Advisory Circular

CAA-AC-SMS009

January, 2023

SAFETY PERFORMANCE MANAGEMENT

1.0 PURPOSE

1.1 The purpose of this Advisory Circular (AC) is to provide guidance on the conduct of safety performance measurement and monitoring within an organization.

1.2 The implementation of processes related to the safety performance measurement and monitoring shall be in accordance with requirements prescribed by the Authority in the Civil Aviation (Safety Management) Regulations. This AC provides information necessary to enable service providers to comply with these regulations.

2.0 REFERENCES

2.1 The Civil Aviation Act

2.2 The Civil Aviation (Safety Management) Regulations

2.3 ICAO Doc 9859 – Safety Management Manual

3.0 INTRODUCTION

3.1 Civil Aviation (Safety Management) Regulations prescribe for service providers to verify the safety performance and validate the effectiveness of safety risk controls. To achieve this, it requires the use of a combination of internal audits and the establishment and monitoring of safety performance indicators (SPIs). Assessing the effectiveness of the safety risk controls is important as their application does not always achieve the results intended. This will help identify whether the right safety risk control was selected and may result in the application of a different safety risk control strategy.

3.2 The primary task of safety assurance is control. This is achieved through safety performance measurement and monitoring which is the process whereby the safety performance of the organization is verified in comparison with the safety policy and approved safety objectives. Safety assurance control is conducted by monitoring and measuring the outcomes of activities that operational personnel must engage in for the delivery of services by the organization.

3.3 The following provides a list of generic aspects or areas to be considered to “assure safety”

through safety performance monitoring and measurement.

3.3.1 **Responsibility.** Who is accountable for management of the operational activities (planning, organizing, directing, controlling) and its ultimate accomplishment;

3.3.2 **Authority.** Who can direct, control or change the procedures and who cannot as well as who can make key decisions such as safety risk acceptance decisions;

3.3.3 **Procedures.** Specified ways to carry out operational activities and that translate the "what" (objectives) into "how" (practical activities).

3.3.4 **Controls.** Elements of the system, including, hardware, software, special procedures or procedural steps, and supervisory practices designed to keep operational activities on track.

3.3.5 **Interfaces.** An examination of such things as lines of authority between departments, lines of communication between employees, consistency of procedures, and clear delineation of responsibility between organizations, work units and employees.

3.3.6 **Process Measures.** Means of providing feedback to responsible parties that required actions are taking place, required outputs are being produced and expected outcomes are being achieved.

4.0 SAFETY PERFORMANCE

4.1 Safety is defined as '*the state in which risks associated with aviation activities, related to, or in direct support of the operation of aircraft, are reduced and controlled to an acceptable level*' and safety performance is defined as '*a service provider's safety achievement as defined by its safety performance targets and safety performance indicator*s'. These definitions provide a good indication of the complexity related to measuring safety performance. In many areas, safety metrics tend to focus on serious incidents and accidents, as these are easy to measure and often receive more attention. In terms of safety management, the focus on such negative events should be considered with some caution, because:

4.1.1 in systems such as aviation with a low number of high consequence negative outcomes, the low frequency of such outcomes may give the wrong impression that your system is safe;

4.1.2 the information is available too late to act on it;

4.1.3 counting final outcomes will not reveal any of the systemic factors, hazards or latent conditions that have a potential to result in high consequence negative outcomes, under the same conditions; and

4.1.4 where the resilience of a system has been undermined, such outcomes are more likely to occur by chance and therefore these outcomes may draw unwarranted attention and use scarce resources when they are not predictive of later events.

4.2 The issue is further complicated because the aviation system is a highly dynamic, complex system with many different players, interactions, dependencies and parameters that may have a bearing on final safety outcomes. Therefore, in most cases it is impossible to establish a linear relationship between specific parameters or safety actions and the final, aggregate safety outcome. Hence, the absolute measurement of safety is itself unachievable. Whilst there are many models of what makes up the level of safety (and conversely the level of exposure to risk), indicators will always constitute imperfect markers of these levels.

4.3 Safety is more than the absence of risk; it requires specific systemic enablers of safety to be maintained at all times to cope with the known risks, to be well prepared to cope with those risks that are not yet known, and to address the natural 'erosion' of risk controls over time. Thus, from the perspective of your company there cannot be any direct measures of safety.

4.4 Measures should in particular focus on those features of your system that are intended to ensure safe outcomes —those elements that will constitute organizational enablers of safe outcomes and specific safety controls and barriers for any risks identified. Measures also need to address how external factors may influence these enabling elements, risk controls and barriers or how these controls and barriers influence each other. This approach is aligned with current industry practice in the area of quality management as promoted for example by International Organization for Standardization (ISO) 9000 series standards; when the resulting output cannot be directly measured, the underlying systems and processes need to be validated instead.

