2. Auditor Competency

Level 1) Company uses mainly unqualified and/or inexperienced resources for HSE audits.
Level 2) HSE personnel involved in audits first undergo formal HSE audit training. There is a process describing the required competency for auditors.
Level 3) Personnel in other parts of the organisation as well as safety and audit personnel undergo HSE audit training and competency development.
Level 4) Company has access to, and only uses, qualified, experienced personnel with high credibility to perform HSE audits.

8. Management Review

8.1. Management Review General

Level 1) Modifications to the HSE MS are instigated and followed up by senior management when shortcomings have been highlighted as a result of incidents or failure to meet targets or regulatory requirements. There are no scheduled formal reviews of the system.
Level 2) Management reviews of the HSE MS have taken place but these are not undertaken in accordance with a predefined schedule and are not documented.
Level 3) There is a defined process for formal and regular review of the HSE MS.
Level 4) Senior management review the effectiveness of the HSE MS following a defined process and implementing the conclusions. Taken into account are changes in risk exposure, stakeholders, business environment and performance.

Appendix B.3 CANSO Standard of Excellence in SMS

The CANSO Standard of Excellence (SoE) in SMS presents guidelines for safety management at air navigation service providers [10]. It includes a definition of SMS maturity levels along five levels (from A to E) for its SMS objectives. The table below provides descriptions of the three upper levels C, D, and E of the CANSO SMS maturity scheme [10].

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
General SMS principles applicable to each study	The SMS standard processes are in use across the	The SMS framework is effective in achieving the	SMS processes set international best practice,

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
area	organisation and are producing consistent results. The results are being measured using qualitative techniques. The SMS framework meets the required regulatory standard and complies with the SMS requirements of ICAO Annex 19. Processes are defined, and performance is managed.	overall safety policy and objectives of the organisation. SMS processes are quantitatively managed. Quantitative safety objectives are based on customer, end user and organisational needs.	focusing on innovation and improvement. There is recognition that planning for safety is a continual process within an ANSP. Safety processes/systems are firmly embedded within the organisation. The effectiveness of the SMS and safety improvement actions is measured and evaluated against defined improvement criteria.
General principles for SMS framework implementation	The SMS implementation plan is largely complete.	The SMS framework is complete, functioning and effective in achieving the overall safety policy and objectives of the organisation.	The SMS framework is regularly reviewed and enhanced to achieve excellence in ATM safety management. Ongoing planning ensures that safety management activities are integrated and drive priorities for operational safety improvement.
General principles for performance monitoring	The organisation is collecting safety reports under a controlled process, and is responding to safety issues identified as a result of individual incident investigations.	The organisation is quantitatively measuring safety performance. It has identified its key safety risks and has developed plans for improvement.	The organisation is managing its key safety risks in conjunction with external stakeholders and can demonstrate improved safety performance.
1.1: A positive and proactive, flexible, and informed safety culture (the shared beliefs, assumptions, and values regarding safety) that supports reporting and learning led by management.	Employees are being trained to acquit their safety management related duties. The value which safety plays in the organisation is recognised and promoted. Management systems and approach demonstrates a genuine interest and commitment to address the safety issues which are raised. There is acceptance at all levels of the organisation that optimum safety performance can only be achieved when there is cross-organisational co-operation.	Employees are adequately trained to perform their safety management related duties. The value of safety to the organisation is promoted both within and outside the organisation. Management systems and processes support employees in their quest to be informed of and be adequately prepared for changes that may affect safety. Lessons learnt are actively sought and utilised to improve safety standards and processes. Individuals and organisational process support sharing safety	All within the organisation openly seek and exchange safety information. Employees are involved in the on-going review of safety. A future vision for safety within the organisation is documented and communicated. Management systems and approach encourages employees to challenge procedures/practices and people in their quest to improve safety performance. Management cooperates and supports customers, suppliers and contractors to improve their safety

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
		information and concerns across organisational boundaries.	standards.
1.2: A just and open climate for reporting and investigation of occurrences NB: Thorough reporting and investigation must include the complete process from notification, data gathering, reconstruction, analysis, safety recommendation and implementation of remedial actions, up to final reporting, exchange of lessons learned and effective monitoring.	Policy and procedures which support an open reporting climate, and Just Culture principles are in place. Safety data-sharing and publication policies are supported by the staff. Safety data are sufficiently protected from external interference within legal limits.	Within the organisation, the line between acceptable and unacceptable behaviours is established and is known and accepted by the all levels in the organisation. Just culture reporting and investigation principles and processes are systematically applied within organisation.	Under certain legal regimes, there is a clear and published policy on how dialogue with judicial authorities and media is established and followed. As the organisation changes and evolves, the organisation sustains and maintains its Just Culture approach. Lessons from within the organisation and different industry sector are used to enhance to organisation's approach to Just Culture.
1.3: Regular measurement of safety culture and an improvement programme.	Safety culture is measured and results are available. An improvement plan has been documented which addresses the need for individuals to be aware of, and support, the organisations shared beliefs, assumptions and values regarding safety	The organisation assesses its safety culture on a regular basis and implements improvements to any identified weaknesses. Safety Culture enablers and barriers are identified, and solutions to reduce barriers are being implemented.	All personnel are proactive and committed to improving safety. Safety Culture Surveys confirm that within the organisation, there is a high level of alignment between what is said what is done, and what is believed. Organisational management approves a continuous improvement plan.
2.1: The safety policy of the organisation presents the organisation's commitment to both safety and its resourcing. The priority of safety within the organisation is also articulated.	The safety policy has been finalised and signed by an accountable executive. It presents the organisation's commitment to both safety and its adequate resourcing. There is a periodic review of the policy to assure that it continues to be relevant and appropriate.	Updates to the policy are undertaken when the accountable executive changes or if the organisation believes that the policy does not adequately address the organisation's commitment to safety.	The organisation benchmarks its safety policy against other ANSPs and high reliability industries. Gaps and deficiencies are addressed in the policy, and actioned through the SMS.
2.2: The safety policy addresses key attributes of the organisation's approach to safety. These attributes will most likely include culture, visible endorsement, communication and safety reporting.	The policy is beginning to drive the form of the SMS and the organisation's approach to safety. It includes safety reporting, and the types of behaviours that are unacceptable and include the circumstances under which disciplinary	Periodic reviews of the organisation's approach to safety management are being undertaken. If necessary these are reflected in updates to the safety policy.	The organisation continues to question its overall approach to safety and its management. It will implement change when evidence is available that the current approach can be enhanced.

