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Practical guide on safety management systems for continuing airworthiness activities

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This document is a guide for Part M/G continuing airworthiness management organisations associated with commercial air transport operators, and for Part 145 maintenance organisations.

It has been drawn up based on the regulations presented in the Order of 22/12/08 and the associated instruction, and taking into account the experience of the organisations on this type of subject.

It should be used above all as an aid in the implementation and operation of the safety management systems (SMS) and not as a series of detailed regulatory obligations to be strictly applied.

The proposed methods should be adapted by each organisation according to its particular characteristics.

The concrete cases presented here are proposed simply by way of example in order to help the organisations to better understand certain concepts.

Any comments regarding any specific points in this guide may be sent to the airworthiness maintenance and approval office of the DGAC (e-mail address: franck.sainton@aviation-civile.gouv.fr), stating the reference number of this guidance.

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1. SUBJECT

This guidance is a simplified guide describing the various elements of the safety management systems (SMS) suited to continuing airworthiness management and maintenance.

2. SCOPE

This guidance applies:

- to continuing airworthiness management organisations approved in compliance with Subpart G of Part M (Annex I) of regulation EC 2042/2003 and which are associated with commercial air transport companies in possession of an AOC (delivered in accordance with annex III of regulation 3922/91 or the Order of 23 September 1999);
- to maintenance organisations approved in accordance with Part 145 (annex II) of regulation EC 2042/2003.

3. REFERENCES

- ICAO guide published with reference number: 9859/AN 474 issue 2 of 2009, entitled "Safety Management Manual (SMM)" (available for consultation from the ICAO site at the address: http:// www.icao.int)
- Order of 22/12/08 and associated instruction (available for consultation from the Legifrance site at the address: http://www.legifrance.gouv.fr and from the site of OSAC)
- European Commission regulation EC 2042/2003 of 28/11/03 and its revisions (available for consultation from the site of the EASA at the address: http://www.easa.eu.int)
- Information Bulletin No. 2009/06: "Implementation of safety management systems (SMS) in the domain of continuing airworthiness associated with commercial air transport" (available for consultation from the OSAC site at the address: http://www.osac.aero)
- "Guide to setting up safety management - continuing airworthiness systems," published under reference P-50-10 (available for consultation from the OSAC site at the address: http://www.osac.aero)
- DGAC guides: "Practical guide to the implementation of safety management systems by public air transport companies and maintenance organisations" (due for distribution on the DGAC site)

This guidance received the approval of the DGAC in a letter referenced 11-0116-DSAC-NO-AGR of 08/03/2011.

4. DEFINITIONS

AD:	Airworthiness Directive
ALI:	Airworthiness Limitation Item
AOG:	Aircraft On Ground
CRS:	Certificate of Release to Service
CFIT:	Control Flight Into Terrain
CMR:	Certification Maintenance Requirement
DGAC:	Direction Générale de l'Aviation Civile
DSAC:	Direction de la Sécurité de l'Aviation Civile
OVH:	Overhaul
HF:	Human Factors
IFSD:	In-Flight Shut Down
MGN:	Specifications manual for airworthiness management organisations
MOE:	Specifications manual for maintenance organisations
MRB:	Maintenance Review Board
NDT:	Non-Destructive Test
OSAC:	Organisation pour la Sécurité Aviation Civile
LLP:	Life-limited part
QRF:	Quick Return Flight
SB:	Service Bulletin
SMS:	Safety Management System
QS:	Quality System

5. INTRODUCTION

5.1. THE GUIDE IN BRIEF

In light of the originality and the nature of the new "Safety Management System" (SMS) concept, the utility of drafting a simplified guide to the SMS in the framework of continuing airworthiness activities soon became clear.

This guide comes in addition of the DGAC SMS guide entitled "Practical guide to the drafting of an SMS manual by public air transport companies and maintenance organisations", which presents the regulatory requirements and acceptable resources associated with the SMS, along with the structure of a standard SMS manual, and the principal information to feature in this SMS manual, as applicable to all entities that need to put in place an SMS:

- AOC holders (including the associated Part M/G organisations)
- AOC holders (including the associated Part M/G organisations) with an integrated Part 145 maintenance organisation
- independent Part 145 maintenance organisations

<u>This new guide has been drawn up as an aid in particular for independent Part 145 maintenance organisations that maintain equipment/engines.</u>

In order to cover comprehensively the Part 145 maintenance activities, this guide also addresses the case of independent Part 145 maintenance organisations that provide aircraft maintenance.

This guide can also be used by Part 145 maintenance organisations that are integrated into operators. Bearing in mind the important links between the continuing airworthiness management organisations and the maintenance organisations, it was also considered pertinent to cover in this guide certain specific aspects of SMS functions linked to Part M/G organisations integrated into AOC holders.

In the latter case, it is important to note that the SMS elements of these organisations integrated into operators need to be built up consistently with the SMS elements of the operators. The SMS system of an operator with Part M/G certification and, in certain cases, a Part 145 maintenance organisation must form a whole: one single SMS system (same principle as for the Quality Systems of Part M/G operators/organisations).

As is the case with Quality Systems, the SMS system of a Part 145 approved organisation with one or more non-approved subcontractors for certain maintenance activities must also cover its non-approved subcontractors. This principle is also applicable to Part M/G organisations and their non-approved subcontractors.

5.2. CONTENTS OF THIS GUIDE

The principle of this new guide is not to reproduce elements already detailed in the guide entitled: "Practical guide to the drafting of an SMS manual by public air transport companies and maintenance organisations", but to provide additional information making it possible, for certain given subjects, to better understand the concept of the SMS in the framework of continuing airworthiness activities.

<u>It provides examples, practical solutions and lines of approach for the implementation of this SMS in the framework of continuing airworthiness.</u>

The concrete examples presented in this guide should enable better understanding of certain notions associated with the SMS. These examples are presented systematically in italics and inside boxes throughout this guide.

To make it easy to read, this guide has the same structure as the first guide detailed above.

It is important to study the first guide concerning the drafting of the SMS manual before taking into consideration this simplified guide to the SMS linked to continuing airworthiness.

5.3. SMS IN THE FRAMEWORK OF CONTINUING AIRWORTHINESS

Although the SMS approach may be new in terms of its designation, it is important to insist on the fact that a large proportion of the elements of this SMS is, in one way or another, already in place in the organisations in various forms:

- Certain elements are already formally in place pursuant to regulatory requirements published in Part M and Part 145 (analysis of major events, feedback on maintenance errors, safety policy, notions linked to Human Factors, introduction of supplementary inspections in the context of jobs carried out on critical elements, procedures for minimising the risks of multiplying errors on identical critical systems, etc.).
- Functioning rules not associated already with the given requirements, and not necessarily formalised but applied in practice by those working in the organisations. This often involves principles that are used spontaneously and intuitively and which call upon the common sense and experience of personnel regarding safety-related subjects (change management taking into account the associated risks, communication on matters of safety, etc.).

<u>The introduction of the SMS within an organisation needs to be considered as the consolidation in a more formal mode of existing elements that are already mature, existing elements that are on the way to maturity and some new elements that need to be formalised and applied more systematically in the future.</u>

In the framework of this SMS approach, it is therefore more a matter of reinforcement of the consistency of initiatives already in place and coordinating more efficiently their interactions than creating a full new management system from nothing.

The SMS is a tool enabling organisations to be managed taking into account in more systematic manner the risks associated with the activities of these organisations. What it does in fact is to make it possible to distinguish between the subjects that are important and the subjects that are less important in terms of safety, and therefore more efficiently define the priorities for actions of improvement and change.

It supplements the other systems already existing within organisations, such as the Quality System (QS).

The QS is essential for guaranteeing processing uniformity and the simplest possible processing within the same organisation. It is a system that serves as a driving force for process development, and for the drafting of procedures enabling operatives to know what they need to do in classic situations. This QS makes it possible to check that what has been defined in practice is correctly applied, and that the major functions are compliant with expectations.

However, these processes are often represented as stable processes, with standardised inputs and outputs (comparable qualified personnel, etc.).

The daily reality, the operating conditions, the situation of the enterprise, its external environment, and so on offer reminders that the organisation is a complex and variable system. It cannot be perfectly modelled and the established procedures cannot claim to cover every possible scenario. The SMS is therefore conceived as an aid for the analysis of processes, with respect to the risks that they may generate and the threats that may disrupt them.

The Quality System and Safety Management System approaches are therefore complementary. They need to feed into each other. Certain observations with regard to QS monitoring (significant findings that may potentially be linked to safety) may be used by the SMS (analysis of a weak point for a given process), and certain results emanating from the SMS (concerning risks) may be used to re-orientate the actions of the QS (adapting QS monitoring for a given function).

One final point needs to be underlined: the SMS is not a body of supplementary rules that the organisation needs to integrate and with which it will need to comply.

The spirit of the SMS is, on the contrary, to enable treatment of everything that is not fully addressed by the regulation and which could not be efficiently addressed by more rules.

The only rules presented therefore concern the implementation of the SMS and how to ensure its correct operation. This is also the reason why the presentations of the SMS are based more on explanatory guides than on the explanation of rules, as has traditionally been the case to date.

6. SAFETY POLICY & ORGANISATION

6.1. COMMITMENT OF THE RESPONSIBLE MANAGER

The successful implementation of an SMS is directly linked to the management position vis-à-vis this new system.

The Accountable Manager (AM) of the organisation needs to play a leading role in this project and come across as completely committed to the implementation of this new SMS. It is therefore important for the AM to be convinced of the benefits of this SMS approach in order, in turn, to demonstrate conviction about the subject in exchanges with other management echelons and with the personnel as a whole.

It is the duty of the AM to draw up and formally sign a safety policy, and update it when necessary. The mode of distribution of this policy needs to be suited to the company, so that it can be brought to the attention of all personnel.

Example of how to distribute the safety policy to all personnel

- *via a letter sent to each employee of the organisation, and/or*
- *through posting up a document describing the safety policy in the facilities of the organisation (hangars, workshops, offices, etc.), and/or*
- *via specific meetings to present this SMS policy to the personnel*

6.2 ORGANISATION OF THE SMS

Generally speaking, the SMS must be proportionate to the size and complexity of the organisation, the complexity of the products subject to maintenance and the complexity of the activities of the organisation.