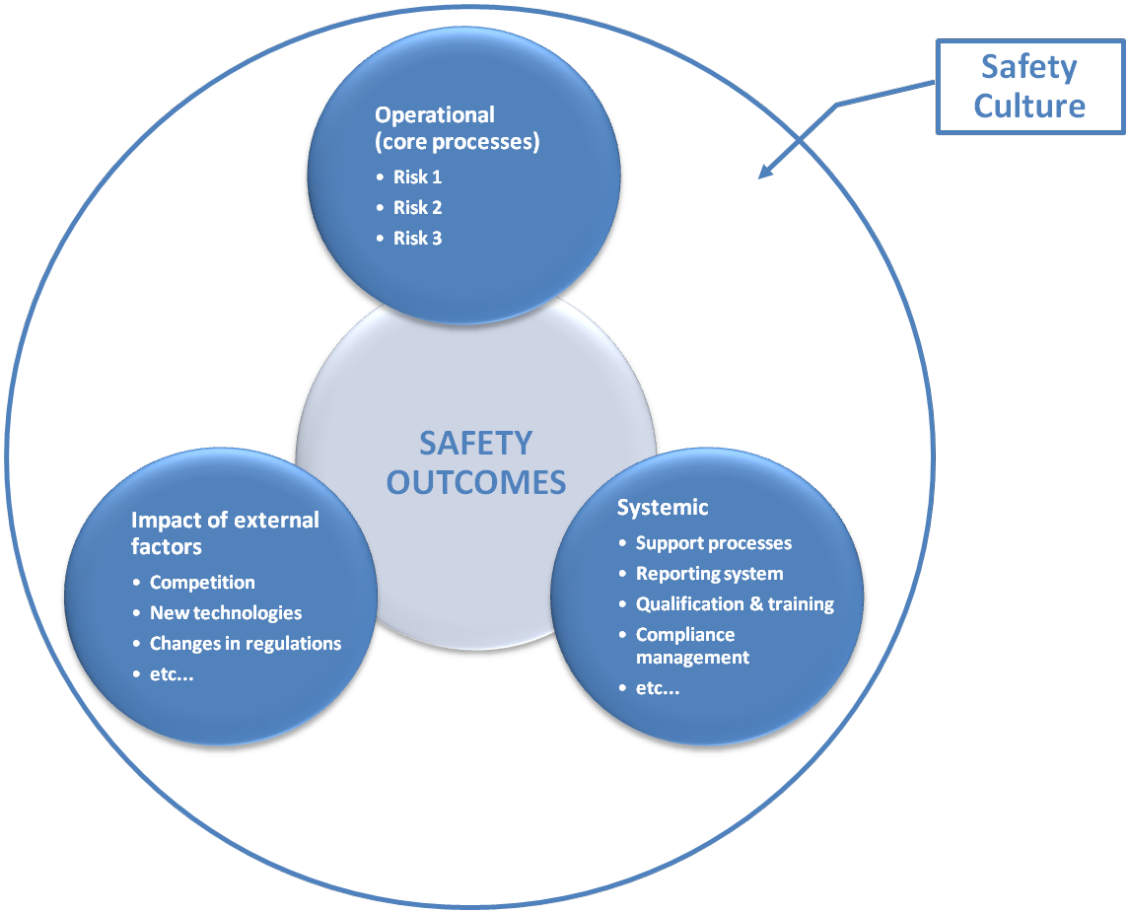


Figure 1: Components of safety performance

5.0 WHY MEASURE SAFETY PERFORMANCE?

5.1 ICAO Annex 19 promotes the development and maintenance of means to verify the safety performance of your organization and to validate the effectiveness of safety risk controls. The analysis and assessment of how your company 'functions' to deliver its activities should form the basis for defining your safety policy, the related safety objectives and the corresponding safety performance indicators and targets.

5.2 SMS requires a systemic approach as with any other element of business management (e.g., quality, finance), and in this respect safety performance measurement provides an element that

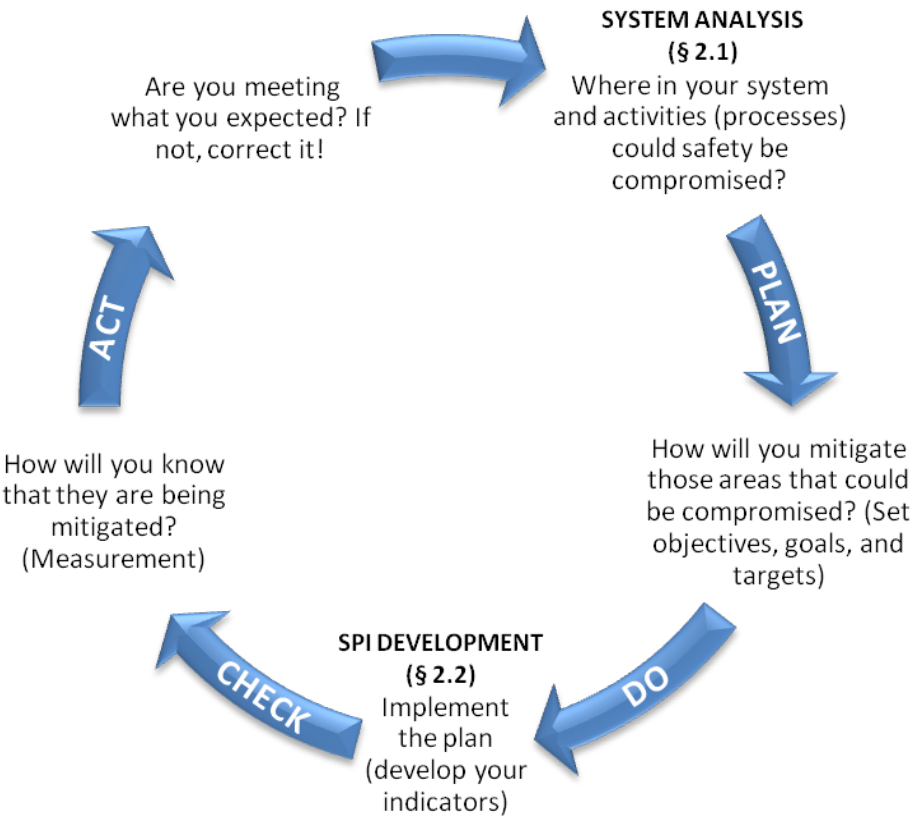
is essential for management and effective control: 'feedback.'

5.2.1 Feedback will allow management to validate the analysis and assessment of how well your organization functions in terms of safety and to make adjustments as required (Plan-Do-Check-Act).

5.2.2 Feedback to your management will guide decision-making and resource allocation.

5.2.3 Feedback to all staff will ensure that everyone is informed on your company's safety achievements. This will help to create commitment and contribute to fostering your company's safety culture.

Figure 2: The measurement cycle



5.3 Effective safety performance measurement will support the identification of opportunities for improvement not only related to safety, but also to efficiency and capacity.

5.4 The management of safety relies on the capabilities of your organization to systematically anticipate, monitor, and further develop your organizational performance to ensure safe outcomes of your activities. Effective safety management requires a thorough understanding and sound management of your system and processes. This cannot be achieved without some form of measurement. Rather than randomly selecting outcomes that are easy to measure, you should select safety performance indicators that consider the type of feedback needed to ensure your company's capabilities for safety management can be properly evaluated and improved.

This implies that you will need to measure performance at all levels of your organization by adopting a broad set of indicators involving key aspects of your system, and operations and allowing to measure those key aspects in different ways.

6.0 SAFETY PERFORMANCE INDICATORS (SPIs) AND SAFETY PERFORMANCE TARGETS (SPTs)

6.1 A safety performance indicator (SPI) is defined as a 'data-based safety parameter used for monitoring and assessing performance'. Whereas, a safety performance target (SPT) is defined as 'the planned or intended objective for safety performance indicator(s) over a given period that aligns with safety objectives'

6.2 SPIs are used to measure operational safety performance of the service provider and the performance of their SMS. SPIs rely on the monitoring of data and information from various sources including the safety reporting system. They should be specific to the individual service provider and be linked to the safety objectives already established.

6.3 SPIs are used to help senior management know whether or not the organization is likely to achieve its safety objectives. These safety objectives are brief, high-level statements of safety achievements or desired outcomes to be accomplished. Safety objectives provide direction to the organization's activities and should therefore be consistent with the safety policy that sets out the organization's high-level safety commitment. Establishing safety objectives provides strategic direction for the safety performance management process and provides a sound basis for safety related decision-making.

6.4 Safety Performance Indicators are commonly classified as below:

6.4.1 **Lagging Indicator**

6.4.1.1 Lagging SPIs measure events that have already occurred. They are also referred to as "outcome-based SPIs" and are normally (but not always) the negative outcomes the organization is aiming to avoid.

6.4.1.2 Lagging indicators are mainly used for aggregate, long-term trending, either at a high level or for specific occurrence types or locations. Because they measure safety outcomes, they can be used to assess the effectiveness of safety measures, actions, or initiatives and are a way of validating the safety performance of the system. Also, trends in these indicators can be analyzed to determine if latent conditions exist in present systems that should be addressed.

6.4.1.3 Lagging SPIs are divided into two types:

(a) **low probability/high severity**: outcomes such as accidents or serious incidents. The low frequency of high severity outcomes means that aggregation of data (at industry segment level or regional level) may result in more meaningful analyses. An example of this type of lagging SPI would be "aircraft and/or engine damage due to bird strike".