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
	action would not apply.		
3.1: An approved, clearly documented, and recognised system for the management of safety. Management structure, responsibilities, accountabilities and authorities are clearly defined and documented.	Authorities, responsibilities, and accountabilities for the management of safety have been defined and documented. This includes an accountable executive who, irrespective of other functions, has ultimate responsibility and accountability, on behalf of the organisation, for the implementation and maintenance of the SMS. Delineation of responsibility for the development, oversight and implementation of the SMS is clearly understood.	Procedures are in place to address the need to review safety authorities, responsibilities, and accountabilities after any significant organisational change.	Safety authorities, responsibilities, and accountabilities are periodically reviewed to determine whether they are suitable and effective (i.e., continuous improvement of safety management).
3.2: A clearly defined safety management function/safety manager that is independent of line management.	The safety management function is independent of line management and has the authority to develop and maintain an effective SMS. The safety manager has access to the resources required for the proper development and maintenance of the SMS.	The highest organisational level recognises its role in the SMS and actively supports the development, implementation, maintenance, and promotion of the SMS throughout the organisation (including support departments).	There is clear evidence that the highest organisational level plays a pro-active role in the continuous improvement of the SMS.
3.3: Clear understanding and acceptance of safety management accountabilities and responsibilities by all relevant staff and contractors.	All staff and contractors are aware of how their actions impact the safety of the wider operation and how the actions of others impact safety. Accountability for safety in the organisation is understood by all relevant staff and contractors.	All staff and contractors across the organisation are actively promoting and improving safety. All staff and contractors take proactive day-to-day action to have rules and procedures changed where they identify a safety benefit by the change.	The organisation regularly reviews and assesses documented safety management responsibilities.
4.1: Emergency response procedures and an emergency response plan that documents the orderly and efficient transition from normal to emergency operations and return to normal operations.	All primary systems have redundant capabilities, and emergency response procedures have been developed, documented, and distributed to appropriate staff. The emergency response plan is properly coordinated with the emergency response plans of those organisations it must	Primary air traffic management systems are reliable and have redundant capabilities and back-up systems. The emergency response plan and procedures have been rehearsed through desktop or operational exercises.	The emergency response planning processes and emergency procedures and plans are regularly exercised and revised to keep them up-to-date.

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
	interface with during the provision of its services. (Annex 11 – 1.4)		
5.1: A formal SMS that meets all applicable safety and regulatory requirements.	The essential parts of the SMS are implemented, and the organisation meets the standards established through safety regulatory requirements. The requirements expressed in the SMS Implementation Plan have been completed.	The SMS is fully implemented and effective. SMS processes and outputs are monitored regularly to identify deviations.	Where applicable, the organisation is committed to going beyond compliance and operating at the highest international safety standard.
5.2: Clearly defined and documented safety standards and procedures.	The documentation of the essential parts of the SMS processes and procedures is complete. The processes and procedures ensure that the organisation is compliant with all applicable safety and regulatory requirements.	There is clear evidence that the safety and safety management documentation is readily available to all personnel in the organisation. This documentation details safety and safety management processes and procedures that meet or exceed the applicable safety and regulatory requirements.	Processes are in place and are being applied to give effect to the organisation commitment to continuously improve safety and safety management processes and procedures.
5.3: Safety management documents are regularly reviewed, assessed, and maintained.	The process to maintain a manual of all safety and safety management procedures is documented and practised.	There is a formal process in place to periodically review safety and safety management procedures and ensure that they remain relevant, consistent with industry practice and effective. The authority (or authorities) responsible for the updates are clearly identified. All safety-related procedures are documented in an appropriate manner and are known by the staff.	Changes within the organisation that could affect safety and/or the safety management framework are subjected to formal review.
6.1: An organisation that takes into account the need to ensure, in a timely manner, that there are no inconsistencies with regional/international safety standards.	Regional and international safety standards are known and met as required.	There is a process in place to address the need for timely and consistent compliance with regional or international safety standards.	The organisation has a structured mechanism to address the need for ongoing and consistent compliance with regional or international safety standards. It contributes to a regional or international dialogue to improve these

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
			standards.
7.1: Hazards to operations are reported and assessed.	There is a growing number of staff who are able to assist in the identification and assessment of hazards. The organisation is continuing to expand the number of hazards that it assesses. Consequence and likelihood tables are now well understood by relevant staff. Hazard identification is based on a combination of reactive, proactive and predictive methods of safety data collection.	Hazard identification and analysis process are continually refined on the basis of internal experience and growing knowledge in the safety management practitioners. More hazard identification techniques are being used, and more quantitative analysis techniques are being adopted in relevant scenarios. The organisation recognises the increasing need to include stakeholders in both the identification and assessment process.	Documentation and practice reflect the use of both proactive and predictive methods to inform the organisation about inherent risk levels. Improvement activities focuses on: • Recording and dissemination of risk information • Use of risk information as performance metrics
7.2: Assessed risks are mitigated or controlled.	Analysis, assessment, mitigation and control of risk is being undertaken, based on the severity of the risk outcome. The risk levels which managers can accept is well known, and being applied.	An increased range of risk controls are being considered for implementation to address gaps or deficiencies. Formal risk management schemes can be replaced by ALARP (as low as reasonably practicable) assessments based on proactive and predictive methods of safety data collection.	The organisation uses hierarchy of controls to assure that risks are well managed.
7.3: Risk controls are monitored for effectiveness, and remedial action taken if controls are not working effectively.	Processes are documented and are being practically implemented which allow the organisation to identify, document and monitor risk controls.	Processes and practices are being refined to assure that the organisation understands its risk baseline, the controls which are in place, and any performance deviations or deficiencies. An increased range of risk controls are being considered for implementation to address gaps or deficiencies.	The organisation works to improve the performance and existing controls where they are found to be deficient, introduce new controls where gaps are identified and increase the integrity of the risk control framework through capital expenditure programmes.
8.1: Design addresses the whole system, people, procedures, airspace and equipment. Systems contain features to ensure they	Success and failure cases are considered during the design process. Safety features are designed using an ad-hoc rather than data	A robust process using objective data is followed to identify safety features which can be implemented in new and existing system	Causal factors are used as leading indicators to inform a continuous safety performance improvement