Currently, the European regulation projects make provision for the implementation of a Management System (incorporating, in particular, Quality and Safety). The question of how to implement a common Quality/SMS system is therefore a timely one.

In the case of a company that possesses an AOC, a Part M/G approval and, where applicable, a Part 145 approval, the SMS must be treated as a single system.

6.3. SMS MANAGER

A manager must be designated for coordinating the SMS approach. The natural solution is to assign this new responsibility to a new manager dedicated to this function.

However, depending on the size of the organisation, it may be possible to assign the SMS Manager function to the person already assuming the role of the Quality Manager for the organisation. This solution is often justified by the difficulties faced by these organisations in designating a new manager who is sufficiently independent from the activity of the organisation. It also offers the benefit of a level of consistency that is easier to put into place and maintain between the SMS systems and the Quality systems.

In the case of small organisations that have chosen, moreover, to assign the QS responsibilities to the Accountable Manager, it should also be possible, under certain conditions, to assign the SMS responsibility to the AM too.

However, in this case it is important that the person with this SMS responsibility is able to draw on the requisite skills in safety management and disposes of sufficient technical expertise concerning the activity of the organisation.

If the SMS Manager does not possess all the skills required for guaranteeing all the tasks linked to the SMS, an SMS coordinator needs to be designated in order to assist this SMS manager.

It is important that the person (SMS manager or assistant coordinator) responsible for compiling and analysing the risks should be recognised by the personnel of the organisation for their technical skills, communication competencies, analysis skills and legitimacy for guaranteeing the confidentiality of the information collected.

Example:
In a small maintenance organisation, a person working in the Technical Office who has in the past acquired significant production experience as a mechanic and/or team leader or control staff could assure this role of part-time assistant SMS coordinator to support the SMS manager.

6.4. SAFETY RESPONSIBILITIES

The main managers of the organisation should facilitate the implementation of the SMS and know precisely their roles and the specific tasks that they need to fulfil in the framework of this SMS. The organisations therefore need to define the roles of each individual vis-à-vis the SMS.

The introduction of the SMS provides a good opportunity to reinforce the interfaces and the communication between the various domains of the organisation concerned with regard to safety matters.

It is recommended to create a safety group or committee bringing together the various business specialities of the organisation, designating the persons who are to make up this committee on an ongoing basis.

The function of this committee would be to filter and select the events to be analysed in detail, to determine the lines of approach for predictive analyses, etc.

Example composition of a safety group for a small Part 145 maintenance organisation

- *SMS/QS Manager*
- *SMS Coordinator (assistant to the SMS/QS Manager)*
- *Production Manager of the organisation*
- *Logistic staff*
- *Technical Office staff*

6.5 SAFETY OBJECTIVES AND INDICATORS

This involves defining the indicators and associated objectives for tracking the progress evolution and certain safety-related objectives.

The safety performance objectives for continuing airworthiness management and maintenance organisations are not always easy to define.

It is essential to define, from the very start, quantified objectives or anticipated trends for each indicator, even if these objectives need subsequently to be adjusted, taking into account experience and items of reference that may coming from different sources (specific studies, exchanges between organisations, etc.).

Example safety indicators for an SMS of a continuing airworthiness management organisation:

- *Indicators concerning operating incidents / events (major delays, parking feedback, QRF, diversions, IFSD, etc.) due to defects emanating from the Part M/G organisation itself (failure to initiate tasks, or poor initiation of tasks)*
- *Indicators concerning ultimate events observed directly by the continuing airworthiness management organisation (e.g., retrospective observation of exceeded AD, ALI, CMR concerning one or more aircraft/engines/equipment items in operation)*
- *Indicators linked to risk processing (number of events studied and processed, number of actions taken, time spent on analysis and implementation of measures)*
- *Indicators linked to feedback to personnel (number of articles published on the subject of SMS, time taken to communicate measures adopted subsequent to the determination of risks, etc.)*

Example safety indicators for an SMS of a maintenance organisation:

- *Indicators concerning operating incidents / events / workshop feedback on equipment observed as defective upon leaving the workshop due to non-compliant maintenance emanating from the maintenance organisation and communicated by the Part M/G customers/operators/organisations*
- *Indicators concerning ultimate events observed directly by the maintenance organisation (e.g., retrospective observation of incorrect application of a modification concerning one or more aircraft/engines/equipment items in operation)*
- *Indicators deriving from voluntary notification by operators of maintenance errors*
- *Indicators concerning faults observed in the framework of production inspections linked to the maintenance tasks implemented*
- *Indicators linked to risk processing (number of events studied and processed, number of actions taken, time spent on analysis and implementation of measures)*

6.6. COORDINATION OF EMERGENCY RESPONSE PLANNING

This point concerns the management of crises and emergency situations.

The organisations should envisage crisis situations that could fundamentally call into question their normal operations for a given period and compromise flight safety.

They should prepare for these eventualities and formally establish the basic rules to be followed in these cases by the persons concerned.

Examples of crisis situations for a continuing airworthiness management organisation

- *Aircraft monitoring system unavailable for a significant period*
- *The main Part 145 contractor of the Part M/G organisation going into liquidation and rapidly becoming incapable of fulfilling the entire maintenance contract*

Example crisis situations for a maintenance workshop:

- *Fire destruction of a part of the installations*
- *Flooding of certain workshops*
- *Inoperative heating system in extremely cold conditions*
- *IT system down for a significant period, etc.*

The objective of this SMS element is to define a mode of organisation for immediately taking charge of the actions linked to a major event, while guaranteeing the smooth running of the rest of the activities that are not directly affected by the event in question but which could be disturbed by it.

This function should make it possible to manage this transitional period, and enable a return to a normal situation within a satisfactory time frame.

6.7. DOCUMENTATION

Every organisation must draft and manage an SMS manual.

Initially, in order to be able to revise more easily the documentation associated with the SMS, the organisations are recommended to draw up an SMS manual that is separate from the main organisation manual (MOE or MGN based on the case).

This single manual solution is even more suited to continuing airworthiness organisations and maintenance organisations that are integrated into an AOC holder.

If an independent Part 145 organisation wishes to describe its SMS in its organisation manual (MOE), it is recommended that the description of the SMS in this case should be subject to a specific chapter in this manual (same principle as for chapter 3 in the MOE specifically relating to Quality Systems).

For drafting this SMS manual, it is advisable to refer to the DGAC guide entitled: "Practical guide to the drafting of an SMS manual by public air transport companies and maintenance organisations".

7. SAFETY RISK MANAGEMENT

Risk management consists in collecting a set of data linked to safety, identifying the risks, analysing them in detail and assessing the criticality of these risks, defining their acceptability levels and taking any necessary measures. Prevention, avoidance, recovery and limitation are the essential elements of risk management.

Before addressing the risks definition and risks management processes, it is important to consider the concepts associated with risk management.

Various reference documents concerning safety management systems refer to "Adverse Events" (AE) and "Ultimate Events" (UE).
The notion of "Adverse Event" (AE) refers to an inappropriate action or decision taken in a given situation or circumstance which may, in certain cases, lead to a serious or catastrophic consequence or "Ultimate Event" (UE).

The notion of "risk" is a relative notion and is characterised by a frequency level for the occurrence of an "Adverse Event" and a severity level for the consequences linked to this event.

The notion of "threat" (or hazard) corresponds to the notion of causes, conditions or circumstances that may explain the occurrence of an "adverse event".

The notions of "preventive barrier" and "protective barrier" are inseprable from the notion of "event". These barriers contribute directly to the management of risks.
The "preventive barriers" set up upstream of possible adverse events are intended to prevent the occurrence of these adverse events. These barriers may take various forms: training, precise task definition, checklists, etc.
The function of the "protective barriers" is to detect the occurrence of an adverse event and to rectify the associated situation in order to avoid the generation of an ultimate event. These barriers may take various forms: tasks inspection, functional testing, inventory of means used, inspection of records, etc.

The objective for the organisations is, by anticipation, to avoid any "Ultimate Event" by preventing upstream the occurrence of any "Adverse Event" that may lead to this ultimate event, by detecting this Adverse Event in order to be able to avoid the possible consequences, and possibly putting in place systems designed to mitigate the consequences in question.

The notion of "Adverse Event" is generic and may not be considered an absolute as such. Its composition depends on the activity of the individual organisation.

For an operator, the notion of "Ultimate Event" can be assimilated with the notion of "accident" or of "serious operational incident" involving death, injury and/or damage to property or to the environment, possibly culminating in their total loss or destruction. The notion of "Adverse Event" is an operational situation (in flight, while taxiing) that may lead to an "Ultimate Event".

Examples of ultimate events and adverse events for an operator:

- *Ultimate events: CFIT, crash after loss of control in flight, collision on the ground, collision in flight, runway overshoot, damage/injury*
- *Adverse events: non-stabilised approach, incursion on runway, weight / balance fault, hazardous weather conditions, loss of thrust for an engine on a multiple-engined aircraft, depressurisation, deviation from flight path, contaminated runway, fire / smoke, failure of thrust reversers.*

With respect to the operational activity proper, which is the domain most directly exposed to accidents and incidents, the continuing airworthiness management organisations and aircraft, engine and equipment maintenance organisations can also generate ultimate events.

With regard to operation, these organisations should most frequently be considered as "potential contributors" (like other activities upstream of operation such as flight preparation, loading, etc.)

It is not easy for Part M/G organisations and Part 145 organisations to isolate events deriving from maintenance which may lead directly, or more or less directly, to an ultimate event in operation (accident, serious incident).

From the operator point of view, aircraft maintenance organisations and continuing airworthiness management organisations may generate "threats" which, when combined with others, may contribute to the generation of an "adverse event in operation" and therefore possibly to an "ultimate event in operation".

These "threats" linked to the maintenance of aircraft, which the operator faces, may therefore be considered by the aircraft maintenance organisation as "ultimate events in aircraft maintenance" that may be grouped under the term: "unsafe delivered aircraft" (idem for continuing airworthiness management).

From the aircraft maintenance organisation point of view, an Engine/Equipment maintenance organisation may also generate "threats" which, when combined with other threats, may contribute to the generation of an "adverse event in aircraft maintenance" and therefore possibly to an "ultimate event in aircraft maintenance".