(b) **high probability/low severity**: outcomes that did not necessarily manifest themselves in a serious accident or incident, these are sometimes also referred

to as precursor indicators. SPIs for high probability/low severity outcomes are primarily used to monitor specific safety issues and measure the effectiveness of existing safety risk mitigations. An example of this type of precursor SPI would be "bird radar detections", which indicates the level of bird activity rather than the amount of actual bird strikes.

6.4.2 **Leading Indicator**

6.4.2.1 Leading SPIs measure processes and inputs being implemented to improve or maintain safety. These are also known as "activity or process SPIs" as they monitor and measure conditions that have the potential to lead to or contribute to a specific outcome.

6.4.2.2 Leading indicators, which are particularly relevant from a management perspective, may be used to influence safety management priorities and the determination of actions for safety improvement. You may use this type of indicator to proactively develop ('drive') your company's safety management capabilities, in particular during initial implementation of SMS. This may entail the setting of performance targets.

Example: The percentage of changes to Standard Operating Procedures that have been subject to hazard identification and safety risk management

6.4.2.3 Leading indicators may also be used to inform your management about the dynamics of your system and how it copes with any changes, including changes in its operating environment. The focus will be either: on anticipating emerging weaknesses and vulnerabilities to determine the need for action, or on monitoring the extent to which certain activities required for safety are being performed. For these 'monitoring' indicators, alert levels can be defined.

Example: The extent to which work is carried out in accordance with Standard Operating Procedures

6.5 Safety performance measurement should ideally consider a combination of leading and lagging indicators. The main focus should be to measure and to act upon the presence of those systemic and operational attributes that enable effective safety management within your company and meanwhile, use lagging indicators to ensure that this safety management is effective. Lagging indicators, particularly indicators for lower level system failures, are useful to validate the effectiveness of specific safety actions and risk barriers or to support the analysis of information derived from your leading indicators.

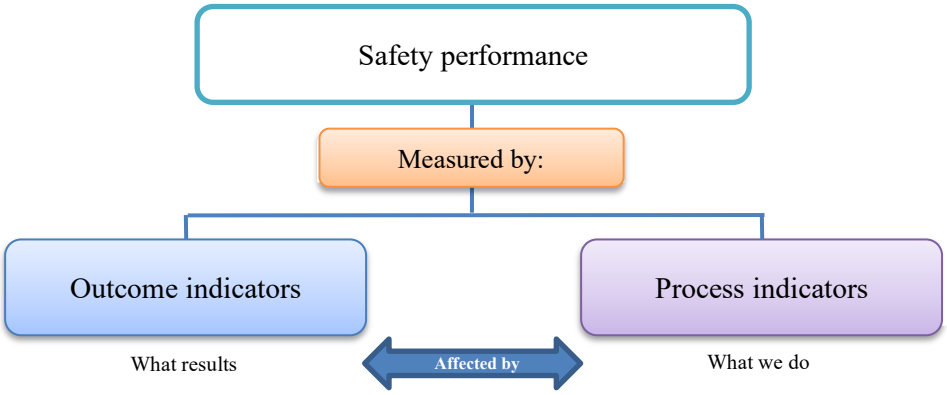


Figure 3: Leading & Lagging Indicators

6.6 When establishing SPIs service providers should consider:

6.6.1 **Measuring *the appropriate parameters***: Determine the best SPIs that will show the organization is on track to achieving its safety objectives. Also consider what are the biggest safety issues and safety risks faced by the organization, and identify SPIs which will show effective control of these. The SPIs can be generated from the organizational systemic factors, operational or related external factors. ***Appendix I*** indicates the typical SPIs and methods for measurement or monitoring.

6.6.2 **Availability *of safety data and safety information***: Is there data and information available which aligns with what the organization wants to measure? If there isn't, there may be a need to establish additional data collection sources. For small organizations with limited amounts of data, the pooling of data sets may also help to identify trends. This may be supported by industry associations who can collate safety data from multiple organizations.

6.6.3 **Reliability *and integrity of the data***: Data may be unreliable either because of its subjectivity or because it is incomplete.

6.6.4 **Common *industry SPIs***: It may be useful to agree on common SPIs with similar organizations so that comparisons can be made between organizations. The regulator or industry associations may enable these.

6.7 The Safety performance targets (SPTs) define short-term and medium-term safety performance management desired achievements. They act as "milestones" that provide confidence that the organization is on track to achieving its safety objectives and provide a measurable way of verifying the effectiveness of safety performance management activities. SPT setting should take into consideration factors such as the prevailing level of safety risk, safety risk tolerability, as well as expectations regarding the safety of the particular aviation sector. The setting of SPTs should be determined after considering what is realistically achievable for the associated aviation sector and recent performance of the particular SPI, where historical trend data is available.

6.8 The combination of safety objectives, SPIs and SPTs working together should be SMART, to allows the organization to more effectively demonstrate its safety performance. There are multiple approaches to achieving the goals of safety performance management, especially, setting SPTs. One approach involves establishing general high-level safety objectives with aligned SPIs and then identifying reasonable levels of improvements after a baseline safety performance has been established. These levels of improvements may be based on specific targets (e.g. percentage decrease) or the achievement of a positive trend. Another approach which can be used when the safety objectives are SMART is to have the safety targets act as

milestones to achieving the safety objectives. Either of these approaches are valid and there may be others that an organization finds effective at demonstrating their safety performance. Different approaches can be used in combination as appropriate to the specific circumstances.

Setting targets with high-level safety objectives

6.9 Targets are established with senior management agreeing on high-level safety objectives. The organization then identifies appropriate SPIs that will show improvement of safety performance towards the agreed safety objective(s). The SPIs will be measured using existing data sources, but may also require the collection of additional data. The organization then starts gathering, analysing and presenting the SPIs. Trends will start to emerge, which will provide an overview of the organization's safety performance and whether it is steering towards or away from its safety objectives. At this point the organization can identify reasonable and achievable SPTs for each SPI.

Setting targets with SMART safety objectives

6.10 Safety objectives can be difficult to communicate and may seem challenging to achieve; by breaking them down into smaller concrete safety targets, the process of delivering them is easier to manage. In this way, targets form a crucial link between strategy and day-to-day operations. Organizations should identify the key areas that drive the safety performance and establish a way to measure them. Once an organization has an idea what their current level of performance is by establishing the baseline safety performance, they can start setting SPTs to give everyone in the organization a clear sense of what they should be aiming to achieve. The organization may also use benchmarking to support setting performance targets. This involves using performance information from similar organizations that have already been measuring their performance to get a sense of how others in the community are doing.

Considerations for SPI and SPT selection

6.11 The When selecting SPIs and SPTs, the following should also be considered:

6.11.1 ***Workload management***. Creating a workable amount of SPIs can help personnel manage their monitoring and reporting workload. The same is true of the SPIs complexity, or the availability of the necessary data. It is better to agree on what is feasible, and then prioritize the selection of SPIs on this basis. If an SPI is no longer informing safety performance, or been given a lower priority, consider discontinuing in favour of a more useful or higher priority indicator.

6.11.2 ***Optimal spread of SPIs***. A combination of SPIs that encompass the focus areas will help gain an insight to the organization's overall safety performance and enable data-driven decision-making.