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
operate safely and support the operator's decision-making process. Equal weight is given to the success and failure case approaches.	driven process.	designs. The success and failure cases are given equal importance during the design process.	process.
9.1: Effectively managed safety-related internal interfaces (e.g, quality management system, security, and environment).	Internal safety-related interfaces are managed with a solid understanding of the boundaries and relationships between the interfaces.	Safety-related internal interfaces are coordinated, and relationships are managed through interface agreements (e.g., letters of agreement (LOA), memoranda of understanding (MOU), service-level agreements (SLA)).	A process is in place to regularly identify weaknesses in agreed interface arrangements (LOA/MOU/SLA etc.).
9.2: The effective management of external interfaces with a safety impact (e.g., military, airspace users, airports). Formalised processes and procedures dealing with external agreements, services, and supplies (e.g., cross-border letters of agreement). (NB: For certain organisations MET, CNS and/or AIS are internal interfaces of the organisation).	Safety requirements are specified and documented in appropriate agreements.	Activities with safety related external interfaces are coordinated and relationships are managed through documented agreements. Safety requirements within contractual agreements are systematically reviewed and revised as necessary.	External services and suppliers are surveyed/audited and systematically monitored to identify deviations from the documented arrangements.
10.1: A data-driven means by continuously monitoring and managing fatigue-related safety risk that aims to ensure relevant personnel are performing at adequate levels of alertness.	A formal risk based system which focuses on fatigue-related risk is being implemented which addresses: • Responsibilities of both management and operational personnel • Methods for assessing and managing fatigue risk	Compliance with fatigue-related risk procedures is continually assessed. Processes are in place to assess and continually improve approaches to fatigue-risk management.	The organisation uses the data and information from internal and external sources to continually improve its approach to managing fatigue-related safety risk.
11.1: A continuing organisation-wide process to report and investigate safety occurrences and risks.	The system in place is commensurate with the size of the organisation The organisation has a complete and formal system that records all reported information relevant to the SMS, including incidents and accidents. Corrective and	Identified safety related risks and deficiencies are actively and continuously monitored and reviewed for improvement.	Personnel who report safety occurrences, risks and problems are empowered to suggest corrective actions, and there is a feedback process in place.

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
	preventive actions are taken in response to event analysis.		
12.1: Internal and independent (external) operational safety surveys and SMS audits.	Internal operational safety surveys and SMS audits are conducted on a periodic basis. Based on the output of operational safety surveys and SMS audits, a process is in place that requires the development and implementation of appropriate improvement plans.	Internal or external operational surveys and SMS audits are carried out in a systematic way. There is a process in place to monitor, analyse trends, and identify areas that require follow-up safety surveys or audits. Follow-up surveys, audits, and gap assessments are conducted in all areas affecting operational safety and the SMS.	Independent (external) operational safety surveys and SMS audits are periodically conducted. The outputs from operational safety surveys and SMS audits are incorporated as appropriate into operations or the SMS. There is a process in place that requires external data (e.g, pilot performance trend information) to be considered when selecting areas to be subject to operational safety surveys and SMS audits.
13.1: An established and active monitoring system that uses and tracks suitable safety indicators and associated targets (e.g., lagging and leading indicators).	The safety monitoring system has been implemented and documented. Indicators and targets have been set: limited to meeting the safety regulatory requirements to verify the safety performance of the organisation.	Additional indicators are also defined and monitored to meet both organisational and local safety requirements. All indicators are tracked against thresholds/targets on a regular basis. Trends are analysed for safety improvement purposes.	Safety indicators covering all aspects of the system/ operations are mature and used to measure safety improvement. There are comprehensive metrics in place to measure and monitor indicators and thresholds throughout the system.
13.2: Methods to measure safety performance, which is compared within and between ANSPs.	Qualitative techniques are in place, and the implementation of quantitative techniques has started to verify the safety performance of the organisation and to validate the effectiveness of risk controls.	Safety performance is measured using statistical and other quantitative techniques. Internal comparative analysis is done, and external comparative analysis has begun. Results are used to drive further safety improvements across the organisation.	The reporting, operational safety survey and SMS auditing programmes are integral parts of the management and operational processes. Internal and external comparative analysis is well-established.
14.1: Documentation and reporting mechanisms are in place to assure that internal and external stakeholders are provided with assurance about the means by which safety risks which may be introduced during and/or	Change management practices are being implemented. Stakeholders including the regulator have been briefed on the process, and their role in the process. Changes are being assessed for impact ahead	Change management practices are refined on the basis of experience within the organisation. More formalised assessed on the performance of controls and mitigators is	The organisation continually looks to refine its approach to change management. Efforts will revolve around to better: • Define and report on transitional risks

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
following implementation of change are managed and mitigated.	of the change and the impacts of the controls and mitigators are being assessed after the change has occurred.	being introduced.	• Address differing scales of change within processes • Involve internal stakeholders.
15.1: An integrated planning process drives the continual improvement of the SMS.	Formalising planning processes are in place, which are reviewed for effectiveness on a regular basis.	A plan to improve the SMS and proactively manage safety risk published on a periodic basis with specific accountable and measurable safety management goals and targets.	The Safety Improvement plan (or Corporate Safety Plan) goals and objectives are developed and prioritised based on corporate safety risks which have been identified through trend analysis, risk assessment processes and identified system safety deficiencies. Where appropriate (considering ANSP size and complexity), the organisation is committed to share and implement ATM safety management international best practices.
15.2: A structured approach to gather and share information on operational safety and SMS best practices from the industry.	A structure has been established to identify applicable operational safety and SMS best practices from the industry to enable improvements to the SMS. Best practices are shared with industry stakeholders as required by regulation.	Industry best practices are periodically reviewed to provide the most current information which is then assessed for applicability, and adopted as appropriate. Sharing of safety related best practices with industry has demonstrated improved safety performance.	All relevant best practices are readily accessible to appropriate personnel. The organisation actively participates in developing industry best practices.
16.1: Staff, and contractors where appropriate, that are educated and trained, in safety and safety management, and where required, licensed. Note this objective is primarily focused on ATC, Engineering and Senior staff who have the ability to affect the safety of the operational service.	An annual planning process for training is in place. The plan assures that appropriate staff will be aware of all safety management practices which they may be called upon to apply and contribute to, and there is an understanding of the organisation's safety approach.	There is a process for the training provider(s) to receive feedback on the effectiveness of training programmes; based on feedback, the training programmes are revised to improve effectiveness.	Training plans cover safety and SMS activities and allow for the improvement of staff skills and competency.
16.2: Staff are competent to conduct their obligations under the SMS	Competency methods have been designed and are applied to ensure staff, where appropriate, are educated, trained and competent to perform the	Means by which competency standards are determined are subject to review and refinement.	Competency methods (including proficiency, licensing, and training) are periodically reviewed and improved with industry best

