Feasibility study aimed to improve the Safety Management System process in an EASA Part CAMO organisation

(versão final após defesa)

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Dissertação para obtenção do Grau de Mestre em
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Resumo

A implementação do Sistema de Gestão de Segurança Operacional na indústria aeronáutica tem revelado ao longo dos anos ser um tema de extrema importância visto que a sua aplicação visa promover a segurança operacional de todos os intervenientes numa empresa e uma melhor gestão de recursos humanos e materiais.

Neste contexto, é importante que cada empresa se encarregue de fazer uma avaliação do Sistema de Gestão de Segurança implementado, de forma a rever a sua eficácia nos vários departamentos, e verificar se são cumpridos os princípios impostos pela ICAO (International Civil Aviation Organisation).

Foi comprovado que um Sistema de Gestão de Segurança eficiente reverte para um melhor sistema de identificação de riscos, reporte de ocorrências, promoção de cultura de segurança entre os funcionários, e criação de barreiras para mitigar riscos indesejados.

Esta dissertação consistiu assim no estudo de viabilidade de melhorar o processo do Sistema de Gestão de Segurança Operacional de uma empresa do setor aeronáutico, a PHS Aviation, nas atividades realizadas no âmbito da gestão de aeronavegabilidade, comumente denominada de Parte-CAMO, através da criação de Indicadores de Desempenho de Segurança.

A este respeito, para o desenvolvimento deste estudo, a PHS Aviation identificou quatro perigos que pretende controlar relacionados com as suas atividades de gestão da aeronavegabilidade continuada. A identificação destes perigos pela empresa foi realizada através da avaliação de risco da PHS Aviation ("RA 01/2022"), já realizada pela empresa durante a transição da Subparte G do Anexo I (Parte-M) para o Anexo Vc (Parte-CAMO) do Regulamento da Comissão (UE) 1321/2014.

Após identificação dos perigos, foi criado um Indicador de Segurança Operacional para cada perigo identificado para o monitorizar, seguindo os regulamentos e requisitos que a empresa considera mais importantes.

Palavras-chave

Sistema de Gestão da Segurança Operacional; PHS Aviation; Indicadores de Desempenho de Segurança; Parte-CAMO; Aeronavegabilidade Continuada.

Abstract

The implementation of the Operational Safety Management System in the aeronautical industry has been over the years a topic of extreme importance since its application aims to promote the operational safety of all stakeholders in a company and better management of human and material resources.

In this context, it is important that each company is responsible for assessing the Safety Management System implemented, reviewing its effectiveness in the various departments, and verifying if the principles of ICAO (International Civil Aviation Organisation) are met. It was proven that an efficient Safety Management System reverts to a better system of risk identification, occurrence reporting, promotion of safety culture among employees, and creation of barriers to mitigate unwanted risks.

This dissertation consisted in the feasibility study to improve the Safety Management System process of an aeronautical company, PHS Aviation, in the activities performed in the scope of airworthiness management, commonly known as Part-CAMO, through the creation of Safety Performance Indicators.

In this regard, for the development of this study, PHS Aviation has identified four hazards it intends to control related to its continuing airworthiness management activities. The identification of these hazards by the company was performed through the PHS Aviation risk assessment ("RA 01/2022"), already performed by the company during the transition from Subpart G of Annex I (Part-M) to Annex Vc (Part-CAMO) to Commission Regulation (EU) 1321/2014.

After identifying the hazards, an Operational Safety Indicator was created for each identified hazard to monitor it, following the regulations and requirements that the company considers most important.

Keywords

Operational Safety Management System; PHS Aviation; Safety Performance Indicators; Part-CAMO; Continued Airworthiness.

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List of Acronyms

ANAC	Autoridade Nacional da Aviação Civil
AOC	Air Operator Certificate
CAME	Continuing Airworthiness Management Manual
CAMO	Continuing Airworthiness Management Organisation
CAO	Combined Airworthiness Organisation
CMPA	Complex Motor-Powered Aircraft
EASA	European Aviation Safety Authority
EU	European Union
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organisation
MRO	Maintenance, Repair and Overhaul
NCC	Non-commercial operations with complex motor-powered aircraft
NCO	Non-Commercial with Other-than-complex motor-powered-aircraft
PHS	Premium Aviation and Handling Services
SMM	Safety Management Manual
SMS	Safety Management System
SOP	Standard Operating Procedure
SPIs	Safety Performance Indicators
SPO	Specialised Operations Certificate
SPTs	Safety Performance Targets
SRM	Safety Risk Management
SSP	State Safety Plan

1. Introduction

1.1. Motivation

Since the beginning of the 21st century, competent authorities, air operators and aviation-related organisations have been searching for the best strategies to increase safety to reduce occurrences, accidents and incident rates.