6.11.3 ***Clarity of SPIs.*** When selecting an SPI, it should be clear what is being measured and how often. SPIs with clear definitions aid understanding of results, avoid misinterpretation, and allow meaningful comparisons over time.

6.11.4 ***Encouraging desired behaviour***. SPTs can change behaviours and contribute to desired outcomes. This is especially relevant if achievement of the target is linked to organizational rewards, such as management remuneration. SPTs should foster positive organizational and individual behaviours that deliberately result in defensible decisions and safety performance improvement. It is equally important to consider the potential unintended behaviours when selecting SPIs and SPTs.

6.11.5 ***Choosing valuable measures***. It is imperative that useful SPIs are selected, not only ones which

are easy to measure. It should be up to the organization to decide what the most useful safety parameters are; those that guide the organization to improve decision-making, safety performance management, and achievement of its safety objectives.

6.11.6 ***Achieving SPTs.*** This is a particularly important consideration, and linked to the desired safety behaviours. Achieving the agreed SPTs is not always indicative of safety performance improvement. The organization should distinguish between just meeting SPTs and actual, demonstrable organizational safety performance improvement. It is imperative that the organization consider the context within which the target was achieved, rather than looking at an SPT in isolation. Recognition for overall improvement in safety performance, rather than an individual SPT achievement, will foster desirable organizational behaviours and encourage exchange of safety information that lies at the heart of both SRM and safety assurance. This could also enhance the relationship between the State and the service provider and their willingness to share safety data and ideas.

6.12 It is not always necessary or appropriate to define SPTs as there may be some SPIs that are better to monitor for trends rather than use to determine a target. Safety reporting is an example of when having a target could either discourage people not to report (if the target is not to exceed a number) or to report trivial matters to meet a target (if the target is to reach a certain number). There may also be SPIs better used to define a direction of travel to target continuous safety performance improvement (i.e. to reduce the number of events) rather than used to define an absolute target, as these may be difficult to determine.

6.13 The following should also be considered in deciding appropriate SPTs:

6.13.1 ***Drive undesirable behaviours***; if managers or organizations are too focused on achievement of the numbers as an indicator of success they may not achieve the intended improvement in safety performance.

6.13.2 ***Operational targets***; too much focus on achieving operational targets (such as: on time departures, reduction in overhead costs, etc.) without a balance of SPTs can lead to "achieving the operational targets" while not necessarily improving safety performance.

6.13.3 ***Focus on quantity rather than quality***; this can encourage personnel or departments to meet the target but in doing so deliver a poor product or service.

6.13.4 ***Cap innovation;*** although not intended, once a target is met this can lead to a relaxation and that no further improvements are needed and complacency can set in.

6.13.5 ***Organizational conflict***; targets can create conflict between departments and organizations as they argue over who is responsible rather than focusing on trying to work together.

7.0 SAFETY PERFORMANCE MANAGEMENT PROCESS

7.1 Effective safety management, defining and using safety performance indicators must be a dynamic process. A step-by-step process for developing your own set of safety performance indicators is proposed, which follows the ‘Plan-Do-Check-Act’ logic for continual improvement.

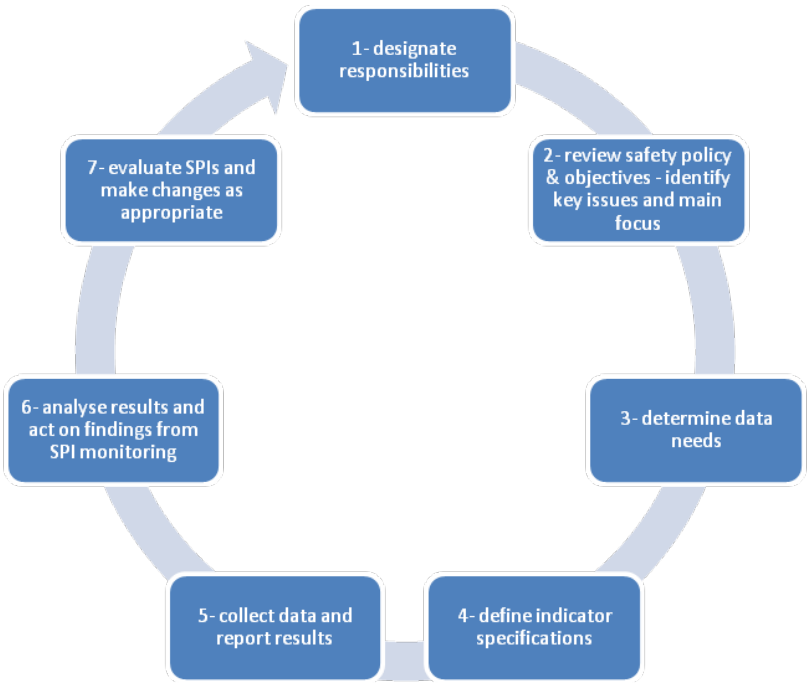


Figure 3: SPM process steps

7.2 Step 1: Designate responsibilities

7.2.1 It is critical to the success of SMS implementation that your management are fully committed to implementing SPIs as a fundamental part of your company's safety management approach. Rather than just supporting a system of SPIs, management must define aspects of your organization that require measurement and management and then must commit to a systematic approach to managing those elements, in accordance with your safety policy and defined safety objectives.

7.2.2 The first step for establishing SPIs will be for management to designate personnel with responsibilities for initiating the effective promotion and coordination of the introduction of the SPIs. This will require responsibility for ensuring effective communication and generally overseeing the implementation, with due consideration of your existing organizational setup in relation to safety management. These personnel (hereafter referred to as 'SPI team') should ideally include, and certainly have access to, personnel with appropriate experience and knowledge of safety and/or quality management principles and data analysis. They should also have experience applying this knowledge and these skills in the context of your policies, programs, operational procedures and practices.

7.2.3 Process owners must be directly involved even if 'specialists' are used to supply measurement expertise or to support/facilitate the SPI development process. Also, it is essential that process owners take ownership of safety performance measurement for their processes. The SPI team (or individual with designated responsibilities, depending on the size and complexity of your organization) must clearly be shown to be in either a support or advisory role to management and process owners.

7.2.4 Management should be kept informed of progress on a regular basis and should take an active role in steering the process of implementing SPIs. For larger organizations it may be useful to

develop an analysis of the costs and benefits of the SPI development project, with particular focus on the positive effects on your company's 'management information system' that will lead to improved resource allocation.

7.2.5 Finally the SPI team should set a reasonable timetable, including milestones, to ensure adequate progress in developing the SPIs.

7.3 Step 2: Review safety policy and objectives – identify key issues and main focus

7.3.1 At this step, the SPI team should identify the scope and focus of measurement considering the results of the system analysis, paying particular attention to the completeness and adequacy of your SMS.

7.3.2 To define indicators for specific operational safety issues, the bow-tie methodology or similar tools can be used to determine the safety actions and risk barriers that would be most suitable for the definition of operational SPIs. A thorough hazard identification will be required as part of your system analysis to provide a good understanding of threats to safety in your operations.