CANSO objective	Level C: Managed	Level D: Assured	Level E: Optimised
	specific duties required of them by the SMS.		practices adopted.
17.1: Staff are informed about safety and safety management standards which are relevant to their position.	Communication strategies are being developed to ensure that staff are aware of the safety management practices which are relevant to their position. Specific communication strategies are being implemented to address situations where procedures have changed or when critical safety action has been taken.	Communication mediums are regularly assessed for effectiveness. Gaps and deficiencies are acknowledged and addressed.	Safety is a key focus of internal communication. The organisation is looking to increase the number of mediums through which safety messages are sent within the organisation.
17.2. An organisation-wide means to record and disseminate lessons learned and safety critical information.	The process for sharing safety lessons learned is systematic and operational and the majority of data is shared with appropriate personnel. The rationale for taking action and making changes to procedures is explained to staff. Safety-critical information is disseminated to all appropriate staff.	All safety lessons learned are systematically shared across the organisation at all appropriate levels. Corrective actions are taken to address lessons learned.	There is clear evidence that the internal lessons learned dissemination process is embedded across the organisation at all levels and is periodically reviewed.
17.3: Appropriate safety information and knowledge is shared with industry stakeholders. Information disclosure is compliant with agreed publication and confidentiality policies/ agreements.	Safety data and information is shared internally, nationally, and with international bodies when it is required by regulation.	There is a clear and published policy that encourages the proactive sharing of safety related information with other parties.	Safety data and information are actively shared internally, nationally, with recognised international bodies, and with other industry stakeholders. The organisation has a process to receive and act on safety data and information from external stakeholders.
17.4: A general public knowledgeable of the ANSP's performance through routine publication of achieved safety levels and trends. (Information disclosure complies with the requirements of ICAO Annex 13, Attachment E)	High-level safety related performance information is made available according to regulatory requirements.	Safety performance information not governed by regulatory requirements is also made available to the public.	The organisation voluntarily makes available appropriate safety-related performance information to the general public. The achieved safety levels and trends are transparent to the general public.

Appendix C GENERIC AIR TRANSPORT SMS MATURITY ASSESSMENT TOOL (SMAT)

This appendix provides all topics of the generic air transport SMS Maturity Assessment Tool (SMAT). The topics are grouped by each of the four SMS components according to ICAO Annex 19 [2, 3]. Each topic can be scored on a level ranging from A to E using the answering table in Table 4 (page 21). Here an explanation should be provided, which justifies the selected level. The development of SMAT was based on SMS maturity schemes by EASA, CANSO and Shell (see Appendix B), as well as insights from developments in research in FSS P5, Safety-II and resilience engineering. In comments added to the topics, their main source is explained.

Appendix C.1 Component 1: Safety policy and objectives

1.1 Authorities, responsibilities, and accountabilities for safety management

A. No formal designation of authorities, responsibilities or accountabilities for the management of safety exists.
B. Safety authorities, responsibilities, and accountabilities have been identified but not yet formalised. Line managers assume responsibility for safety.
C. Authorities, responsibilities, and accountabilities for the management of safety have been defined and documented. This includes an accountable executive who, irrespective of other functions, has ultimate responsibility and accountability, on behalf of the organisation, for the implementation and maintenance of the SMS. Delineation of responsibility for the development, oversight and implementation of the SMS is clearly understood.
D. **All of Level C plus:** Procedures are in place to address the need to review safety authorities, responsibilities, and accountabilities after any significant organisational change.
E. **All of Level D plus:** Safety authorities, responsibilities, and accountabilities are periodically reviewed to determine whether they are suitable and effective (i.e., continuous improvement of safety management).

Comments

Question is based on EASA 2.1 / CANSO 3.1.

1.2 Safety management function

A. A safety management function has not yet been appointed to develop the SMS.
B. A safety management function has been appointed to develop and maintain the SMS.
C. The safety management function is independent of line management and develops and maintains an effective SMS. The safety manager has access to the resources required for the proper development and maintenance of the SMS.
D. **All of Level C plus:** The highest organisational level recognises its role in the SMS and actively supports the development, implementation, maintenance, and promotion of the SMS throughout the organisation (including support departments).
E. **All of Level D plus:** There is clear evidence that the highest organisational level plays a pro-active role in the continuous improvement of the SMS.

Comments

Question is based on EASA 2.2 / CANSO 3.2

1.3 Implementation and management of the SMS

A. There is no SMS in place. The need for an SMS implementation plan is recognised.

B. A SMS is partially implemented, but it does not yet meet standards established through safety regulatory requirements. A compliance gap analysis has been performed and an SMS implementation plan has been developed towards improvement.
C. The essential parts of the SMS are implemented, and the organisation meets the standards established through safety regulatory requirements. The requirements expressed in the SMS implementation plan have been completed.
D. **All of Level C plus:** All parts of the SMS are implemented and the coupling between the SMS processes have be shown to be functional
E. **All of Level D plus:** There is continuous monitoring of the effectiveness and efficiency of the various SMS processes, and management takes effective measures to control the performance of the SMS. Latest insights on effective safety governance are used for this purpose.

Comments

Question is based on EASA 3.1 / CANSO 5.1, with adaptations

1.4 Consistency with regional/international safety standards

A. There is little awareness of the regional or international safety standards.
B. There is an awareness of the regional and international safety standards. Work has started in some areas.
C. Regional and international safety standards are known and met as required.
D. **All of Level C plus:** There is a process in place to address the need for timely and consistent compliance with regional or international safety standards.
E. **All of Level D plus:** The organisation has a structured mechanism to address the need for ongoing and consistent compliance with regional or international safety standards. It contributes to a regional or international dialogue to improve these standards.

Comments

Question is based on EASA 3.2 / CANSO 6.1

1.5 SMS documentation

A. Operations manuals do not contain any specific safety management procedures.
B. The documentation of SMS processes and procedures has started and is progressing according to the SMS implementation plan containing as a minimum: a. Safety policy and objectives; b. SMS requirements; c. SMS processes and procedures; d. Accountabilities, responsibilities and authorities for SMS processes and procedures; and e. SMS outputs.
C. The documentation of the essential parts of the SMS processes and procedures is complete. The processes and procedures ensure that the organisation is compliant with all applicable safety and regulatory requirements.
D. **All of Level C plus:** There is clear evidence that the safety and safety management documentation is readily available to all personnel in the organisation. This documentation details safety and safety management processes and procedures that meet or exceed the applicable safety and regulatory requirements.
E. **All of Level D plus:** Processes are in place and are being applied to continuously improve the SMS documentation.