Aviation regulators and authorities play a crucial role in improving safety performance. At the European Union level, the European Aviation Safety Agency (EASA) is the authority responsible for promoting the highest common safety and environmental protection standards in civil aviation.

It monitors the implementation of standards through inspections in the Member States and provides the necessary technical expertise, training and research (EASA, 2022). In Portugal, the aeronautical authority responsible for regulating aviation activities is the Autoridade Nacional de Aviação Civil (ANAC).

It performs the functions of regulating, inspection and supervision of the civil aviation sector and is governed in accordance with the provisions of international and European law (ANAC, 2022).

Additionally, there is International Civil Aviation Organisation (ICAO), which, although not an international aviation regulator, has a vital role in operational safety. ICAO's core mandate, then as today, was to help States to achieve the highest possible degree of uniformity in civil aviation regulations, standards, procedures and organisation (ICAO, 2022).

One of the ways that have been proven to be most effective in controlling risks and consequently increasing operational safety in aviation organisations has been the implementation of the Safety Management System (SMS). Efficient safety management has proven to proactively contain and mitigate risks and improve the management of human and material resources.

However, the decision for mandatory SMS implementation by EASA was made only for air operators in 2014 and did not cover continuous airworthiness management. Only recently, in June 2020, EASA, after verifying the benefits of SMS implementation, published the new Annex Vc of (EU) 1321/2014 (Part-CAMO) to replace Subpart G of Annex I (Part-M) to Commission Regulation (EU) No 1321/2014 and introduce the principles of SMS.

Since PHS Aviation is Part-CAMO certified to manage continuing airworthiness, it must have an effective SMS following the regulations.

Thus, the main motivation of this dissertation is to support the introduction of SMS in Part-CAMO and its continuous improvement in order to enhance safety at PHS Aviation.

1.2. Objective

To study the feasibility of improving the PHS Aviation Safety Management System process related to the management of aircraft's continuous airworthiness activities, according to the regulations from the competent aeronautical authorities, through the implementation of Safety Performance Indicators.

1.3. Work requirements

The work presented in this dissertation is carried out under the objectives of PHS Aviation and based on compliance with the requirements imposed by the applicable regulations and the relevant aeronautical authorities.

1.4. Methodology

The methodology used included in the first phase a research of the theoretical framework of the Safety Management System in an organisation approved according to Annex Vc of (EU) 1321/2014 (Part-CAMO) and the applicable legislation and analysis of the existing regulations in PHS Aviation. In the second phase, an identification is made through the PHS Aviation risk assessment ("RA 01/2022") of the main hazards related to airworthiness activities to improve the safety of PHS Aviation as a CAMO organisation.

1.5. Work limits

The most significant limitation was the lack of information about the effectiveness of Part-Camo SMS in the company since its implementation is very recent.

1.6. Structure

This dissertation is divided into five chapters.

The first chapter introduces the topic addressed in this dissertation, with the motivation, objective, work requirements, methodology, work limits and structure described.

The second has a brief presentation of PHS Aviation in terms of its history, composition and structure related to the management of continuing airworthiness activities.

The third chapter is the state of art related to SMS in an organisation approved according to Annex Vc of (EU) 1321/2014 (Part-CAMO). An introduction is made to the Safety Management System, briefly explaining its concept and evolution over the years. A framework of the current SMS implemented in the company is also performed. In addition, an introduction is given to the Annex Vc of (EU) 1321/2014 (Part-CAMO) and its SMS connection.

The fourth is the case study, where the proposed implementation process to improve the effectiveness of the company's current SMS in its continuing airworthiness management activities is presented in detail.

Firstly, four hazards the company intends to control, present in the PHS Aviation risk assessment ("RA 01/2022"), are identified. Then, an analysis of the identified hazards is performed, and an implementation plan consisting of Safety Performance Indicators is proposed to improve and monitor the effectiveness of the SMS.