7.3.3 The SPI team may also review typical indicators used within your industry segment and assess them to determine whether they are pertinent to your organization. For example, measuring the number of internal reports may not be meaningful if your system analysis reveals that there are no easily accessible means to report or there are concerns about confidentiality.

7.4 Step 3: Determine data needs

7.4.1 To be meaningful, measures of performance must be based on reliable and valid data, both qualitative and quantitative. Therefore the SPI team should identify all pertinent data and information that is available within your organisation and determine what additional information is needed. It should also consider information available through the internal audit/compliance monitoring system.

7.4.2 Regardless of the type of data, quality is one of the most important elements in ensuring that the data can be integrated and used properly for analysis purposes. Data quality principles and practices should be applied throughout the processes from data capture and integration to analysis.

7.4.3 You may be tempted to identify things that lend themselves to being measured instead of identifying what you should measure. This is likely to result in identifying SPIs that are most obvious and easy to measure rather than SPIs that are most valuable for effective safety management. Therefore, at this step of the process, it is important to focus on what changes your organization wants to 'drive' and what aspects it needs to 'monitor.' You should also consider that, to be effective at assessing system safety, a broad set of indicators involving key aspects of your system and operations should be developed; this will reduce the possibility of having a narrow and therefore potentially flawed view of your organisation's safety performance.

7.4.4 Also, it may be necessary to measure the same system in several ways in order to gain a more precise idea of the actual level of safety performance. For example, only assessing your company's safety culture without measuring operational parameters will merely provide a very partial indication of safety performance.

7.4.5 In the area of hazard identification and risk management in operations (core processes),

availability of data will depend in part on the maturity of your internal safety reporting schemes. Aggregate data for your industry segment may also be considered, particularly when your SMS has not yet generated sufficient data. Other information, such as number of flights, fleet size, and financial turnover, etc may contribute to a better understanding of the context of operations. Continuous availability of data should be ensured to generate relevant and timely indicators. Delays in compiling data for the generation of indicators are likely to delay any safety actions that may be required.

7.5 Step 4: Define indicator specifications

7.5.1 Once the scope and focus of your SPIs have been determined and available data/information reviewed, the specifics need to be defined. Each SPI should be accompanied by sufficient information (or metadata) which enables any user to determine both the source and quality of the information, and place this indicator in the context necessary to interpret and manage it effectively.

7.5.2 Whenever possible, indicators should be quantitative, as this facilitates comparison and detecting trends. Quantitative metrics should be precise enough to allow highlighting trends in safety performance over time or deviations from expected safety outcomes or targets.

7.5.3 For qualitative SPIs, it is important to minimize subjectivity. This may be achieved through an evaluation by members of staff not directly involved in the definition of SPIs.

7.5.4 Depending on the size of your company and the complexity of your activities, a hierarchical framework for your SPIs could be defined to reflect the different processes and sub-systems within your organizational structure. While some indicators for assessing systemic issues may be common to different processes and subsystems, indicators for assessing operational issues will need to be specific. This underlines the importance of having performed an accurate system analysis identifying all system components and sub-systems as a prerequisite for implementing SMS. SPIs should be:

7.5.4.1 related to the safety objective they aim to indicate;
7.5.4.2 selected or developed based on available data and reliable measurement;
7.5.4.3 appropriately specific and quantifiable; and
7.5.4.4 realistic, by taking into account the possibilities and constraints of the organization.

7.5.5 There should be a clear link between lagging and leading SPIs. Ideally lagging SPIs should be defined before determining leading SPIs. Defining a precursor SPI linked to a more serious event or condition (the lagging SPI) ensures there is a clear correlation between the two. The contents of each SPI should include:

7.5.5.1 a description of what the SPI measures;
7.5.5.2 the purpose of the SPI (what it is intended to manage and who it is intended to inform);
7.5.5.3 the units of measurement and any requirements for its calculation;
7.5.5.4 who is responsible for collecting, validating, monitoring, reporting and acting on the SPI (these may be staff from different parts of the organization);
7.5.5.5 where or how the data should be collected; and
7.5.5.6 the frequency of reporting, collecting, monitoring and analysis of the SPI data.

7.6 Step 5: Collect data and report results

7.6.1 Once you have defined your SPIs, you must decide how you will collect the data and report the results. Data collection approaches (i.e., data sources, how data will be compiled, and what

the reports will look like), as well as roles and responsibilities for collection and reporting, should be specified and documented. Data collection procedures should also consider the frequency with which data should be collected and the results reported for each SPI.

7.6.2 The presentation format of the indicator results should take into account the target audience. For example, if you track several indicators addressing the same key issue, it may be useful to identify a subset of the most critical indicators to be given greater emphasis for reporting to top management. The presentation of indicator results should facilitate understanding of any deviations and identification of any important trends (e.g., scoreboards with traffic lights, histograms, linear graphs).

7.6.3 For submission of SPIs to the Authority, service providers are required to fill in the *KCAA* indicator *form:AC-SMS009 (Appendix II)* for both State and organization-specific SPIs. The Authority will review the submitted SPIs and issue an acceptance letter after agreement with the service provider.

7.7 Step 6: Analyze results and act on findings from SPI monitoring

7.7.1 This is the most relevant step in terms of safety management, as the ultimate goal of implementing SPIs is to maintain and improve your company's safety performance over time. There is no point in collecting information if the results are not used. Remember that SPIs are indicators of safety performance, not direct measures of safety. The information collected through different SPIs needs to be carefully analyzed, and SPIs collected for different issues need to be put in perspective and the results interpreted, so as to gain an overall picture of the organization's safety performance. The results obtained through an individual indicator may be insignificant if taken in isolation, but may be important when considered in combination with other indicators.

7.7.2 Inconsistencies between SPIs may be an indication of an inaccurate system description or problems with the SPIs themselves. For example, you may encounter situations where leading and lagging indicators associated with the same safety issue provide contradictory results or where a positive trend in systemic indicators goes with a negative trend in operational indicators.

7.7.3 If you find that the metrics are not defined well enough to capture safety critical information the SPIs should be reviewed. Any inconsistencies in the overall picture represent a potential opportunity for learning and for adjusting not only the SPIs (see Step 7) but your SMS itself.

7.7.4 Indicators should not be simply seen as a metric, with actions being taken to get a good score rather than to improve safety performance. It is important that results obtained through the collection, analysis and interpretation of SPIs are conveyed to your management for decision and action. Ideally, these results should be presented at regular meetings (e.g., management reviews, safety review board meetings) to determine what actions are required to address deficiencies or to further improve the system. It is important that such actions do not focus on certain indicators in isolation, but on optimizing your organization's overall safety performance.

7.7.5 As part of your safety communication and promotion, all staff should be informed of the results obtained through the collection, analysis, and interpretation of SPIs.

7.8 Step 7: Evaluate SPIs and make changes as appropriate

7.8.1 The systems analysis of your organization, along with the set of SPIs and their specifications, including the metrics and any defined targets, should be periodically reviewed and evaluated to consider:

7.8.1.1 the value of experience gained,
7.8.1.2 new safety issues identified,
7.8.1.3 changes in the nature of risk,
7.8.1.4 changes in the safety policy, objectives; and priorities identified,
7.8.1.5 changes in applicable regulations, and
7.8.1.6 organizational changes, etc.