These "threats" linked to Engine/Equipment maintenance, which the aircraft maintenance organisation faces, may therefore be considered by the Engine/Equipment maintenance organisation as "ultimate events in Engine/Equipment maintenance" that may be grouped under the term: "unsafe delivered engines / equipment"

The adverse events, ultimate events, threats and preventive & protective barriers presented in this chapter are simply some examples designed to help organisations to define their own scenarios concerning them more specifically.

The diagrams in appendices I, II and III offer a representation of the above principles.

NB: The reference documents on the SMS for the most part are all focused on aircraft operation, and refer to the concepts of "adverse event" and "ultimate event" (or equivalent terms meeting the same criteria).

The exercise of transposing the SMS on to maintenance activities is done in this guide according to the principle of using the same terms as those used for operations activities. The principle is to avoid referring to other terms such as "feared event" or "serious ultimate event" and in this way generate confusion, or even very different safety management systems according to the types of activity in question. This principle can confirm the responsibility of each organisation upstream of operations in the processing of threats/risks that concern them directly. The ultimate event should therefore be considered by a Part 145 or Part M/G organisation as a serious event: an event to be avoided by different ways.

7.1 COLLECTION AND CLASSIFICATION OF DATA

The first important function in risk management concerns the collection and classification of events that have already taken place and which may serve to determine some of the risks concerning the organisation. These events may be of various types.

Examples of reports to be transmitted to the SMS
• *Observed ultimate events concerning the organisation itself (incident reports, reports from customers, internal reports following retrospective discovery of an ultimate event, etc.)* • *Observed errors in the application of a task, notified directly by the operators* • *Observed errors in the application of a task observed in the framework of control of these tasks (functional tests, operational tests, production inspections, product inspection, etc.)* • *Significant deviations in the application of procedures as reported by the Quality System (quality reports)* • *Ultimate events published by various organisations (BEA, accident reports, etc.)*

The organisation should make an inventory of this information. All this information should follow an internal communication process and should, depending on the case, be notified externally (authorities, customers/operators, TCH). These communication processes for each type of information should be verified in order to guarantee that the necessary information is properly communicated to a designated function of the SMS to be taken into account.

<u>It is essential that the SMS determine the criteria for selecting the potentially significant events that have a direct link to safety and that should be treated as such, and the other more minor findings that only require light curative and corrective actions.</u>
An initial summary analysis by the SMS should make it possible to carry out preliminary sorting of this information.

<u>For maintenance organisations, the priority action in this domain concerns more particularly the notification of information linked to maintenance errors by the mechanics themselves.</u>

The quantity and quality of feedback on this subject needs to be assured. If there is only limited feedback, the organisation should seek to establish the cause of this. A diagnostic of the situation may be useful. The organisation should ask itself questions about the quantity and nature of the notified maintenance errors.

Examples:
• *Has a non-punitive policy on the subject been published?* • *Does it clearly detail the decision of the organisation not to sanction the persons who notify the errors?* • *Is the means of notification available, appropriate and familiar?* • *Is the maintenance error notification form simple and easy to complete?* • *Are there no simpler means that can be used for the subject (email, etc.)?*

An anonymous questionnaire passed on to all technicians may be an appropriate means of understanding the limited quantity of events notified, and of obtaining directly from those concerned proposals for improving this feedback process. While the organisation needs to ask questions about its "fair" or non-punitive policy, it may also envisage putting in place encouragement measures in order to increase the level of feedback, or indeed envisage asking, in the first instance, operators to provide an identical predefined number of notifications per mechanic over a given period for the most significant observed errors.

7.2. HAZARD / RISK DETERMINATION AND MANAGEMENT

Risk identification may be carried out by means of three approaches:

- A "reactive" approach
- A "proactive" approach
- A "predictive" approach

These appear chronologically in the construction approach for the risk management function as applicable to the organisations. These approaches are therefore complementary, because they incorporate past, present or potential data. It is important that these approaches are understood and identified from the very start by all personnel concerned.

7.2.1 Risk identification

7.2.1.1 Risk identification via the reactive approach.

In the framework of the reactive approach, the ultimate event ("unsafe delivered aircraft/engine/equipment") has occurred and been notified to the SMS.
The first objective is to determine the adverse event that has led to this ultimate event.
The important phase is therefore the investigation and the detailed analysis of these events in order to draw all conclusions and take the corrective actions that are required.

These actions are already required by virtue of the regulations. The implementation of the SMS should provide an opportunity to assess the operation of this investigation and analysis process and, where necessary, to reinforce the associated means (resources and skills).

<u>It is important that the reactive approach should be fully in place before consolidating the proactive approach and prior implementing any predictive approach.</u>

Examples of questions in the framework of the assessment of this events analysis function

- *Have the analyses been carried out well? Do they take into account all the aspects that may culminate in isolating the true causes at the origin of these events?*
- *Are these analyses also carried out well with regard to the human factors?*
- *Are the detected causes most often linked to organisational factors and not, in general, linked to frontline operators?*
- *Has an analysis of the existing preventive and/or protective barriers been carried out well?*
- *Do the actions cover curative and preventive actions?*
- *Are these preventive actions composed of actions that are not limited to simple actions of the type: "reminder of instructions in the context of on-the-job training" or "drafting information bulletins" or "revising procedures"?*

<u>In the framework of the reactive method, the analysis of an ultimate event that has been observed and notified consists in studying in detailed manner the sequence of actions that have led to this event and the conditions thereby enabling definition of the adverse event and the associated causes (what, when, who, how, why, etc.).</u>

This analysis should remain as factual as possible. No rapid judgement or decision should be made vis-à-vis the observed facts before properly understanding the dynamics of the facts in question. The analysis should be carried out from a systemic perspective. It may not simply conclude, for example, that there has been non-compliance of the rules by the frontline actors.

All those concerned, either closely (frontline operators) or remotely (those involved in upstream functions in terms of logistics, preparation, management, etc.) should be approached in order to understand how the facts have been made possible.
The collected information must remain confidential and those responsible for implementing this approach should be recognised as legitimate and competent.

All specific factors that have accompanied certain actions should be determined.
Among these, the human factors should be taken into account as a priority (communication within the team, relations with management, pressure levels associated with these actions, stress, personnel fatigue, individual behaviour, match-up of skills to the specific tasks in question, suitability of the environment, interfaces between the personal concerned and the maintenance means and data, etc.).

In the framework of this analysis, it is also important to determine the level of decision-making and autonomy of those who have a role in this event. It may be useful in this regard to refer to the table in appendix III of guidance P-54-45 on the Human Factors approach.

Part of this analysis should relate to the preventive barriers and protective barriers that have not worked properly.

After collecting all the factual information concerning the event in question, the principle is to determine the main causes that may explain it.

Simplified example of a risk analysis linked to continuing airworthiness management

- ***Notified aircraft maintenance ultimate event**: "Unsafe delivered aircraft" with a repetitive AD that has exceeded its time limit*
- *Determined adverse event: incorrect entry of data linked to the last implementation of this AD in the AD monitoring system*
- *Main cause of the adverse event: data entry error by the operator and absence of systematic formal control of this type of recorded information*

Simplified example of risk analysis linked to Aircraft maintenance

- ***Notified aircraft maintenance ultimate event**: "Unsafe delivered aircraft" with faulty movement of a flight control surface*
- *Determined adverse event: reinstallation of a part not carried out in the framework of the refitting of a flight control system assembly and partially performed test after that.*
- *Main causes of the adverse event: refitting interrupted following emergency assignment of the mechanic to another troubleshooting operation, no rules for recording work carried out/still to be done in the case of suspended operations, excess workload at the end of a job for inspectors, complex tasks carried out at night-time with no specific compensatory measures, operator fatigue*

Simplified example of risk analysis linked to Equipment maintenance

- ***Notified equipment maintenance ultimate event**: "Unsafe delivered equipment" / hydraulic cylinder with operating fault: deployment speed of cylinder non-compliant*
- *Determined adverse event: reverse refitting of a subassembly leading to the limitation of the deployment speed of the hydraulic cylinder, tests on leaving workshop not covering this specification*
- *Main causes of the adverse event: maintenance data and process sequences not sufficiently precise on the sequencing of refitting of the subassembly concerned. Test described in the CMM not covering a check of the hydraulic cylinder deployment speed*

7.2.1.2 Risk identification via the proactive approach.

Rather than waiting for an ultimate event to occur in a given situation, detection of observed or potential maintenance findings and the occurrence of significant malfunctions make it possible to isolate weaknesses in the production chain and encourage actions to be taken without waiting for the ultimate event to occur.

The analysis of the information collected via the proactive method differs slightly from the previous approach, in that this analysis is not prompted by a notified ultimate event, but by a notified error/finding that may often correspond to the notion of adverse event, for which at least one protective barrier has worked efficiently.
The first stage consists in evaluating the ultimate event that might have been associated with this type of notified adverse event, presupposing that none of the protective barriers had proved effective.

Just as for the reactive approach, the exercise consists subsequently in assessing the specific factors that have accompanied the tasks/activities in question, the preventive barriers and any protective barriers that have not worked properly, and determining the main causes to explain the notified event.

Simplified example of a risk analysis for continuing airworthiness management

- ***Notified adverse event***: *recording the execution of an AD presented as entirely implemented whereas only the transitional actions have been carried out, so that the action cannot be considered to be closed. Error immediately detected by the AD record inspection system.*
- *Potential aircraft maintenance ultimate event: "Unsafe delivered aircraft" with non-implemented AD*
- *Main causes of the adverse event: imprecise AD implementation information from the maintenance organisation. On data input, no search for consistency between the signed work order/work card and the information linked to the AD in question, associated with the CRS; decision to apply the AD final action immediately for the other aircraft with the exception of this aircraft*

Simplified example of risk analysis for Aircraft maintenance

- ***Notified adverse event***: *incorrect adjustment of an engine power control system notified by the mechanic himself*
- *Potential aircraft maintenance ultimate event: "Unsafe delivered aircraft" with engine performance power fault*
- *Main cause of the adverse event: incorrect interpretation of the maintenance data, job carried out for the first time by the operator with no particular supervision*

Simplified example of risk analysis for Equipment maintenance

- ***Notified adverse event***: *use of non-compliant glues when repairing an evacuation slide. Error detected during inspection tests*
- *Potential equipment maintenance ultimate event: "Unsafe delivered equipment" / non-functional evacuation slide*
- *Main cause of the adverse event: error with the glue to be used linked to inadequate labelling and packaging of the glue, identical to the packaging of the glue intended for use for this operation; emergency action implemented to meet an express request of an operator with AOG*

Just as for the reactive method, it is important to put in place and to reinforce the proactive method before implementing the following predictive method.