The fifth chapter presents the conclusion of the work, recommendations, and future work that can be developed to further the subject in question.

2. PHS Aviation

2.1. History

PHS Aviation is an aviation company founded on July 10th, 2009, based at Palmeira Municipal Aerodrome, Hangar 3, in Braga. It is a recent company that, although legally constituted in 2009, began operations only in 2011, assuming itself as an imminently service exporting company.

PHS Aviation is a small Operator and contracts Part 145[1]/Part CAO[2] approved maintenance organisations to meet Part M, Part CAMO, and Part ML requirements as applicable. Work beyond the scope of approval granted to PHS Aviation will be contracted out to certified and approved suppliers.

Currently, the company holds the Air Operator Certificate (AOC PT-01/11), Specialised Operations Certificate (SPO Nº PHS 01/2022) and is Part CAMO certified to manage continuing airworthiness. PHS Aviation as CAMO (Continuing Airworthiness Management Organisation) (PT.CAMO.034) offers control of all maintenance and aircraft continuing airworthiness management.

As an Air Transport Operator (AOC), PHS Aviation performs:

- Executive Aviation Flights;
- Air Ambulance Flights;
- ONT[3] (Organ Transport) Flights.

As an Air Transport Operator (NCC[4]/NCO[5]), PHS Aviation performs:

- Non-revenue flights.

As an Air Work Operator (SPO), PHS Aviation performs:

-Observation flights and aerial coordination;

-Aerial photography and filming.

1 EASA Part 145 defines the administrative conditions and criteria that operators and maintenance organisations (MRO) must meet to implement aircraft maintenance.
2 "Part-CAO provides a new set of requirements for Combined Airworthiness Organisation: such organisation may perform CAMO activities or Maintenance Organisation activities, or both, but limited to non-complex aircraft not used by a licensed air carried" (sic) (EASA, 2021, November, p.3).
3 ONT is the term used in the PHS Aviation Continuing Airworthiness Management Manual to refer to the operation of an aircraft for the emergency transport of human organs for transplantation.
4 Non-commercial operations with complex motor-powered aircraft.
5 Non-Commercial with Other-than-complex motor-powered-aircraft.

PHS Aviation's fleet consists of the following aircraft presented in Table 1.

Table 1 - PHS Aviation's fleet
Source: (PHS Aviation, 2022a, p.22)

Aircraft	Type of Operation
Citation 550 II	AOC / NCC
Cessna T210L	SPO
Cessna 501	NCC
Citation 551	NCC
Cessna 510 (Citation Mustang)	AOC / NCC

2.2. Organisation and structure

The general organisation of PHS Aviation is presented in Figure 1.