7.8.2 Periodic reviews will help to ensure that the indicators are well defined and that they provide the information needed to drive and monitor safety performance. Periodic reviews will also help identify when specific 'drive' indicators are no longer needed (e.g., if the intended positive changes have been achieved) and allow adjustment of SPIs so that they always focus on the most important issues in terms of safety. Nevertheless, too frequent reviews should be avoided, as they may not allow establishing a stable system.

7.8.3 After the first two to three cycles, you should have collected enough data and gained sufficient experience to be able to determine which are your 'key' SPIs - those that are most valuable and most effective to monitor and to drive safety performance. At this stage you may be able to derive targets for these key SPIs by extrapolating the data collected during previous cycles. Any such extrapolation needs to consider the 'dynamics' of your organization. You might also compare your SPIs with those implemented by other organizations within your industry segment, but you should never simply copy another organization's SPIs without checking that they are meaningful for your organization.

The Authority has established an annual safety performance reporting cycle. The Authority shall publish submission dates and the data submitted will undergo analysis for aggregation of risks and for formulation of the State Acceptable Level of Safety Performance (ALoSP).

8.0 MONITORING SAFETY PERFORMANCE

8.1 Mechanisms for monitoring and measuring the organization's safety performance should be established to identify what changes may be needed if the progress made isn't as expected and reinforce the commitment of the organization to meet its safety objectives.

8.2 Once the organization's safety performance structure (safety objectives, indicators, targets, triggers) has been established and is functioning, it is possible to learn their baseline safety performance through a period of monitoring. Baseline safety performance is the safety performance at the commencement of the safety performance measurement process, the datum point from which progress can be measured.

8.3 The SPIs and associated SPTs will have to be reviewed to determine if they are providing the information needed to track the progress being made toward the safety objectives and to ensure that the targets are realistic and achievable.

8.4 The set of SPIs and SPTs selected by an organization should be periodically reviewed to ensure their continued meaningfulness as indications of organizational safety performance. Some reasons to continue, discontinue or change SPIs and SPTs include:

8.4.1 SPIs continually report the same value (such as zero per cent or 100 per cent); these SPIs are unlikely to provide meaningful input to senior management decision-making;
8.4.2 SPIs that have similar behaviour and as such are considered a duplication;
8.4.3 the SPT for an SPI implemented to measure the introduction of a programme or targeted improvement has been met;
8.4.4 another safety concern becomes a higher priority to monitor and measure;
8.4.5 to gain a better understanding of a particular safety concern by narrowing the specifics of an SPI (i.e. reduce the "noise" to clarify the "signal"); and
8.4.6 safety objectives have changed and as a consequence the SPIs require updating to remain relevant.

8.5 **Safety Triggers -** A trigger is an established level or criteria value that serves to trigger (start) an evaluation, decision, adjustment or remedial action related to the particular indicator. One method for setting out-of-limits trigger criteria for SPTs is the use of the population standard deviation (STDEVP) principle. This method derives the standard deviation (SD) value based on the preceding historical data points of a given safety indicator. The SD value plus the average (mean) value of the historical data set forms the basic trigger value for the next monitoring period. The SD principle (a basic statistical function) sets the trigger level criteria based on actual historical performance of the given indicator (data set), including its volatility (data point fluctuations). A more volatile historical data set will usually result in a higher (more generous) trigger level value for the next monitoring period. Triggers provide early warnings which enable decision makers to make informed safety decisions, and thus improve safety performance.

8.6 Once SPTs and trigger settings (if used) have been defined, their associated SPI may be tracked for their respective performance status. A consolidated summary of the overall SPT and trigger performance outcome of the complete SPIs package may also be compiled and/or aggregated for a given monitoring period. Qualitative values (satisfactory/unsatisfactory) may be assigned for each SPT achievement and each trigger level not breached. Alternatively, numeric values (points) may be used to provide a quantitative measurement of the overall performance of the SPIs package.

8.7 It should be noted that trigger values serve to trigger (start) an evaluation, decision, adjustment or remedial action related to the particular indicator. An SPI being triggered is not necessarily catastrophic or an indication of failure. It is merely a sign that the activity has moved beyond the predetermined limit. The trigger aims to attract the attention of decision makers who are now in a position to take remedial action, or not, depending on the circumstances.

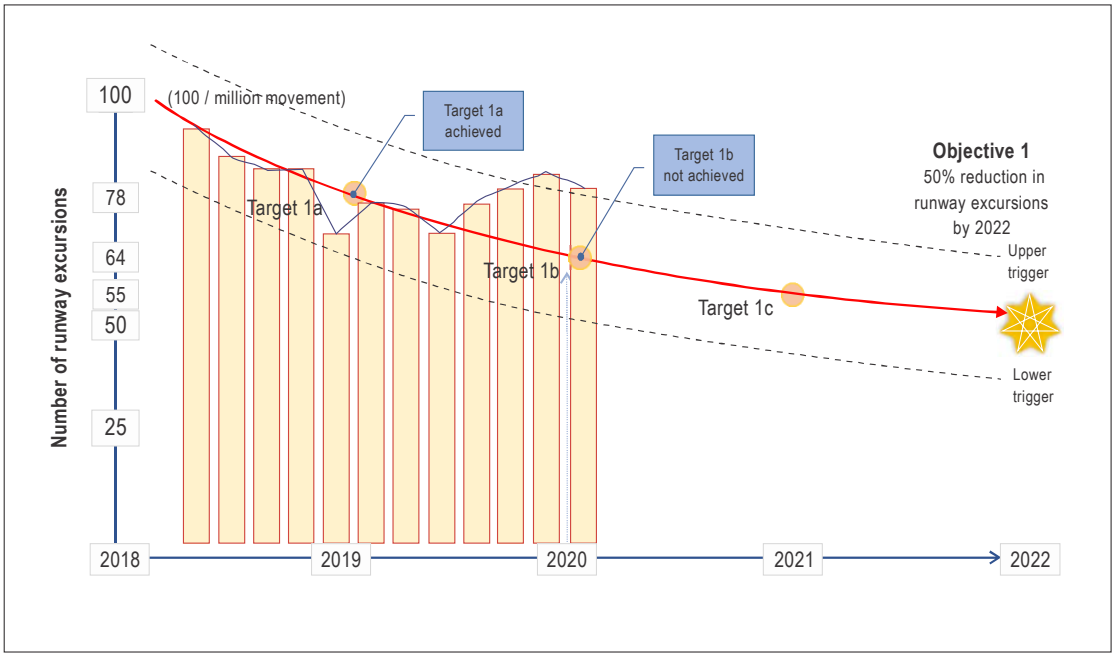


Figure 4: Example of setting safety triggers

9.0 DATA DRIVEN DECISION MAKING

9.1 Arguably the most important outcome of establishing a safety performance management structure is the presentation of information to the organization's decision makers so they can make decisions based on current, reliable safety data and safety information. The aim should always be to make decisions in accordance with the safety policy and towards the safety objectives.