7.2.1.3 Risk identification via the predictive approach.

Rather than waiting for a maintenance ultimate event to occur, or for the occurrence of a precursor factor or a particular problem associated with a process, the principle of the predictive approach is to analyse the level of resistance to findings and to the imponderables of a process, a function or a type of task in order to determine any possible risks and take the necessary actions in order to counter them.
This approach is not therefore linked directly to the information collected upstream, as is the case with the first two approaches.

This predictive approach applies to the following two scenarios:

- Prediction of the threats/risks linked to the activities, the functions in place and the organisation in general. Two types of predictive analysis are possible in this case:
  - Comprehensive mapping of the risks based on an analysis of the entire activity of the organisation concerning the subject.
  - A more limited analysis based on the experience of those actors in the organisation who work in the areas particularly exposed to the risks.

- Prediction of the threats/risks linked to major changes planned by the organisation (predictive analysis of changes). This case is dealt with in chapter 7.3.

7.2.1.3.1 Complete analytical analysis of the risks of the organisation

Drafting a comprehensive map of the risks of an aircraft maintenance organisation (or continuing airworthiness management organisation) consists (based on an analysis of ultimate events [types of accident, major incidents] likely to be encountered during operation) in determining all ultimate events and the possible scenarios of adverse events / threats linked to the activity of the Aircraft maintenance organisation (or continuing airworthiness management organisation) likely to generate these ultimate events.

Another systematic analysis method may be based on the functional analysis of the various subsystems of the organisation, or of the tasks and products dealt with by the organisation. The list of possible functional failures is drawn up along with the adverse events and associated ultimate events. Safety analyses using an events tree (or causes tree, or failure tree, or else the "bowtie method") or the failure mode effects and criticality analysis (AMDEC for systems) are examples of this.

Since this analysis provides a complete matrix of the risks, it is an interesting exercise in absolute terms but cannot necessarily be carried out and is not necessarily perfectly suited to all maintenance organisations (or continuing airworthiness management organisations), in particular small organisations. It requires significant effort and may be difficult to implement in the short term (e.g., extremely general set of causes).

<u>This exhaustive type of method is more difficult to apply when the organisations are not "on the frontline" vis-à-vis of the ultimate events in operation (accidents and/or serious incidents), as is the case for engine and equipment maintenance organisations.</u>

This type of processing requires certain resources and may generate in certain cases some results (e.g., extremely general set of causes) that are difficult to be exploited in the short term and which risk, ultimately, to demotivate the organisation's personnel on the subject of the SMS.
The fact nonetheless remains that the brainstorming and consultation efforts associated with this approach bring positive benefits to risk management, whatever the size of the organisation.

7.2.1.3.2 Restricted risks analysis based on the experience of those concerned

Any type of pragmatic method is to be preferred in this domain.

It is recommended in the first instance to limit oneself to determining an initial partial list of risks/threats linked to the functions/processes of the organisation by drawing on the experience of the front line staff.

The principle is to determine the "fears" felt by the staff and the management concerning the activities/functions in which they work.

This method should therefore be based on brainstorming meetings, direct interviews, and analyses on the ground (audits / inspections) targeting the possible risks associated with certain aspects of a given activity.

This approach makes it possible, above all, to raise awareness directly among some of the personnel to the issue of the SMS and, moreover, to identify specific aspects of the areas at risk that may be corrected immediately.

The fact of identifying the first basic risks/threats and immediately "looping back" to the taken improvement actions and informing the personnel about on this issue is a way of clearly illustrating the utility of this approach from the very start.

This method is, above all, based on the experience of the management personnel and the frontline staff. Even without having directly experienced events linked to accidents / major incidents, experienced personnel have field knowledge, and an experience capital enabling them invariably to be naturally conscious of the existence of the threats / risks concerning the work they do.

A) Identifying risks based on **ultimate events feared** by the organisation

An initial approach may consist in determining the most obvious ultimate events that may potentially be generated by the organisation itself, and by each function in this organisation with an obvious role to play with regard to safety.

Examples of ultimate events for continuing airworthiness management from the perspective of a Part M/G organisation

Unsafe delivered aircraft for operation

- *with a major undetected malfunction on an engine/thrust reverser, flight control assembly, or emergency system resulting from maintenance that has not been ordered and therefore not been carried out"*
- *with an engine that, according to the results of the trend monitoring, should have been replaced before being returned to service"*
- *with an AD or a CMR, ALI item that is due but has not been ordered and therefore has not been implemented"*
- *with an MRB route 5 or 8 item that is due but has not been ordered and therefore has not been implemented"*
- *with an LLP that has exceeded its service life*
- *with a scheduled maintenance check launched for performance with a significant exceeded limitation inspection not accepted through a formal exemption"*
- *with a non-compliant configuration linked to modifications made (incompatible modifications, unapproved modification, etc.)"*
- *with a major non-compliant repair (repair non-compliant, unapproved, etc.)"*
- *with a large number of faults scheduled for deferred treatment following a basic maintenance inspection, leading to repercussions with regard to operations (aircrew workload)"*
- *with equipment not removed for overhaul/testing according to the maintenance programme*

Examples of ultimate events in maintenance from the perspective of an Aircraft maintenance organisation

"Unsafe delivered aircraft for operation

- *with a major hidden fault (not detected during the ordered maintenance operations, or generated by non-compliant maintenance and undetected: non-compliant with the data, use of non-compliant tools, installation of a non-compliant part, use of a non-compliant component)"*
- *with a malfunction of all the redundant systems of the same type or with the same function on an aircraft following maintenance (duplication of the same maintenance error)"*
- *with a major malfunction of the flight control surface system (generated by the implementation of non-compliant maintenance and undetected for correction)"*
- *with a major malfunction of an engine / thrust reverser (generated by the implementation of non-compliant maintenance and undetected for correction)"*
- *with an emergency system failure (not detected during the ordered maintenance operation, or generated by non-compliant maintenance and undetected), not identified during the ordered inspections / tests"*
- *with an AD or a CMR, ALI item that has been ordered but has not been applied, or has been incorrectly applied"*
- *with a non-compliant major modification (incorrect application of the modification)"*
- *with a non-compliant major repair"*
- *with a major fault incorrectly scheduled for deferred treatment"*
- *with an inspection access that has not been reinstalled, or has been incorrectly reinstalled"*

Examples of ultimate events in maintenance from the perspective of an Engine/Equipment maintenance organisation

"Unsafe delivered engines / equipment / items in an aircraft/engines maintenance workshop

- *with a major fault (not detected during the ordered and performed maintenance, or generated by non-compliant maintenance and undetected: non-compliant with the data, use of non-compliant tools, installation of a non-compliant part, use of a non-compliant component, etc.)"*
- *with an undetectable or hard to detected fault (undetected crack on a part, non-compliant surface treatment of a part, defect on an assembly for which the complete operation cannot be tested subsequently, such as the deployment of an evacuation slide)"*
- *with an ordered AD that is not, or is incorrectly applied"*
- *with an ordered modification that has been incorrectly implemented"*
- *with a non-compliant major repair"*
- *with an LLP that has an undetected major fault or an LLP installed with faulty status"*

Based on these ultimate events, the exercise consists in identifying the most probable possible adverse events that may generate them.

For each adverse event, the analysis of the preventive / protective barriers may make it possible to determine the barriers that are probably insufficiently robust, and the most classic threats that may explain the occurrence of such adverse events.

It is not a matter with this approach of looking for all the possible scenarios and causes but of limiting to the most classic, most probable and most appropriate scenarios for the organisation concerned.

Examples of ultimate/adverse events for a continuing airworthiness management organisation

- ***Ultimate event for continuing airworthiness management****: unsafe delivered aircraft with an LLP part which service life has expired*
- *Adverse event in continuing airworthiness management: incorrect information linked to the status of this LLP part entered initially in the IT system concerned.*
- *Cause: data entry error and no inspection this type of data entry*

Examples of ultimate/adverse events for an aircraft maintenance organisation

- ***Ultimate event from the perspective of an Aircraft maintenance organisation****: unsafe delivered aircraft with a crack on a mechanical subassembly.*
- *Adverse event from the perspective of this organisation: incorrect NDT inspection of the subassembly in question*
- *Causes: operators disturbed during the implementation of this inspection*

Examples of ultimate/adverse events for an equipment maintenance organisation

- ***Ultimate event from the perspective of an Equipment maintenance organisation****: unsafe delivered equipment with a non-applied AD, consisting in the modification of an assembly / equipment item involving the replacement of a PN item xxxx with a new PN yyyy.*
- *Adverse event from the perspective of this organisation: during maintenance, replacement of the defective PN yyyy with a PN xxxx part available in the warehouse, with the involuntary consequence of cancelling the modification of the assembly / equipment item and cancellation of the implementation of the associated AD*
- *Causes: no segregation of parts in the warehouse and choice of part not made according to configuration*

B) Identification of risks based on **processes/products that are most particularly risk-sensitive.**

Rather than taking, this time, as the basis feared ultimate events in maintenance (or in continuing airworthiness management), the exercise consists in identifying possible adverse events by determining the activities and products that are particularly exposed to risk (significant consequences of unimplemented or poorly implemented tasks on given systems).

The first stage for the organisation consists therefore in listing these functions, these types of "sensitive" tasks and the types of task concerning "sensitive" systems.