Comments

Question is based on EASA 4.1 / CANSO 5.2, with some adaptation.

1.6 Emergency/Contingency response procedures and plan

A. The organisation does not have redundant capabilities or back-up systems. Relevant external emergency organisations are unfamiliar with the operational hazards in the company and the organisation has not defined an incident command structure in relationship with these external agencies
B. There are procedures and some redundant capabilities and resources to cope with abnormal and unexpected situations. An incident command structure is identified. Regulatory emergency

response requirements are met, while a comprehensive emergency response plan is under development. External emergency agencies are familiar with operational hazards in the company.

C. All primary systems have redundant capabilities, and emergency/contingency response procedures have been developed, documented, and distributed to appropriate staff. The emergency/contingency response plan is properly coordinated with the emergency/contingency response plans of those organisations it must interface with during the provision of its services.

D. **All of Level C plus:** The emergency/contingency response plan and procedures are defined in a flexible, adaptive way, properly allowing ranges of variations in the crises situation. They have been rehearsed through desktop or operational exercises.

E. **All of Level D plus:** The emergency/contingency response plans, procedures and processes are regularly exercised and revised to keep them up-to-date. This includes exercises and coordination with all relevant external agencies, thus creating an agile response capability for the entire air transport system.

Comments

Question is based on EASA 4.3 / CANSO 4.1 and Shell 5.5

1.7. Safety policy

A. The need for a safety policy has been recognised but one does not exist.

B. The organisation recognises that the implemented policy needs to be signed by an accountable executive and communicated to all employees and stakeholders. A draft safety policy is available which reflects the organisation's commitment to safety and its priority. The policy is communicated to staff throughout the organisation and visibly endorsed by an accountable executive.

C. The safety policy has been finalised and signed by an accountable executive. It presents the organisation's commitment to both safety and its adequate resourcing. There is a periodic review of the policy to assure that it continues to be relevant and appropriate.

D. **All of Level C plus:** Updates to the policy are undertaken when the accountable executive changes or if the organisation believes that the policy does not adequately address the organisation's commitment to safety.

E. **All of Level D plus:** The organisation benchmarks its safety policy against other organisations and high reliability industries. Gaps and deficiencies are addressed in the policy, and actioned through the SMS.

Comments

Question is based on CANSO 2.1

1.8 Senior management visibility and involvement

A. Senior managers do not communicate explicitly about their expectations for safety performance and they are not involved in safety management processes.

B. Senior managers communicate their flight safety, occupational safety and, where appropriate, environmental protection expectations to staff reporting to them, but they do not refer to related SMS processes. They review reactive safety indicators such as incidents and accidents, but they are unconvinced about the value of proactive safety indicators as part of safety management.

C. Senior managers discuss and review with staff and subcontractors progress against meeting specific safety result targets and needed activities, usually during appraisals. They participate in the development of objectives and target setting for safety indicators. They review the progress both in the development and the content of the SMS and safety cases. They make available the resources and expertise needed for SMS tasks, evaluation and development.

D. **All of Level C plus:** Senior managers actively participate in safety-related activities such as training, reward and recognition schemes, safety workshops, safety conferences and audits. They jointly develop and discuss both safety results and activity improvement targets with staff and

company contractors. They are fully aware of the high priority areas for improvement identified in the SMS and the status of the follow up remedial programme.

E. **All of Level D plus:** Senior managers drive the process for safety excellence and they are role models for safety. They ensure that all staff have safety results and activity targets in their appraisals. They are personally involved in safety improvement efforts.

Comments

Question is based on Shell 1.1, 1.2, 1.3.

1.9 Sub-contractors

A. The safety competence of sub-contractors is not considered.
B. Sub-contractor safety competence is assessed in the light of the risks to be managed during the contract prior to the invitation to tender and award of contract.
C. Sub-contractor acceptance is conditional upon receiving a description of how safety risks will be systematically managed and interfaces managed on that particular activity.
D. **All of Level C plus:** Compliance with the sub-contractors own SMS is audited within an audit programme defined in the contract. Actions to be taken in the event of different levels of non-compliance are defined in the contract.
E. **All of Level D plus:** The SMS of sub-contractors are subject to continuous improvement during the course of projects and contracts in consultation with the company.

Comments

Question is based on Shell 3.5.

Appendix C.2 Component 2: Safety risk management

Appendix C.2.1 General safety risk management procedures

2.1 Identification of hazards and disturbances

A. Disturbances of operations, including those that have a negative effect on safety (i.e. hazards) are not systematically identified, neither for design or changes to sociotechnical systems, nor for changing circumstances, nor on the basis of feedback from operations.
B. A single approach is used for the identifications of hazards, which is used for designs or changes to sociotechnical systems supporting operations. A limited number of hazards is thus identified.
C. A number of approaches are used for the identification of hazards, as part of assessment of new designs or changes to sociotechnical systems. A broad set of hazards is thus identified.
D. **All of Level C plus:** Hazards are systematically identified on the basis of feedback from operations (coupling with safety assurance), including changes in operational circumstances.
E. **All of Level D plus:** Disturbances and variations in operations are systematically identified, irrespective of the potential effect on safety. This is done for new designs, changes to sociotechnical systems, changing circumstances, and on the basis of feedback from operations.

Comments

This is a new question, which is uniquely focused on the identification of hazards/disturbances, rather than on a combination of identification and assessment as in CANSO7.1. It encapsulates a broader focus than identification of safety hazards only, in line with a resilience engineering / Safety-II perspective.

2.2 Risk assessment for design and change

A. The level of risk is assessed for each identified hazard separately on a scale from low to high safety risk. This assessment is based on the judgement of a single or few people in the organisation.

B. The level of risk is assessed for each identified hazard separately by judgement of the likelihood of the hazard and the severity of its consequences. The assessment is based on the consultation of several people in the organisation, including operators.
C. The level of risk is assessed for scenarios, which represent combinations of hazards in a specific operational context, by judgement of the severity levels of the potential consequences of the scenario and the likelihood of these severity levels. The assessment is based on the consultation of several people in the organisation and on quantitative data of the operations.
D. **All of Level C plus:** For complex scenarios, risk models are used which represent in detail the complexity of the dynamics and interactions in the sociotechnical system. The assessment makes use of computer simulations, which represent a broad range of disturbances and operational variations, to determine the likelihood of safety occurrences. The level of uncertainty in the risk assessment results is indicated.
E. **All of Level D plus:** The risk models of scenarios also represent the effects on key performance areas other than safety of the identified disturbances and operational variations. As such an overall view is attained of the implications of a scenario and of the trade-offs that an operator may need to make in balancing safety with other performance areas.