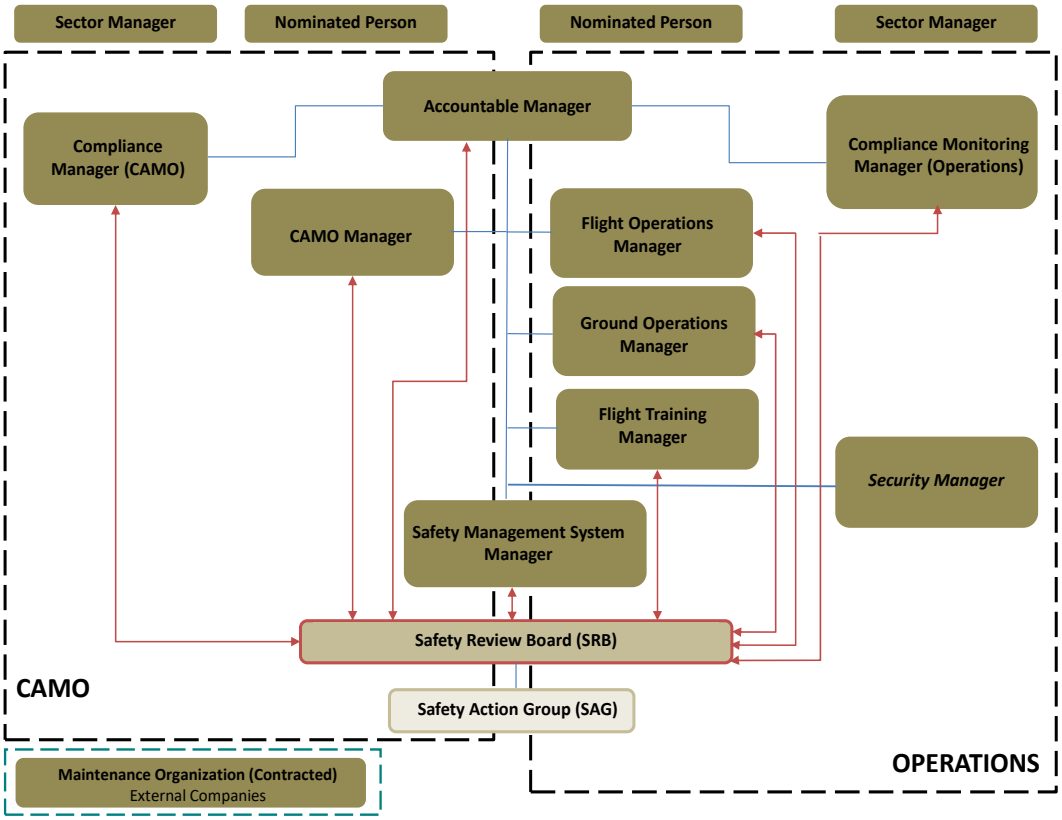


Figure 1 - General organisational structure
Source: (PHS Aviation, 2022, p.21)

2.2.1. Safety department

The diagram of the Safety department is presented in Figure 2.

Figure 2 - Safety Department structure
Source: (PHS Aviation, 2022, p.21)

The PHS Aviation safety department is responsible for monitoring and ensuring the safety of ground and flight operations in accordance with all regulatory requirements, ensuring safety system compliance and performing incident investigations, reporting and documentation reviews.

A brief explanation of the responsibilities of each member of this department are given in the next sections, since they are essential elements to ensure the effectiveness of the SMS in the different activities of the company.

2.2.1.1. Accountable Manager

The Accountable Manager is responsible for operations and the overall implementation and maintenance of the organisation's Safety Management System.

The Accountable Manager has the following safety accountabilities, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.22):

- "Provide enough financial and human resources for the proper implementation of an effective SMS[6]";
- "Promote a positive safety culture[7]";

[6] Safety Management System.

- "Establish and promote the safety policy";
- "Establish the PHS Aviation's safety objectives";
- "Ensure the SMS is properly implemented and performing to requirement";
- "See to the continuous improvement of the SMS".

One of the most effective ways the Accountable Manager can be visibly involved is by leading regular safety meetings, allowing the Accountable Manager to:

- "Review safety objectives";
- "Monitor safety performance and the achievement of safety targets";
- "Make timely safety decisions".

2.2.1.2. Safety Manager

The Safety Manager (SM) is appointed by the Accountable Manager and reports to him/her on all matters related to operational safety. In addition, the SM is responsible for managing the organisation's SMS.

The responsibilities of the Safety Manager, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.23), are to:

- "Ensure and be involved in occurrence/accident investigations and follow-up";
- "Manage the implementation plan on behalf of the accountable manager";
- "Facilitate hazard identification, risk analysis and management";
- "Monitor the implementation of corrective action to ensure their accomplishment";
- "Provide periodic reports on safety performance";
- "Maintain safety documentation";
- "Plan and organise staff safety training";
- "Provide independent advice on safety matters";
- "Advise senior managers on safety matters";
- "Oversee hazard identification systems";
- "Monitor compliance of the SMS";
- "Monitor safety concerns in the aviation industry and their perceived impact on PHS Aviation's operations aimed at product and service delivery";

[7] "The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, shared perceptions of the importance of safety and confidence in the efficacy of preventive measures" (sic) (ACSNI, 1993).

- “Coordinate and communicate (on behalf of the accountable manager) with ANAC and other authorities as necessary on issues relating to safety”.

2.2.1.3. Deputy of Safety

The Safety Manager is replaced by the Deputy of Safety, who is responsible for assisting and supporting the Safety Manager in all matters relating to the PHS Aviation’s SMS and the daily tasks associated with the PHS Aviation’s SMS.

2.2.1.4. Safety Review Board

The Safety Review Board in PHS Aviation is a high-level committee that considers strategic safety functions. The board is chaired by the accountable manager and is composed of heads of each functional area. This committee ensures that appropriate resources are allocated to achieve the established safety performance of PHS Aviation and provide strategic direction to the Safety Action Group.