Examples of "sensitive" types of task/function concerning continuing airworthiness management organisations:

- *AD management,*
- *LLP management,*
- *CMR, ALI item management*
- *MRB route 5 and 8 item management*
- *Management of major modifications and repairs and associated approval*
- *Trend monitoring of engines*

Examples of "sensitive" types of task/function concerning maintenance organisations:

- *Concluding major inspections (risk of major breakdowns on different systems = management overload);*
- *Detailed inspections, application of an AD, or a CMR and/or ALI item.*
- *Complex modifications*
- *Complex adjustments.*
- *NDT activity, welding, surface treatment, measurement, balancing, etc.*
- *Certification/Release to service process*

Examples of types of task/function for continuing airworthiness management and maintenance concerning risk-sensitive parts / assemblies:

- *Maintenance tasks concerning Aircraft systems: landing gear/landing gear door, flight / flight surface control systems, fuel tanks, emergency system, primary structure, engines / thrust reversers, etc.*
- *Tasks concerning Engine units: disks, bearings, engine fittings, shafts, etc.*
- *Tasks concerning Equipment: Landing gear equipment/parts, flight control system, fuel tanks, emergency equipment, fire extinguishers, oxygen cylinders, etc.*
- *Logistics functions (transportation, management of storage limits, specific storage conditions, travel between workshops, etc.) for sensitive equipment/material (e.g., bearings, engine fittings, etc.)*

Based on these "risk-sensitive" functions / task - system types, the exercise for the organisation consists in attempting to identify the most probable adverse events, analysing the existing preventive and protective barriers, and determining the most probable threats that could explain any adverse events.

It is important to distinguish between the generic errors already known via the Human Factors approach *(Incorrectly executed or incomplete maintenance tasks, equipment / parts that have not been reassembled and/or have been incorrectly reassembled, etc.)* and the adverse events that will concern specific activities and/or systems/equipment and which may lead, ultimately, to the generation of ultimate events.

This involves detecting in sufficient detail the adverse events in order to be able to take precise actions when required.

The analysis of the functions/tasks/activities in question should take in all aspects associated with them: the definition of the tasks (level of precision for the description of tasks, details of information available/work cards/procedures in force); the means available in general (skills of the technicians lined up for this type of work, resources, etc.); the associated human factors; and other constraints.

A major part of this analysis consists in checking the robustness of the existing preventive and/or protective barriers that are already in place for preventing a hazard to develop.

Example of a risk to be analysed for the continuing airworthiness management organisation:

- ***Adverse event****: failure of a subcontractor in not carrying out for several days continuous* ***monitoring follow-up*** *of the engines on behalf of the Part M/G organisation, or incorrectly carrying out this function*
- *Ultimate event for continuing airworthiness management: unsafe delivered aircraft with an engine whose parameters should have justified its replacement before release to service of the aircraft*
- *Possible causes: control of the monitoring follow-up function not provided by the contractor and failure of the subcontractor supervision and control by the M/G organisation*

Example of a risk to be analysed for the Aircraft maintenance organisation

- ***Adverse event*** *: Error in the application of a functional test for an aircraft* ***emergency system***
- *Aircraft maintenance ultimate event: Unsafe delivered aircraft with a test not done correctly on an emergency system*
- *Possible causes: No inspection task planned for this type of test, no mandatory recording of results for this type of test (work card signing only)*

Example of a risk to be analysed for the engine/equipment maintenance organisation

- ***Adverse event****: Following maintenance of an* ***LLP part*** *(cleaning, inspection, NDT, etc.), non-visible and unacceptable fault generated during transportation of the part to the reassembly zone*
- *Engine/equipment maintenance ultimate event: unsafe delivered assembly with a fault on an LLP part*
- *Possible causes: unsuitable transport system for parts*

C) **Identification of "risk areas" / threats** that may be the source of adverse events

Another simple way of addressing the predictive method, in the first instance, and which may be suited above all to small organisations, is firstly to consider the "upstream threats" that each organisation can identify with respect to its specific characteristics.
These threats may be organisational in nature, technical, linked to supervision, task preparation, the environment, etc.
In view of the multitude of possible adverse events associated with these generic threats, and considering the difficulty in isolating, in particular, the most probable events, this approach does not enable application of the other phases of identification, assessment and risk-mitigation as detailed subsequently.

However, this approach does enable organisations to identify formally the main threats that concern them: threats that in general are known by the personnel of the organisations but which are not necessarily formally identified and managed as such in systematic manner.
This approach has the advantage of checking that all the significant threats in question are effectively known by the organisation, that general measures have been put in place and that they remain appropriate. The approach should make it possible, in certain cases, to isolate new threats, analyse threats that are already known in greater depth and underpin/reinforce certain mitigation or inspection measures.

These threats may be linked to temporary conditions, specific conditions, unusual situations, situations with significant operational constraints, situations that are not necessarily covered by detailed procedures, and which the organisation must deal with in certain cases.
These risk areas may also be found in situations / functions / activities that are already in place, in operation for several years, and highly "exposed" to external elements that are not therefore directly or completely controlled and managed by the organisations themselves (greater possible disturbances).
Below are several examples of subjects that can be dealt with in terms of the safety aspect by the organisations. The organisations should set priorities for studying a given subject and put in place improvement actions as and when this should prove necessary.

Examples for continuing airworthiness management organisations
- *Assistance / intervention on the part of personnel working for a Part M/G organisation on maintenance activities (e.g., line maintenance work by an M/G agent)* - *Complex/critical continuing airworthiness management tasks carried out by a non-approved subcontractor* - *Maintenance activities contracted totally or for the most part to external Part 145 organisations* - *Supervision of interfaces between the Part M/G organisation and its possible M/G subcontractor* - *Supervision of the interfaces between the Part M/G organisation, its Part 145 organisation (if any) and its Part 145 contractors* - *Operation of the Part M/G organisation nights, weekends and public holidays (on-call duty, availabilities, skills)* - *Case of small structures with personnel having to fulfil Part M/G functions that are not their primary functions (mechanics with technical agent functions for receiving and coordinating actions in the case of urgent ADs issued at night / weekends)* - *Management of a fleet of aircraft of the same type but with different configurations* - *Management of repetitive, complex complaints* - *Process of integrating a new aircraft in the fleet* - *Adjustment of an aircraft for a new maintenance programme* - *Inspection systems for information recorded in the continuing airworthiness management IT systems (automatic inspections, manual inspections).*

Examples for maintenance organisations

- *Multiple updates of the definition of tasks to be carried out during the job*
- *Activities with customers who have widely differing requirements, imposing upon the organisation different processing operations, thereby increasing the complexity of the systems / procedures to be used*
- *Use of parts distributors / brokers in rare cases, and emergencies*
- *Upstream subcontracting of activities that are part of the associated main functions of the organisation (subcontracting of parts warehousing, parts packaging, etc.)*
- *Subcontractors working on a job on site, under the responsibility of the maintenance organisation*
- *Activities with a large number of subcontractors used, and/or subcontracting of major or complex activities*
- *Job with a significant proportion of temporary staff / use and supervision of apprentices*
- *Case of troubleshooting away from home, on unknown way stations*
- *Dealing with an aircraft diverted to another platform*
- *Case of dealing with AOGs in line maintenance (parts circuit, directives, etc.)*
- *Operation of the organisation nights, weekends, public holidays*
- *Case of small structures with persons who need to fulfil functions that are not their primary functions (mechanics with warehousing functions for receiving parts, storing them, distributing them, etc.)*
- *Line maintenance with non-continuous workloads, with major load peaks for certain periods of the day*
- *Activities with significant turnover of technicians on jobs, shift changes on the same job, etc.*
- *Strikes by a category of personnel*
- *Complex tasks carried out for the first time by the organisation*
- *Certification phase for the engine/equipment maintenance, release to service of the aircraft*
- *Last phases / shifts before the release of a long job*
- *Intervention carried out by an engines/equipment maintenance organisation (rating C) on an aircraft / aircraft environment assembly*
- *Intervention / assistance requested by flight crew after start of taxiing*
- *Line maintenance in the event of specific meteorological events: very heavy rain, extreme heat or intense cold, sand/dust storms, hail, lightning, heavy snow, etc.*
- *Work carried out at height, inside a confined space (e.g., fuel tanks)*
- *Complex work carried out on night shifts*
- *Loud noise on jobs (structural repair, etc.)*
- *Work carried out in very low light (outdoor work at night, in fog, even for simple tasks / daily inspections)*
- *Maintenance/certification at the end of a shift the day before a public holiday, a long weekend, departure on holiday*
- *Decisions to interrupt jobs and work tasks, and resumption*

The reactive method and the proactive method for risk management apply to all organisations.

These methods are all the more efficient when they are based on a significant volume of feedback from experience, which is often not the case for small organisations.

The predictive method is suited to all organisations, bearing in mind that it is advised to initiate this approach in the first instance using the principles of a limited analysis of the risks based on the experience of operators (see 7.2.1.3.2).
In the case of small organisations, it is advised in particular to begin working on the subject by applying as a priority the principle of threat analysis (chap C of 7.2.1.3.2).

It should be noted that the benefits of the predictive method are certainly more significant for "open" organisations/systems (high degree of variability, strong exposure to external influences, etc.) compared to "closed" organisations/systems (stable resources, limited field of activity, few subcontractors, etc.).

<u>According to the profile of the activities and their specific characteristics, organisations may decide to deploy the reactive, proactive and predictive methods according to different priorities.</u>

7.2.2 Risk assessment

After identifying and analysing a given risk, its level must be assessed.

To assess the probability of occurrence of an adverse event, it is necessary to identify all possible causes (hence the need to be as exhaustive as possible in identifying the hazards). This is because working on the probability of occurrence of the causes makes it possible to determine the probability of occurrence of the adverse event.

In order to assess the severity of the consequences of the adverse event, it is necessary to identify the possible ultimate events and their consequences. Among these, the "most reasonably possible worst case" needs to be considered; i.e.: not systematically envisaging the extreme consequence for all cases, but taking into account the probability of the envisaged cases.