Comments

- This is a new question, which uniquely focuses on a range of risk assessment techniques from low to high levels of sophistication, rather than on a combination of identification and assessment as in CANSO7.1. It encapsulates a broader focus on the work-as-done by operators, in line with a resilience engineering / Safety-II perspective.

2.3 Safety risk control

A. There is little understanding of the need to control risk, even when risks are recognised. The basic strategy is that the personnel is warned for particular risks.
B. Safety risk control is implemented by posing detailed requirements on human error and system failures, such that the safety risk is considered acceptable.
C. To mitigate safety risks that are considered unacceptable there is development by an interdisciplinary design team of new processes, equipment, training, or staffing arrangements. Residual risk levels are assessed by the design team. Managers can sign off residual risk levels over certain thresholds.
D. **All of Level C plus:** New designs for mitigation of unacceptable risks are assessed in a complete cycle of the safety risk management process to assess that the achieved risk is acceptable and the proposed design does not introduce new hazards. This is done by an assessment team that is independent from the design team. The level of uncertainty in assessed risk levels is included in the risk tolerability decision making.
E. **All of Level D plus:** Performance variability that has been considered as normal in the safety risk assessment is used as a basis to define a range of performance indicators that reflect the work-as-done in the organization. These performance indicators form a basis for measurement in safety assurance processes.

Comments

- This is a new question with some (minor) inspiration by CANSO 7.2. It encapsulates a broader focus on the work-as-done by operators, in line with a resilience engineering / Safety-II perspective.

Appendix C.2.2 Specific operational SRM issues

2.4 Fatigue risk management

A. Fatigue-related risk is not recognised as a safety risk which needs to be managed.

B. Fatigue-related risk is considered as an operational hazard, but there is no formal risk based system by which to manage it. Policy has been developed which recognises the need for a formal risk based approach to fatigue related risk.
C. A formal risk based system which focuses on fatigue-related risk is being implemented which addresses: responsibilities of both management and operational personnel, and methods for assessing and managing fatigue risk.
D. **All of Level C plus:** Compliance with fatigue-related risk procedures is continually assessed. Processes are in place to assess and continually improve approaches for fatigue-risk management.
E. **All of Level D plus:** The organisation uses the data and information from internal and external sources to continually improve its approach to managing fatigue-related safety risk.

Comments

- Question is based on CANSO 10.1

2.5. Sufficiency of resources

A. Risks inherent in operations and emergency procedures are not considered in determining the resource levels.
B. Risks inherent in operations and the emergency procedures are taken into account in determining the resource levels.
C. The level of resources required to assure safety in terms of numbers and function of personnel are fully described in a safety case (i.e. to ensure 'adequate' personnel and resources).
D. **All of Level C plus:** The actual resourcing meets the requirements described in the safety case in number and competency.
E. **All of Level D plus:** Changes to resourcing levels and competencies and associated risks are assessed as part of the change control procedure within the company. Symptoms of under-resourcing are recognised, acknowledged and addressed.

Comments

- Question is based on Shell 3.3

2.6. Maintenance

A. The maintenance program meets the regulatory requirements.
B. Activities within maintenance program are commensurate to the risks they impose. Quality and integrity of the systems are proportional to the risk.
C. There is a data-driven assurance of quality and integrity of systems (e.g. aircraft), facilities and equipment; effective operation and maintenance of critical equipment; and thorough records of inspection, maintenance, repair and alteration.
D. **All of Level C plus:** There are mature reliability programs in place and well-developed, customized maintenance program. Systems, equipment and, facilities are managed in accordance with industry best practices.
E. **All of Level D plus:** There is continuous improvement of the maintenance management based on latest insights in safety management systems.

Comments

- Question is based on Shell 5.2, with adaptations.

Appendix C.3 Component 3: Safety assurance

3.*1 Integrated risk management and safety-related internal interfaces for key performance areas (such as finance, quality, security, and environment)*

A. The various management systems of key performance areas operate in isolation and safety-related interfaces are not considered.
B. Safety-related relations between management systems of key performance areas are managed on an informal or ad hoc basis with a basic understanding of their boundaries and relationships.
C. Safety-related relations between management systems of key performance areas are managed with a solid understanding of their boundaries and relationships.
D. **All of Level C plus:** There is an integrated risk management system for all relevant key performance areas, which systematically addresses all types of risks and their relations. This includes assessment of costs associated with accidents and incidents, and of costs and benefits of risk mitigating measures.
E. **All of Level D plus:** A learning process is in place for continuous improvement of the integrated risk management system.

Comments

- Question is based on EASA 7.1 / CANSO 9.1, with adaptations towards integrated risk management.

3.2 Safety-related interfaces with external parties

A. Safety-related interfaces with external parties are only considered to a limited extent.
B. Safety-related interfaces with external parties are managed on an ad hoc basis, and contractual arrangements are negotiated and implemented.
C. Formal risk management processes are used for all relations with external parties. Safety requirements are specified and documented in appropriate agreements.
D. **All of Level C plus:** External services and suppliers are surveyed/audited and systematically monitored to assure consistency with the agreements and to identify the development of new risks. Agreements and levels of coordination with external parties are revised as necessary.
E. **All of Level D plus:** A learning process is in place for continuous improvement of the safety management processes for external parties.

Comments

- Question is based on EASA 7.2 / CANSO 9.2 with major adaptations.

3.3 Reporting and investigation of safety occurrences

A. There is an informal system in place for reporting safety occurrences, but reports are not reviewed systematically. The reporting system is not organisation-wide. Investigation is done on an ad hoc basis and with little or no feedback.
B. There is a plan to formalise the existing reporting and investigation system. There is commitment from management to allocate resources to implement this system. The reporting system is wide-spread but does not yet cover the whole organisation. Feedback is given on an ad hoc basis.
C. The system in place is commensurate with the size of the organisation. The organisation has a complete and formal system that records all reported information relevant to the SMS, including incidents and accidents. Corrective and preventive actions are taken in response to event analysis.
D. **All of Level C plus:** Identified safety-related risks and deficiencies are actively and continuously monitored and reviewed for improvement.
E. **All of Level D plus:** Personnel who report safety occurrences and problems are empowered to suggest corrective actions, and there is a feedback process in place.

Comments

- Question is based on EASA 8.1 / CANSO 11.1 with some adaptations.