9.2 In relation to safety performance management, data-driven decision-making is about making effective, well-informed decisions based on the results of monitored and measured SPIs, or other reports and analysis of safety data and safety information.

9.3 Using valid and relevant safety data combined with information that provides context supports the organization in making decisions that align with its safety objectives and targets. Contextual information may also include other stakeholder priorities, known deficiencies in the data, and other complementary data to evaluate the pros, cons, opportunities, limitations and risks associated with the decision. Having the information readily available and easy to interpret helps to mitigate bias, influence and human error in the decision-making process.

9.4 Data-driven decision-making also supports the evaluation of decisions made in the past to support any realignment with the safety objectives.

9.5 The following activities can provide sources to monitor and measure safety performance:

9.5.1 ***Safety studies*** are analyses to gain a deeper understanding of safety issues or better understand a trend in safety performance;

9.5.2 ***Safety data analysis*** uses the safety reporting data to uncover common issues or trends that

might warrant further investigation;

9.5.3 ***Safety surveys*** examine procedures or processes related to a specific operation. Safety surveys may involve the use of checklists, questionnaires and informal confidential interviews. Safety surveys generally provide qualitative information. This may require validation via data collection to determine if corrective action is required. Nonetheless, surveys may provide an inexpensive and valuable source of safety information;

9.5.4 ***Safety audits*** focus on assessing the integrity of the service provider's SMS and supporting systems. Safety audits can also be used to evaluate the effectiveness of installed safety risk controls or to monitor compliance with safety regulations. Ensuring independence and objectivity is a challenge for safety audits. Independence and objectivity can be achieved by engaging external entities or internal audits with protections in place - policies, procedures, roles, communication protocols.

9.5.5 ***Findings and recommendations from safety investigations*** can provide useful safety information that can be analyzed against other collected safety data;

9.5.6 ***Collection systems for Operational data*** such as FDA, radar information can provide useful data of events and operational performance;

Civil Aviation Authority

Appendix I

SAFETY PERFORMANCE INDICATORS FOR SYSTEMIC ISSUES

Area	Focus of measurement	Metrics
Compliance	- internal audits/compliance monitoring: all non- compliances	- total number per audit planning cycle / trend - % of findings analyzed for their safety significance,
	- internal audits/ compliance monitoring: significant non-compliances	- number of significant findings versus total number of findings - number of repeat findings within audit planning cycle
	- internal audits/ compliance monitoring: responsiveness to corrective action requests	- average lead time for completing corrective actions per oversight planning cycle - trend
	- external audits/ compliance monitoring: all non- compliances	- total number per oversight planning cycle / trend - % of findings analyzed for their safety significance,
	- external audits: significant non-compliances	- number of significant findings versus total number of findings
	- external audits: responsiveness to corrective action requests	- average lead time for completing corrective actions per oversight planning cycle - trend
	- consistency of results between internal and external audits/compliance monitoring	- number of significant findings only revealed through external audits
SMS effectiveness	- strategic management	- the degree to which safety is considered in the organization's official plans and strategy documents - the frequency with which the organization's official plans and strategy documents are reviewed with regards to safety
	- management commitment	- number of management walk-arounds per month/quarter/year - number of management meetings dedicated to safety per month/quarter/year
	- turnover rate of key safety personnel	- length of term

Area	Focus of measurement	Metrics
		- number of cases where the reasons for departure of key personnel have been analyzed
	- supervision	- number of cases where supervisors provided positive feedback on safety-conscious behavior of your staff per month/quarter/year
	- reporting	- number of reports received per month/quarter/year & trend - % of reports for which feedback to reporter was provided within 10 working days - % of reports followed by an independent safety review
	- hazard identification	- number of accident/serious incident scenarios analyzed to support Safety Risk Management (SRM) per month/quarter/year - number of new hazards identified through the internal reporting system per month/quarter/year & trend - findings from external audits concerning hazards that have not been perceived by personnel/ management previously - number of safety reports received from staff per month/quarter/year & trend
	- risk controls	- number of new risk controls validated per month/quarter/year - % of overall budget allocated to new risk controls
	- HR management & competence development	- % of staff for which a competence profile has been established - % of staff who have had safety management training - frequency for reviewing competence profiles

Area	Focus of measurement	Metrics
		- frequency of reviewing the scope, content, and quality of training programs - number of changes made to training programs following feedback from staff per month/quarter/year - number of changes made to training programs following analysis of internal safety reports per month/quarter/year
	- management of change	- number of organizational changes for which a formal safety risk assessment has been performed per month/quarter/year & trend - number of changes to Standard Operating Procedures (SOPs) for which a formal safety risk assessment has been performed per month/quarter/year & trend - number of technical changes (e.g., new equipment, new facilities, new hardware) for which a formal safety risk assessment has been performed per month/quarter/year & trend - number of risk controls implemented for changes per month/quarter/year & trend - % of changes (organizational/SOP/technical etc.) that have been subject to risk assessment
	- management of contractors	- % of contractors whose safety performance has been assessed - frequency for assessing safety performance of contractors - % of contractors integrated with your company's safety reporting scheme - % of contractors for which safety training has been provided

Area	Focus of measurement	Metrics
		- % of contractors that have implemented training control procedures - % of contractors that have a feedback system on safety issues in place with their customer - number of safety reports received from contractors per month/quarter/year & trend - number of safety actions initiated following assessment of safety performance or safety reports received per month/quarter/year & trend
	- emergency response planning (ERP)	- number of emergency drills per year - frequency of reviewing the ERP - number of trainings on ERP per month/quarter/year - % of staff trained on the ERP within a quarter/year - number of meetings with main partners and contractors to coordinate ERP per month/quarter/year
	- safety promotion	- number of safety communications published - number of trainings performed - number of safety briefings performed. - (per month/quarter/year)
	- safety culture	- the extent to which personnel consider safety as a value that guides their everyday work (e.g., on a scale from 1= low to 5=high) - the extent to which personnel consider that safety is highly valued by their management - the extent to which human performance principles are applied - the extent to which the personnel take initiatives in

Area	Focus of measurement	Metrics
		improving organizational practices or report problems to management - the extent to which safety-conscious behavior is supported - the extent to which staff and management are aware of the risks your operations imply for themselves and for others.