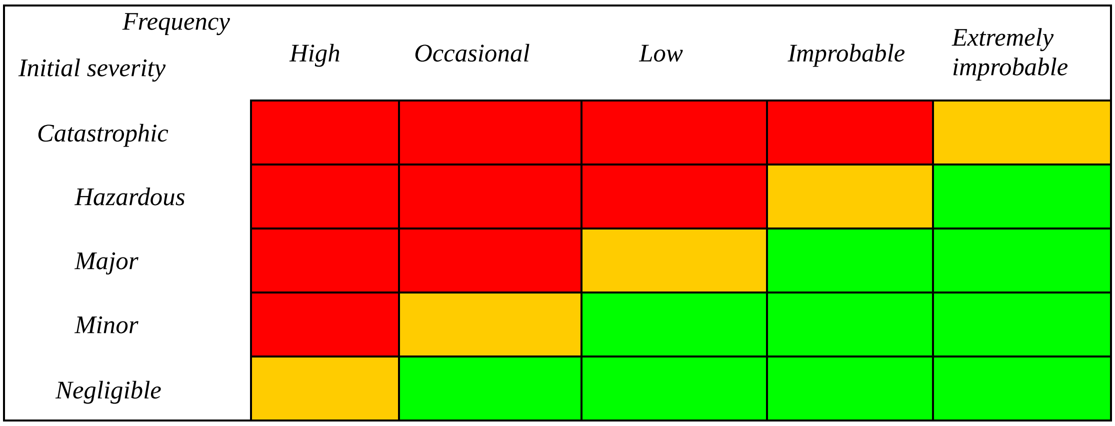
This phase will make it possible to define, if required, the necessary and suitable corrective measures.

<u>The principle is to determine the level of severity and the frequency of occurrence of the adverse event.</u>

The classic method is to use a codified system linked to the severity and the frequency.

An example of a codified system is the use of the two tables below, enabling definition of the level of severity and the frequency along with the associated risks assessment grid. Each organisation may define its own coding system according to its needs and the specific characteristics of its activities.

Risks assessment grid (inspired by the ICAO)



Severity levels of adverse events (inspired by the ICAO)

Severity levels	Meaning
Catastrophic	*Equipment destroyed,* *Death of one or more people*
Hazardous	*Serious injuries,* *Major material damage* *Pronounced reduction in safety margins*
Major	*Slight injuries* *Serious incidents* *Significant reduction in safety margins*
Minor	*Operational restrictions* *Recourse to minor incident* *emergency procedures*
Negligible	*Few consequences*

Frequency levels of adverse events (inspired by the ICAO)

Frequency type	Meaning
Frequent	*Likely to occur many times (has occurred frequently)*
Occasional	*Likely to occur sometimes (has occurred infrequently)*
Remote	*Unlikely to occur but possible (has occurred rarely)*
Improbable	*Very unlikely to occur (not known to have occurred)*
Extremely improbable	*Almost inconceivable that the event will occur*

The criticality level of a risk and its probability of occurrence may be defined vis-à-vis the number of barriers that have not worked effectively and which may not work effectively. It is therefore important to isolate precisely when the event has occurred or may occur.

Examples for continuing airworthiness management:

- *Case of a non-compliant continuing airworthiness management task (incorrect analysis, entry of incorrect information, failure to initiate a due maintenance task, etc.) subsequently discovered by the Part M/G technical agent*
- *Case of a non-compliant continuing airworthiness management task discovered in the light of an inspection planned to take place systematically after this type of task*
- *Case of a non-compliant continuing airworthiness management task recorded and discovered after a more global check (last check before implementation of a new CMR, ALI revision, etc.)*
- *Case of an anomaly in launching a job discovered by chance by a Part 145 workshop before the subsequent flight*
- *Case of a anomaly in launching a major job discovered by the M/G organisation after a series of flights*

Examples for maintenance:

- *Case of a non-compliant event, maintenance task (assembly, repair, fault not discovered during inspection, etc.) discovered by the operator*
- *Case of a non-compliant event, maintenance task, discovered after a production inspection planned to take place systematically after this type of task*
- *Case of a non-compliant event, maintenance task, discovered after the system test planned to take place systematically after this type of task*
- *Case of a non-compliant event, maintenance task, discovered in the context of the certification / CRS process of the aircraft*
- *Case of a major anomaly discovered by chance before flight by a mechanic with no inspection having been ordered for this zone (leakage, deformation, AD not applied, etc.)*
- *Case of a major anomaly linked to a non-compliant maintenance task discovered in pre-flight by a flight crew*
- *Case of a major anomaly linked to a non-compliant maintenance task discovered during taxiing by the crew*
- *Case of an anomaly linked to a non-compliant maintenance task signalled in flight by the aircraft*
- *Case of an anomaly linked to a non-compliant maintenance task detected only by the crew*
- *Case of an anomaly linked to a non-compliant maintenance task detected during the following flight*

…

- *Case of a major anomaly linked to a non-compliant maintenance task carried out prior to several previous flights and detected by chance by a mechanic*

<u>For each risk analysed, the organisation should assess the robustness of the means deployed with respect to the impact of its failures on safety, and determine the acceptability level of this risk.</u>

The acceptability level can be chosen as follows:

- Low risk: Acceptable: signifies that no measure needs to be taken.
- Medium risk: Tolerable with reservation: signifies that measures need to be taken in order to increase the robustness of the function/activity/task studied and on condition that the risk is mitigated as far as possible.
- Major risk: Unacceptable: signifies that the activity cannot be pursued as-is and cannot be resumed unless the risk is brought down at least to the level: "tolerable with reservation".

7.2.3 Risk mitigation

For every analysed risk or adverse event whose acceptability level has been determined as "tolerable with reservation" or "unacceptable", mitigation and control measures need to be taken in order to bring the risk down to an expected criticality level.

- Avoidance measures: The operations or activities are cancelled, suspended or prohibited since the risks exceed the benefits if pursued.
- Reduction measures: Action is taken to:
  - reduce the frequency of the operations / activities and thereby minimise exposure to the risks
  - and/or reduce the frequency of risk occurrence (preventive barrier)
  - and/or reduce the non-detection of the risk (protective barrier)
  - and/or reduce the significance of the consequences of the risks or ultimate events (mitigation)

The importance and the urgency of the measures to be taken will depend on the importance of the risks studied. These actions may take different forms and concern different domains.

Example of avoidance measure in the context of continuing airworthiness management:

- *Rules which not authorize launching for a maintenance organisation for certain similar tasks/jobs on identical sensitive systems/assemblies (modification of two engines on a twin-engine aircraft)*

Example of avoidance measure in the context of maintenance:

- *Rules which limit certain line maintenance activities in the context of exceptional meteorological situations*
- *Decision to suspend a given maintenance activity from the field of activity pending the necessary corrective measures being taken*

Examples of possible measures for reducing the frequency/severity of risks in the context of continuing airworthiness management:

- *Fleet standardisation policy*
- *Optional SB selection policy*
- *Drafting of a restrictive selection policy and management of subcontractors*
- *Reinforced authorisation and surveillance audits of subcontractors / contractors*
- *Drafting a policy of limited use of intermediaries (distributors, brokers)*
- *Reinforced recruitment and training policy for technical agents*
- *Specific qualification training / experience of personnel assigned to subcontractor supervision*
- *Adding warnings with details in the associated Part M/G procedures for certain sensitive tasks*
- *Adding the obligation to record the implementation of certain stages for certain procedures*
- *Adding intermediate inspection tasks for certain sensitive operations (adding inspection loops for information entered in the aircraft monitoring system)*
- *Adding supplementary inspections according to specific circumstances*
- *Adding details about the visual inspections and final functional tests to be carried out*
- *Review checklist of the inspection records/dossiers*
- *Interface / communication procedure between subcontractors and Part M/G organisation*
- *Addition / simplification of implementation / inspection procedures for continuing airworthiness management tasks*
- *Reinforced communication between the Part M/G organisation and operations*
- *Monitoring system for aircraft/engine/equipment records/statuses with tools for automatic verification of the compatibility of the managed information*

Examples of possible measures for reducing the frequency/severity of risks in the context of maintenance:

- *Drafting a policy for the selection and management of subcontractors/contractors (limiting the number of*
- *subcontractors, limiting the use of subcontractors for a limited range of activities, increased monitoring/supervision for certain subcontractors providing maintenance services with strong links to safety)*
- *Drafting a policy for the management of temporary staff (limiting the number of temping agencies, limiting the use of temps, assessing/supervising temps, etc.)*
- *Drafting a policy for the use of intermediaries (distributors, brokers)*
- *Drafting a customer requests management policy*
- *Adding warnings and obligations to record inspection results along with obligations to record the implementation of each sub-task on the work card*
- *Creating a specific procedure / checklist for verifying the presence of the minimum conditions and necessary resources*
- *Adding intermediate inspection tasks for certain sensitive sub-tasks*
- *Adding supplementary inspections according to specific circumstances*
- *Adding details about the visual inspection, final functional tests*
- *Rules limiting the implementation of complex tasks at night*
- *Deployment of resources in order to isolate more easily any missing tools (specific tool, safety pin): suitable maintenance kit, visible flame*
- *Review checklist of records and CRS*

Once the measures are defined, the corrected risk should be reassessed taking into account these measures. The new position on the matrices defines the acceptable character or otherwise of the risk.

A regular risks review should also be carried out in the organisation in order to ensure that no new risks have appeared or that the previously acceptable risks have not developed negative trends.

7.3. CHANGE MANAGEMENT

Change management is to be managed according to the principles of the predictive method.

In the case of major changes planned by the organisation, this method consists in studying the possible risks in the context of the implementation phase of these changes and concerning the changes themselves. This enables suitable measures to be taken in order to avoid these risks.

Examples of change situations for continuing airworthiness management:

- *Significant increase in resources, integration of a large number of new employees*
- *Significant reduction in resources (layoffs)*
- *Relocation of all the organisation's premises*
- *Introduction of a new type of aircraft into the field of activity*
- *Significant planned increase in the volume of activity (step effect)*
- *Introduction of a new aircraft of a type that has only recently gone into production*
- *Project to use a non-approved subcontractor for carrying out certain Part M/G tasks*

Examples of change situations for maintenance:

- *Opening of a new line station*
- *Opening of a new Base maintenance site*
- *Significant increase in resources, integration of a large number of new employees*
- *Significant reduction in resources (layoffs)*
- *Integrating a job with a large number of temporary staff*
- *Relocation of the entire organisation*
- *Introduction of a new type of aircraft into the field of activity*
- *Significant planned increase in the volume of activity (step effect)*

The predictive approach may be implemented in the first instance as a priority via the processing of the major changes of an organisation.