3.4 Monitoring of safety indicators

A. Ad hoc safety performance data related to individual incidents is available, but there is no systematic approach for measuring safety performance There are no indicators, thresholds, or formal monitoring system in place to measure safety achievements and trends.

B. There is a plan to implement a monitoring system. The implementation of some qualitative and quantitative techniques and indicators in certain parts of the organisation has started.

C. The safety monitoring system has been implemented and documented. Indicators and targets have been set, which are limited to meeting the safety regulatory requirements to verify the safety performance of the organisation.

D. **All of Level C plus:** A broader set of indicators is used and safety performance is measured using statistical and other quantitative techniques. All indicators are tracked against thresholds/targets on a regular basis, including trend analysis. Internal comparative analysis is done, and external comparative analysis has begun. Results are used to drive further safety improvements across the organisation.

E. **All of Level D plus:** Safety indicators cover all aspects of the system/operations and they include indicators for performance variability of work-as-done in the organisation. There are comprehensive metrics in place to measure and monitor indicators and thresholds throughout the system. Internal and external comparative analysis is well-established.

Comments

- Question is based on EASA 9.1 / EASA 9.2 / CANSO 13.1 / CANSO 13.2, with an extension for Safety-II.

3.5 Operational safety surveys and audits

A. There is no plan to conduct systematic operational safety surveys and audits. Operational safety surveys, audits, and gap assessments are conducted on an ad hoc basis (e.g., when deficiencies in the system or in working arrangements are found).

B. There is a plan in place to formalise the conduct of systematic operational safety surveys and audits. A limited number of operational safety surveys and SMS audits have been carried out.

C. Internal operational safety surveys and audits are conducted on a periodic basis. Based on the output of operational safety surveys and audits, a process is in place that requires the development and implementation of appropriate improvement plans.

D. **All of Level C plus:** Internal or external operational safety surveys and audits are carried out in a systematic way. There is a process in place to monitor, analyse trends, and identify areas that require follow-up operational safety surveys or audits. Follow-up operational safety surveys, audits, and gap assessments are conducted in all areas affecting operational safety. Operational safety surveys and audits are actively reviewed to assess opportunities for system improvement.

E. **All of Level D plus:** Independent (external) operational safety surveys and audits are periodically conducted. The outputs from operational safety surveys and audits are incorporated as appropriate into operations. There is a process in place that requires external data to be considered when selecting areas to be subject to operational safety surveys and audits.

Comments

- Question is based on EASA 10.1 / CANSO 12.1, where SMS auditing has been removed and included in question 3.6

3.6 Auditing and improvement of SMS methods

A. There is no formal process that maintains the SMS, nor is there an identified authority (or authorities) responsible for the updates. SMS audits are conducted on an ad hoc basis.

B. A process to maintain safety management procedures exists. The authority (or authorities) responsible for the updates are partially identified. The procedures are kept up-to-date on an ad hoc basis.

C. SMS audits are conducted on a periodic basis. The process to maintain SMS documentation is defined and practised.

D. **All of Level C plus:** Internal or external SMS audits are carried out systematically. There is a process in place to monitor, analyse trends, and identify areas that require follow-up SMS audits. SMS audits are actively reviewed to assess opportunities for system improvement. There is a formal process in place to periodically review safety and safety management procedures and ensure that they remain relevant, consistent with industry practice and effective. The authority (or authorities) responsible for the updates are clearly identified.
E. **All of Level D plus:** Independent (external) SMS audits are periodically conducted. Changes within the organisation that could affect the safety management framework are subjected to formal review. New insights about improving SMS in the scientific literature are actively followed and the organization participates in studies to evaluate the effectiveness of such innovations for its organisation.

Comments

- Question is based on EASA 10.1 / CANSO 12.1 / CANSO 5.3, with some addition.

3.7 Variations with respect to procedures and standards

A. It is considered that there are no variances in the work-as-done with respect to procedures and standards. Non-compliance with procedures and standards is denied and is not recorded.
B. Procedures for variances with respect to procedures and standards exist, but they are impractical and few variances are reported.
C. There is a system for reporting variances in work-as-done with respect to procedures and standards, which is well documented and communicated to the employees. There are records for variances for many types of work all over the organisation..
D. **All of Level C plus:** Reasons of reported variances are analyzed on an ad-hoc basis. Lessons learned range from better training and education to changes in company procedures. They are systematically communicated to people who reported the variances and to others who are involved.
E. **All of Level D plus:** Safety assurance includes processes that systematically use the feedback from reported variances for organizational learning. Performance variability is explicitly considered (assumed) in safety risk management and reported variances are compared with the assumptions made. Company procedures are updated if needed and active collaboration with industry stakeholders is sought to change standards.

Comments

- Question is based on Shell 6.3 with major adaptations reflecting a Safety-II perspective.

3.8 Auditor competency

A. Company uses mainly unqualified and/or inexperienced resources for SMS audits.
B. Personnel involved in audits first undergo formal SMS audit training. There is a process describing the required competency for auditors.
C. Safety and audit personnel as well as personnel in other parts of the organisation periodically undergo audit training.
D. **All of Level C plus:** Relevant personnel undergo an audit training and competency development program. The company has been subject to external audits by peers.
E. **All of Level D plus:** Company works with individually tailored development programs aligned with best practises and it frequently uses external audits by peers.

Comments

- Question is based on Shell 7.2, with major adaptations.

3.9 Management of change

A. No change management processes are in place, although the organisation recognises that impacts of change need to be managed.
B. Some change management procedures exist and they are applied on an ad hoc basis.

C. A systematic set of change management processes are used to address: how the impact of change can be assessed from a risk perspective; how to involve stakeholders; how to document and evaluate the impacts; who will determine whether a change is authorised or not.
D. **All of Level C plus:** Quantitative approaches for risk assessment are used. Risk control functions are being monitored following the change.
E. **All of Level C plus:** The organisation continually looks to refine its approach to change management on the basis of experience within the organisation and using knowledge of state-of-the-art in management of change.

Comments

- Question is based on CANSO 14.1, with major adaptations.

Appendix C.4 Component 4: Safety promotion

4.1 Safety culture measurement and an improvement programme

A. The organisation does not see the need to have a safety culture measuring mechanism in place.
B. The organisation is aware of the need to have periodic measurements of safety culture in place, as well as an improvement plan. However, what will be measured, and when, is still being defined.
C. Safety culture is measured and results are available. An improvement plan addresses the need for individuals to be aware of, and support, the organisation's shared beliefs, assumptions and values regarding safety.
D. **All of Level C plus:** The organisation assesses its safety culture on a regular basis and implements improvements to any identified weaknesses. Safety Culture enablers and barriers are identified, and solutions to reduce barriers are being implemented.
E. **All of Level D plus:** The organisation is gathering data on safety culture on a continuous basis and it is constantly reflecting on the effects of all decision-making and changes on safety culture.