SAFETY PERFORMANCE INDICATORS FOR OPERATIONAL ISSUES

Area	High Severity outcome to be prevented	Metrics
Air operators See also Air Traffic management/ Air Navigation Services for additional indicators	- traffic collision	- number of Traffic Collision Avoidance System (TCAS) resolution advisories per 1000 flight hours (FH)
	- runway excursion	- number of unstabilized approaches per 1000 landings
	- ground collision	- number of runway incursions per 1000 take-offs
	- controlled flight into terrain	- number of Ground Proximity Warning System (GPWS) and Enhanced Ground Proximity Warning System (EGPWS) warnings per 100 take-offs
	- accident/incident related to poor flight preparation	- number of cases where flight preparation had to be done in less than the normally allocated time - number of short fuel events per 100 flights - number of fuel calculation errors per 100 flights
	- accident/incident related to fatigue	- number of extensions to flight duty periods per month/quarter/year & trends
	- accident/incident related to ground-handling	- number of incidents with ground handlers per month/quarter/year & trends - number of mass and balance errors per ground handler per month/quarter/year & trends - number of dysfunctions per ground handler per month/quarter/year & trends

Area	High Severity outcome to be prevented	Metrics
	- maintenance related accident/incidents	- Pilots Reports (PIREPS) per 100 take offs - deferred items per month and aircraft - In Flight Shut Down (IFSD) per 1000 FH - In Flight Turn Backs (IFTB) and deviations per 100 take offs - number of service difficulty reports filed with the Civil Aviation Authority dispatch reliability: - number of delays of more than 15 minutes due to technical issues per 100 take offs - number of cancellations per 100 scheduled flights due to technical issues - rejected take offs per 100 take offs due to technical issues
Maintenance organizations	- maintenance planning/rostering related accident/incidents	- % of work orders for which a detailed planning has been made
	- maintenance planning/rostering related accident/incidents	maintenance engineer fatigue / maintenance error: - % of work orders with a difference > 10% between the expected lead time and the actual processing time - % of work orders with a difference > 10% between the estimated work force and the actual needs
	- maintenance related accident/incidents	maintenance error: - % of work orders that required re-work - number of duplicate inspections that identified a maintenance error
	- maintenance data related accident/incidents	- number of safety reports related to ambiguous maintenance data
	- maintenance related accident/incidents	- number of investigations performed following components removed from service significantly before expected life limit was reached
Air Traffic	- traffic collision	- number of level busts/exposure

Area	High Severity outcome to be prevented	Metrics
management/ Air Navigation Services		- number of TCAS required action (RA) (with and without loss of separation) /exposure - number of minimum separation infringement/exposure - number of inappropriate separation (airspace in which separation minima is not applicable) /exposure - number of aircraft deviation from air traffic control (ATC) clearance/exposure - number of airspace infringements/exposures
	- traffic collision / controlled flight into terrain	- number of aircraft deviations from air traffic management (ATM) procedures/exposure - number of inappropriate or absences of ATC assistance to aircraft in distress
	- controlled flight into terrain	- number of near Controlled Flight Into Terrain (CFIT) IFSD /exposure
	- runway excursion	- number of inappropriate ATC instruction (no instruction, wrong information, action communicated too late, etc.)
	- runway incursion	- % of runway incursions where no avoiding action was necessary - % of runway incursion where avoiding action was necessary
Airports	- post-accident/incident fire	- Fire Extinguishing Services (ICAO Airport Fire Fighting Categories) decrease in value (# decrease- hours/ # airport annual operating hours) - number of radio/phone failures per 100 operations number of fire rescue vehicles failures per 100 operations
	- runway incursion	- runway incursions per 1000 operations signage: - number of failures or defects found during routine inspection - number of defects reported - average lead-time for repair/replacement

Area	High Severity outcome to be prevented	Metrics
		- (per month/quarter/year & trends)
	- collision with vehicle on ground / ground-equipment	- notified platform safety rules violations per 1000 operations.
	- ground collision with wildlife	- number of ground collisions with wildlife - number of inspections of fences and other protective devices per month/quarter/year
	- FOD (Foreign Object Damage)	- number of FOD found during routine inspections - number of FOD found out of inspections and after report
	- runway incursion	runway lights - number of failures or defects found during routine inspection - number of defects reported - average lead-time for repair/replacement (per month/quarter/year & trends)
	- bird-strike In Flight Shut Down (IFSD)	- number IFSD per 10000 FH following bird-strike
Flight training organizations	- accident/incident related to poor training	- number of trainees per instructor - number of changes in instructor per training - number of major changes to training program (per month/quarter/year & trends)
	- accident/incident related to poor training/complacency during examinations	- number of significant deviations from average pass rates
Design organizations	- design related accident/incidents	During the design phase: - number of design changes requested due to design errors per program and per period - number of rejected compliance demonstrations per program and per period
	- design planning related accident/incident	- % of technical reports with a difference > 10% between the expected lead time and the actual processing time - % of technical reports with a difference > 10% between the estimated work force and the actual needs

Area	High Severity outcome to be prevented	Metrics
	- design related accident/incidents	Post certification: - number of service difficulty/safety reports due to design errors per program and per period - number of safety reports related to ambiguous design data - number of design changes classified incorrectly (minor/major) per period
Manufacturing organizations	- manufacturing related accident/incidents	- number of service difficulty/safety reports due to manufacturing errors per program and per period
	- manufacturing process related accident/incidents	- % of work orders that required re-work - number of investigations performed following work orders that required re-work
	- manufacturing process related accident/incidents	- % of duplicate inspections that identified a manufacturing error
	- manufacturing process related accident/incidents	- number of cases where final delivery was delayed due to significant non-compliances - number of investigations performed following delayed delivery
	- manufacturing data related accident/incidents	- number of safety reports related to ambiguous manufacturing data
	- manufacturing planning related accident/incidents	Production personnel fatigue / production error: - % of work orders with a difference > 10% between the estimated work force and the actual needs - % work orders with a difference > 10% between the expected lead time and the actual processing time

INDICATORS TO MONITOR EXTERNAL FACTORS

Area	Monitoring focus	Metrics
Regulations	- new regulations	- number of new regulatory requirements that will affect your organization within the next 12 months
	- amendments to regulations	- number of amended regulatory requirements that will affect your organization within the next 6 months
	- evolution towards performance-based regulations	- number of objective based rules for which you have defined your own means of compliance
Technology	- new technologies relevant to your core business – hardware	- % of total investment that is spent on new technologies
	- new technologies relevant to your core business – software	- % of total investment that is spent on new technologies
	- new technologies relevant to your core business	- rate of obsolescence of existing qualifications
	- new technologies installed in aircraft	- number of aircraft modifications / Supplemental Type Certificates (STCs) that require a change to your company's rating
	- new technologies installed in aircraft	- number of new modifications / STC that require new qualifications
Competition	- financial turn -over	- evolution in your turnover
	- staff turnover	- average time to fill a vacant post - number of staff leaving to work for a competitor
	- market opportunities	- evolution in the number of requests for quotation from new customers - ratio of requests for quotation from new customers that are followed by a firm order
	- competitors	- evolution in the number of your direct competitors

Appendix II

Form: AC-SMS009

AREA OF OPERATIONS		
PART A: INDICATOR IDENTIFICATION		
1. INDICATOR		
2. DESCRIPTION		
PART B: INDICATOR SPECIFICATIONS		
3. INDICATOR TYPE ☐ activity-related (predictive or leading) ☐ outcome-related (reactive or lagging) OR		
4. RATIONALE		
5. LIMITATIONS		
6. DEFINITION OF TECHNICAL OR SPECIFIC TERMS		
7. CALCULATION METHOD/FORMULA		
PART C: DATA		
In the table below, provide information about the data supporting the measurement of the indicator.		
8. DATA SET(S)	**9. PROVIDER**	**10. CUSTODIAN**
PART D: ADMINISTRATIVE DETAILS		
Completed by:		**Date:**
Approved by:		**Date:**
PART E: CIVIL AVIATION AUTHORITY		
Accepted/not accepted: ☐ Yes ☐ NO		**Date:**
Accepted by:		**Date:**