This solution is an easy way of raising personnel awareness over the short term with regard to the predictive approach and, subsequently, defining a definition of the hazards/risks in a more general manner.
A form and a detailed aid for change management are available in the: "Practical guide to the implementation of safety management systems by public air transport companies and maintenance organisations" (distribution on the DGAC site)

7.4 INTERFACE MANAGEMENT

In terms of interfaces, the priority when constructing an SMS for an organisation is to take into account the non-approved subcontractors which are approved and used by the Part M/G and Part 145 organisations.
As is the case for the quality system, the SMS systems of approved organisations need to cover the non-approved subcontractors who have no obligation to put in place an SMS.

Subsequently, the interface management must also concern the links between the SMS of the AOC / Part M/G organisations and the SMS of their main Part 145 approved contractors.
The contracts already existing between the Part M/G and Part 145 organisations should be amended in order to include the obligations of each party vis-à-vis the SMS aspects (communication of adverse/ultimate events, regular SMS meetings, etc.).

8. SAFETY ASSURANCE

This chapter is designed to check the ongoing suitability of the means and resources used for risk management and for updating the risk management of the enterprise or organisation.

Pertinent indicators relating to the major risks must be established to demonstrate the correct operation of the safety data collection and analysis systems that constitute the structure on which the SMS is based.

8.1 INTERNAL SAFETY AUDITS

Checking the conformity of the SMS itself (risk management function, communication, safety promotion, etc.) should be periodically audited like any other function of the organisation.
These SMS operation audits should be carried out by an entity independent of the SMS entity. Logically, the Quality system should take charge of these audits.

In addition to these conformity audits, as is the case for any management system, the SMS requires facilities for assessing the system efficiency. One means of achieving this is to carry out audits and inspections whose purpose is not to check regulatory conformity but the efficiency of the system and its results. In order to avoid any confusion between the two subjects, we shall refer in what follows to "SMS operation assessment" when considering this second aspect. The operational assessments of the SMS system may be carried out by the SMS manager and/or any other person who has been trained in the SMS. The methods for carrying out these assessments are formalised in the SMS documentation. The results of SMS operation assessments constitute an SMS record.

8.2.MONITORING SAFETY INDICATORS

A safety indicators monitoring system should be put in place in order to check the result trends.
These elements should make it possible to check the correct implementation of the SMS and the improvements of the results relating to safety.
Any negative trend for the indicators should be analysed in order to take the appropriate measures.

8.3.MONITORING CORRECTIVE AND PREVENTIVE ACTIONS

All measures to be put into place following the risk studies should be monitored in order to check that these actions are indeed taken, are efficient and reach the set objectives for risk mitigation.

This global monitoring function for these corrective and preventive actions may be assumed directly by the SMS of the organisation or possibly by the Quality System. In all cases, the distribution of roles between the SMS and the QS must be clear and detailed in the reference documents concerned.

8.4 SAFETY REVIEWS

Review meetings on the results of the SMS must be organised and are designed to define the action priorities and the priorities of the risks to be studied, and to review the results in order to be able to redefine the work strategies.

9. SAFETY PROMOTION

9.1. TRAINING AND AWARENESS-RAISING

SMS management requires the acquisition of theoretical and/or practical skills.
Training in the knowledge and the operation of the SMS needs to be run in synergy with the Human Factors training for the personnel of the maintenance organisations.

The SMS manager should, as a minimum, have operational experience of the activity of the organisation and have received training in risk management.

The person carrying out the analyses and the risk management (i.e.: the SMS manager or an SMS coordinator assisting the SMS manager) should undergo specific training linked to these activities.

Training in the analysis of events is fundamental; it enables the organisations, in the framework of investigations, to go beyond simple observations of the chronology of facts or the assignment of responsibility to the front-line agent, by looking into the triggers and the primary causes.

The auditors who are called upon to carry out audits of the conformity of the SMS must receive suitable training in the SMS.

All persons working within the organisations and, as a priority, the management should follow sensitisation training in the SMS.

This training or sensitisation trainings may be carried out internally or externally (same principles as for Human Factors training: see booklet P54-45 - chapter 8.4: "Profile of instructors" and chapter 8.5: "External training").

The on-the-job training of the personnel of the organisation should include elements linked to the SMS (recap of the responsibilities of each individual vis-à-vis the SMS, recap of the objectives, review of the basic threats/risks linked to the organisation, etc.).

9.2. COMMUNICATION AND EXPERIENCE-BASED FEEDBACK

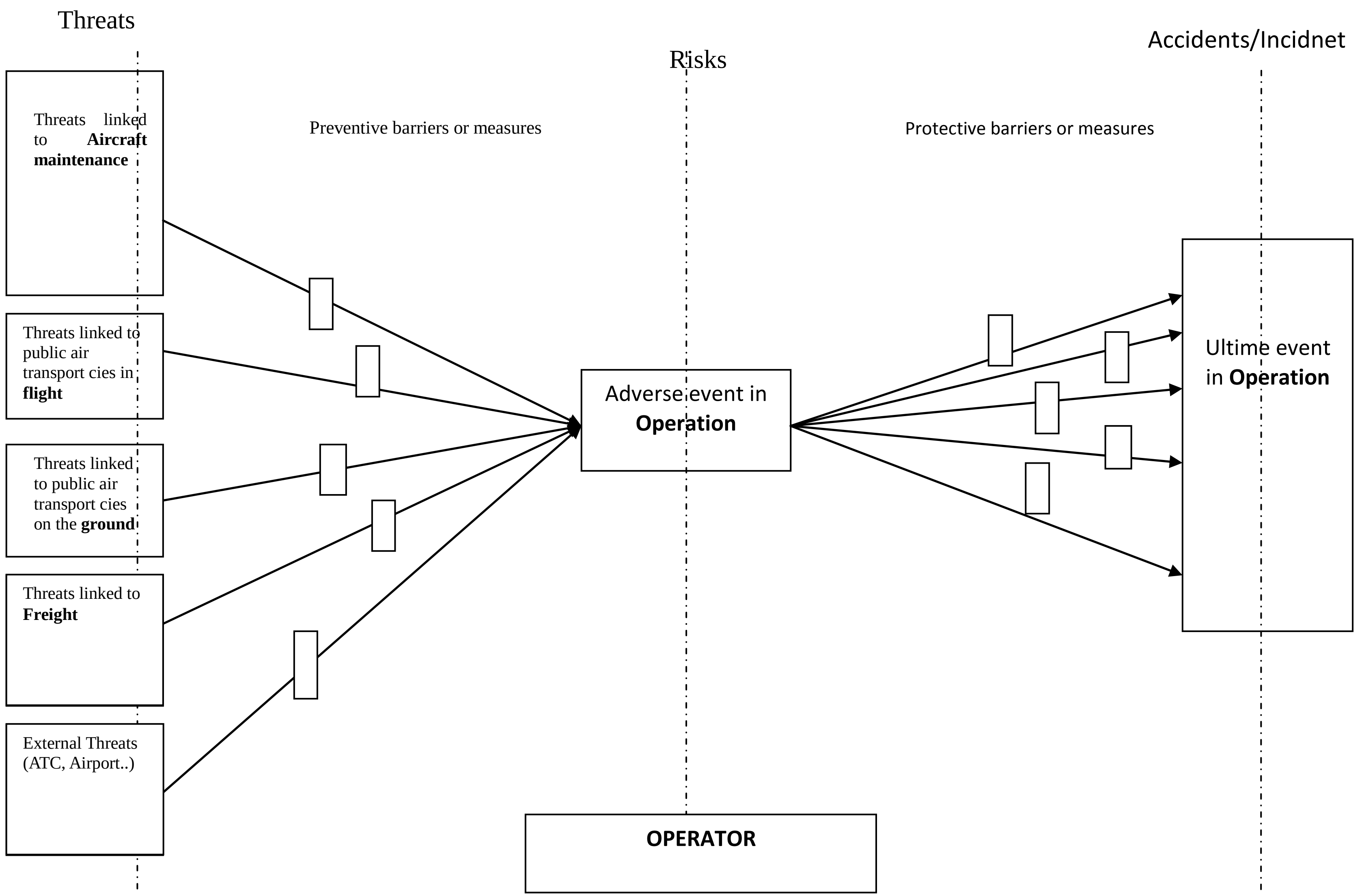
The organisation should develop a formal means of communication on matters of safety to enable efficient communication about all SMS aspects, to disseminate critical safety information and to explain why certain safety measures have been taken and why certain procedures have been introduced or modified.

This communication is vital.