Comments

- Question is based on EASA 1.2 / CANSO 1.3, with some adaptation.

4.2 Promotion of a just and open culture for reporting and investigation of occurrences

A. Management believes there are no issues regarding the existing reporting and investigation culture and therefore does not see the need for any activity or dialogue with the staff in this area.
B. Discussions between staff and management to improve reporting and investigation policies and culture are underway.
C. Safety data-sharing and publication policies are well known and supported by the staff. Safety data are sufficiently protected from external interference within legal limits.
D. **All of Level C plus:** Within the organisation, the line between acceptable and unacceptable mistakes is clearly established and known by the staff. Just reporting and investigation culture principles are in place and systematically applied within the organisation.
E. **All of Level D plus:** There is a clear and published policy on how dialogue with judicial authorities and media is established and followed.

Comments

- Question is based on EASA 1.3 / CANSO 1.2, including several changes in wording towards promotion of a reporting culture instead of the reporting culture itself.

4.3 Knowledge transfer of safety management standards and practices

A. Staff have limited knowledge of the safety policy, SMS processes and procedures.
B. Limited communication is presented as to why particular safety actions have been taken and/or safety management procedures introduced. Internal communications within the organisation does not focus on safety and its management.

C. Communication strategies are being developed to ensure that staff are aware of the safety management practices which are relevant to their position. Specific communication strategies are being implemented to address situations where procedures have changed or when critical safety action has been taken. The safety policy is prominently displayed in a language understood by all staff and contractors. All staff have a personal copy of the safety policy.
D. **All of Level C plus:** Communication mediums are regularly assessed for effectiveness. Gaps and deficiencies are acknowledged and addressed. The personal relevance of the safety policy and changes therein is communicated to all staff by their immediate supervisors or as appropriate.
E. **All of Level D plus:** Safety is a key focus of internal communication. The organisation is looking to increase the number of mediums through which safety messages are sent within the organisation. All staff are able to explain what responsibilities they have to and what they have to do in their work to fulfil the requirements of the safety policy.

Comments

- Question is based on EASA 4.2 / CANSO 17.1, with some adaptations.

4.4 Training and competency in safety and safety management

A. Staff and contractors are provided sparsely with training for safety and safety management activities.
B. Staff and contractors are provided with training and education, but spaces are limited and planning is ad hoc.
C. An annual planning process for training is in place. The plan considers all staff and contractors and the training addresses all safety management practices that which they may be called upon to apply and contribute to.
D. **All of Level C plus:** There is a process for the training provider(s) to receive feedback on the effectiveness of the training programmes. Based on this feedback, the training programmes are revised to improve effectiveness.
E. **All of Level D plus:** There is regular measurement of the level of competency of staff and contractors in safety management practices, and this is used in planning and improvement of training. There is minimum number of SMS personal that has a suitable academic background. Latest scientific insights on effective safety management and training are used for the development of the training programs.

Comments

- Question is based on EASA 5.1 / CANSO 16.1, with major adaptations.

4.5 Recording and dissemination of safety lessons learned

A. Safety lessons learned are known only to those who experience them.
B. Safety lessons are recorded and shared on an ad hoc basis, rather than systematically.
C. The process for sharing safety lessons learned is systematic and operational, and the majority of data is shared with appropriate personnel. The rationale for taking action and making changes to procedures is explained to staff. Safety-critical information is disseminated to all appropriate staff.
D. **All of Level C plus:** All safety lessons learned are systematically shared across the organisation at all appropriate levels. Corrective actions are taken to address lessons learned.
E. **All of Level D plus:** There is clear evidence that the dissemination process of the internal lessons learned is embedded across the organisation at all levels and is periodically reviewed.

Comments

- Question is based on EASA 8.2 / CANSO 17.2.

4.6 Sharing of safety information and knowledge with industry stakeholders

A. Safety data and information are treated as confidential, internal in the organization as well as for industry stakeholders (e.g. airlines, airports, ATM service providers).

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

B. Safety data and information are shared internally, but the organisation is reluctant or unwilling to share data with industry stakeholders.
C. Safety data and information is shared internally, nationally, and with international bodies when it is required by regulation.
D. **All of Level C plus:** There is a clear and published policy that encourages the proactive sharing of safety-related information with other parties.
E. **All of Level D plus:** Safety data and information are actively shared internally, nationally, with recognised international bodies, and with other industry stakeholders. The organisation has a process in place to receive and act on safety data and information from external stakeholders.

Comments

- Question is based on EASA 8.3 / CANSO 17.3, with some adaptation.

4.7 Publication of safety performance information to the general public

A. Safety-related performance information is not made available to the public under any circumstances.
B. A limited amount of safety-related performance information is made available, but only to selected authorities.
C. High-level safety-related performance information is made available to the general public according to applicable requirements.
D. **All of Level C plus:** Safety performance information not governed by applicable requirements is also made available to the public.
E. **All of Level D plus:** The organisation voluntarily makes available appropriate safety-related performance information to the general public. The achieved safety levels and trends are transparent to the general public.

Comments

- Question is based on EASA 9.3 / CANSO 17.4.

4.8 Sharing and learning best practices on operational safety and SMS practices

A. There is no structured approach to learn and share best practices with the industry. The organisation has the capability to identify and adopt industry best practices on an ad hoc basis. There are no plans to release and share best practices with industry stakeholders.
B. There is an ad hoc structure in place to gather information on operational safety and SMS best practices. Some initial implementation has begun. Some internal best practices are spread across units within the organisation, but there is no systematic structure for the adoption of best practices. Sharing of best practices takes place in response to requests for assistance from industry stakeholders.
C. A structure has been established to identify applicable operational safety and SMS best practices from the industry to enable improvements to the SMS. Best practices are shared with industry stakeholders as required by regulation.
D. **All of Level C plus:** Industry best practices are periodically reviewed to provide the most current information which is then assessed for applicability, and adopted as appropriate. Safety related best practices are shared to a wide extend with industry stakeholders.
E. **All of Level D plus:** All relevant best practices are readily accessible to appropriate personnel. The organisation actively cooperates with industry and academic partners in developing best practices.

Comments

- Question is based on EASA 11.2 / CANSO 15.2.