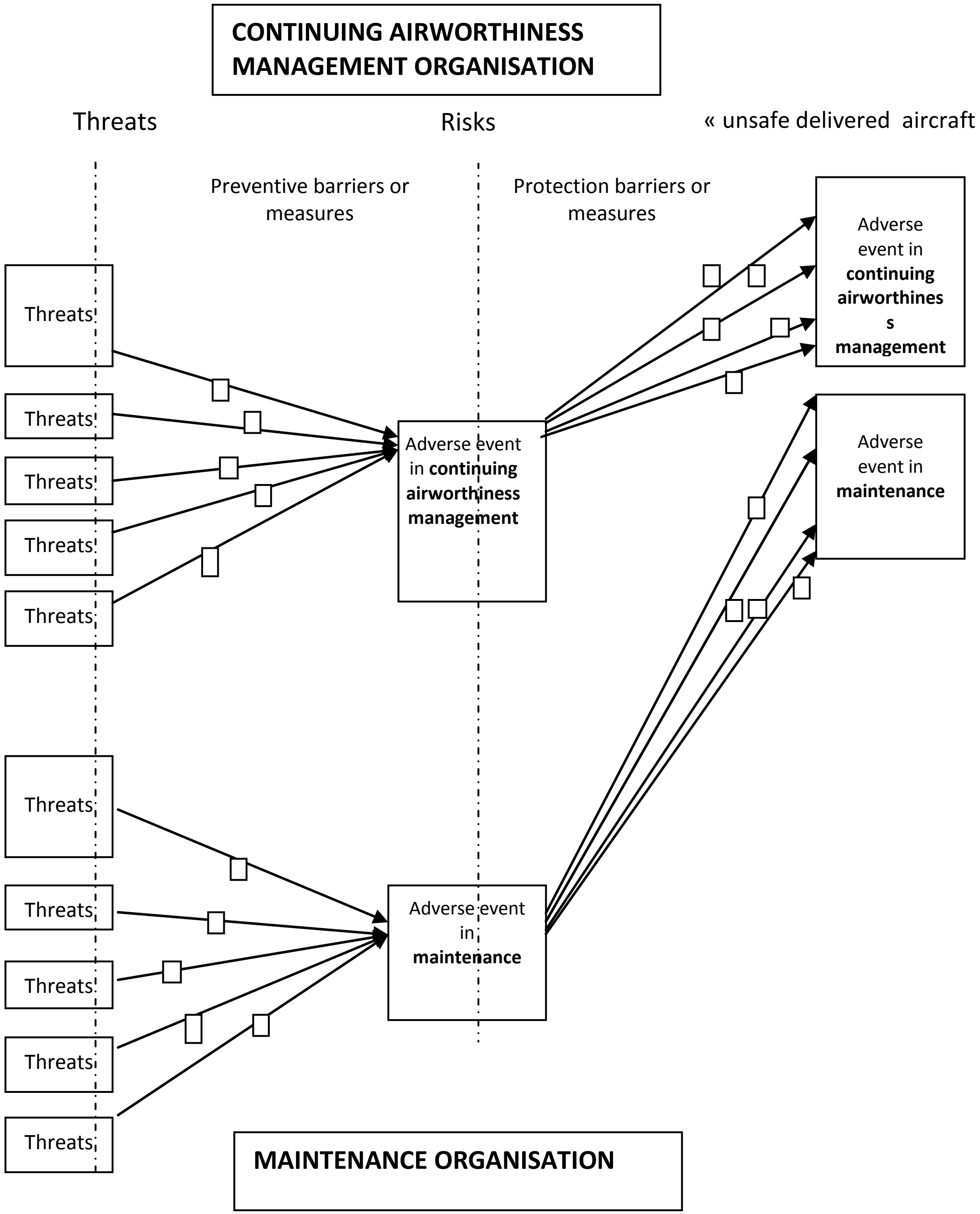
It enables the personnel to be sensitised to safety-related subjects and to provide a common implantation approach for the personnel on how the SMS operates.

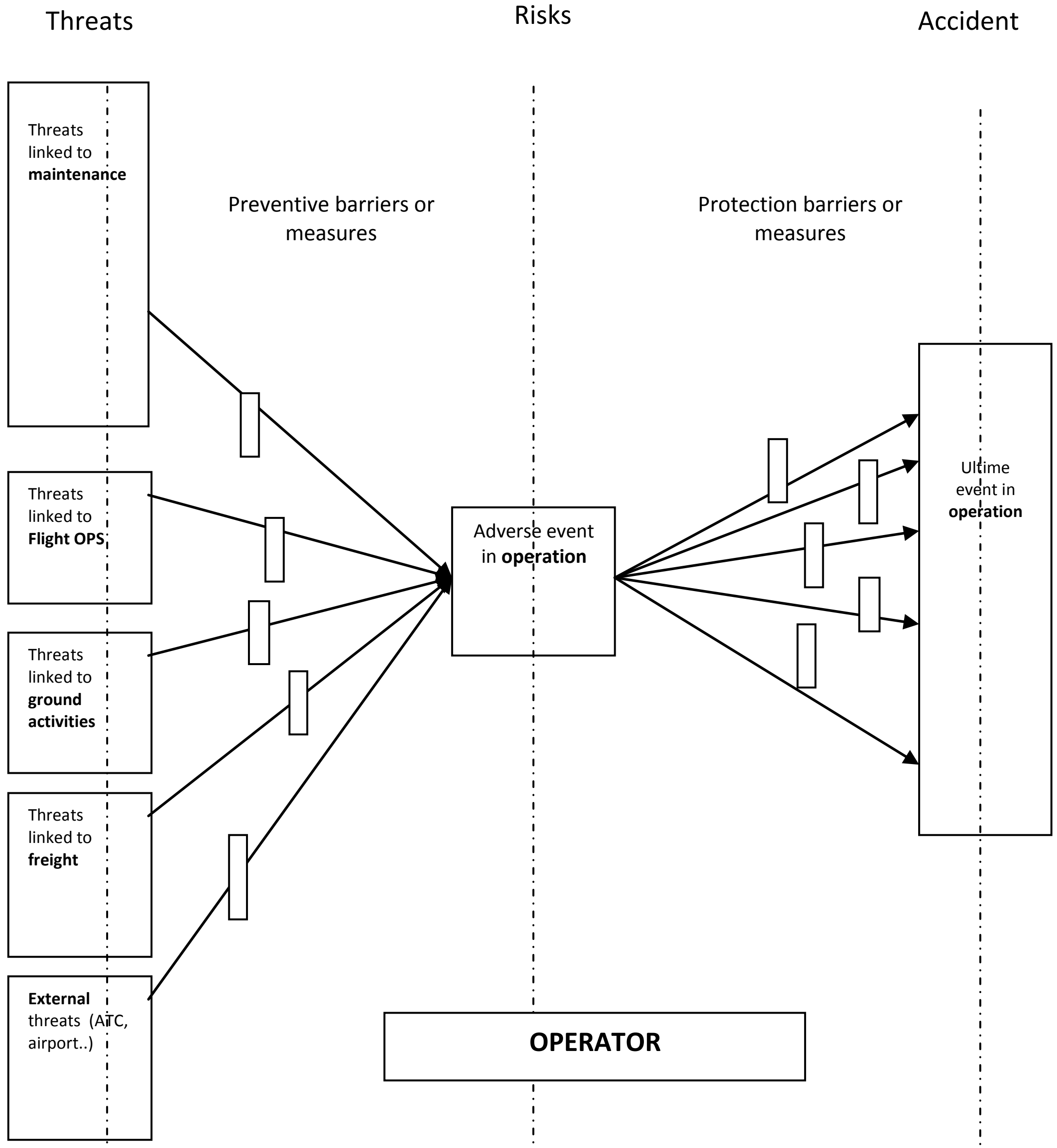
The information about the improvement actions taken is an element designed to encourage the personnel to contribute to this SMS.

APPENDIX I : Operational risk diagram

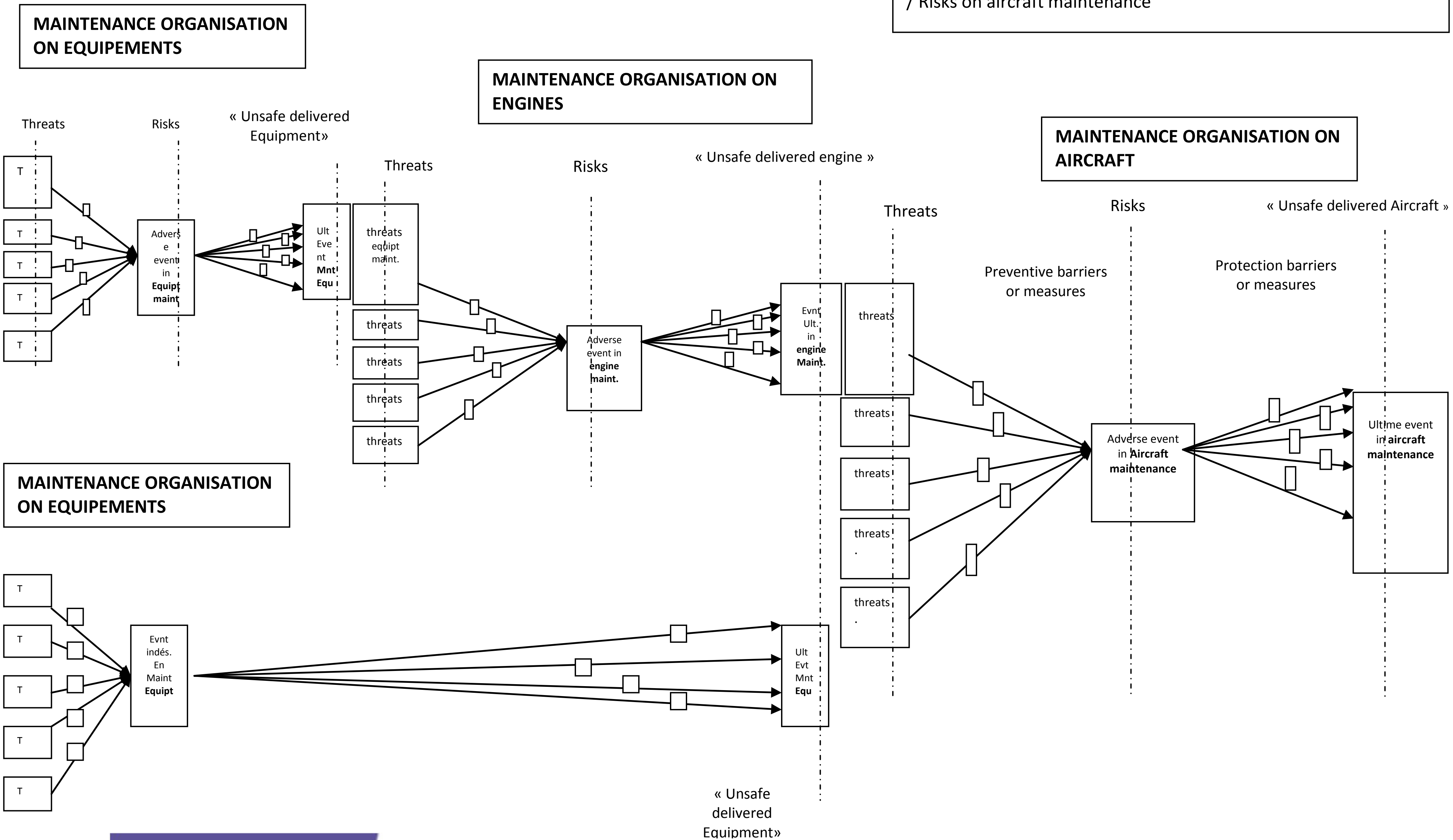


APPENDIX II : Diagram linked to risk on continuing aircraft management and on maintenance / risk of operation





APPENDIX III : Diagram linked to the risks in Engine – Equipments / Risks on aircraft maintenance



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