The Safety Review Board Meetings are held every six months, generally in the months of June and December of each year. However, if necessary, more meetings can be scheduled throughout the year.

The Safety Review Board should, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.24):

- “Monitor the effectiveness of the SMS implementation plan”;
- “Monitor safety performance concerning the safety policy and objectives established by the organization”;
- “Monitor that any safety action is taken in good time”;
- “Monitor the effectiveness of the organisation's management system processes”;
- “Review the results of monitoring compliance with applicable requirements”;
- “Monitor the implementation of corrective and preventive actions related to safety issues”;
- “Monitor the impact of changes introduced in the organization”;
- “Review the effectiveness of safety actions taken previously”;
- “Ensure that appropriate resources are made available to achieve established safety objectives”;
- “Monitor the effectiveness of the SMS implementation plan”.

2.2.1.5. Safety Action Group

The Safety Action Group is an ad-hoc group to assist or act on behalf of the Safety Review Board. It may be composed of managers, supervisors, and personnel from operational areas. The safety action group will evaluate the effectiveness of previous safety recommendations and promote safety awareness in their areas of responsibility.

The Safety Action Group is tasked with or assists in, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.25):

- "Oversee operational safety performance within the functional areas and ensures that hazard identification and safety risk management are carried out as appropriate";
- "Coordinates the resolution of mitigation strategies for the identified consequences of hazards and ensures that satisfactory arrangements exist for safety data capture and employee feedback";
- "Assess the impact of operational changes on safety";
- "Coordinates the implementation of corrective action plans and convenes meetings or briefings as necessary to ensure that ample opportunities are available for all employees to participate fully in management for safety";
- "Ensures that corrective action is achieved within agreed timescales";
- "Reviews the effectiveness of previous safety actions/recommendations";
- "Oversees safety promotion and ensures that appropriate safety, emergency and technical training of personnel is carried out that meets or exceeds minimum regulatory requirements".

2.2.1.6. Compliance Monitoring Manager

The Compliance Monitoring Manager is an independent manager responsible for ensuring that the compliance monitoring programme[8] is adequately implemented and continually reviewed and improved. The main objective of the Compliance Monitoring Manager of the company PHS Aviation is to monitor all activities related to Part M, Part ML, and Part CAMO and all standards specified by the CAME[9].

[8] The compliance monitoring programme ensures that the Compliance Monitoring Manager has full access to the whole organisation, to any contracted organisations and to the accountable manager.
[9] According to CAMO.A.300 of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014) "the organisation shall provide the competent authority with a CAME and, where applicable, any referenced associated manuals and procedures" (sic) (EASA, 2021).

The Compliance Monitoring Manager should, according to the PHS Aviation *Continuing Airworthiness Management Manual* (PHS Aviation, 2022a, p.29):

- "Establishing an independent Compliance System to monitor compliance with EASA / ANAC requirements and liaise closely with ANAC on all matters affecting approval";
- "He/She is responsible for implementing a Compliance audit programme whereby procedures need to be reviewed at regular intervals concerning each type of aircraft operated";
- "He/She is responsible for closing non-conformities resulting from internal and external audits";
- "He/She shall report to the Responsible Administrator any non-compliance with standards or precarious standards, with an indication of the time limit for completion of closure of the non-compliance";
- "Communicates directly with the Responsible Administrator in case of any reported discrepancy that the responsible person does not correctly resolve".

2.2.1.7. PHS Aviation's Managers/ Nominated Persons

Managers are responsible for the safety of their respective areas and for supporting the Safety Manager in managing an effective SMS and meeting the organisation's safety objectives. PHS Aviation has 'nominated persons' for the following four areas of responsibility: Flight operations, Crew training, Ground operations and Continuing airworthiness.

3. State of art of safety and airworthiness management

3.1. Fundamentals

3.1.1. Concept of safety and its evolution

"Aviation safety is dynamic. New safety hazards and risks continuously emerge and must be mitigated. As long as safety risks are kept under an appropriate level of control, a system as open and dynamic as aviation can still be kept safe. It is important to note that acceptable safety performance is often defined and influenced by domestic and international norms and culture" (sic) (ICAO, 2018, p.2-1).

The progress in aviation safety can be described by four approaches, divided into eras of activity, illustrated in Figure 3.

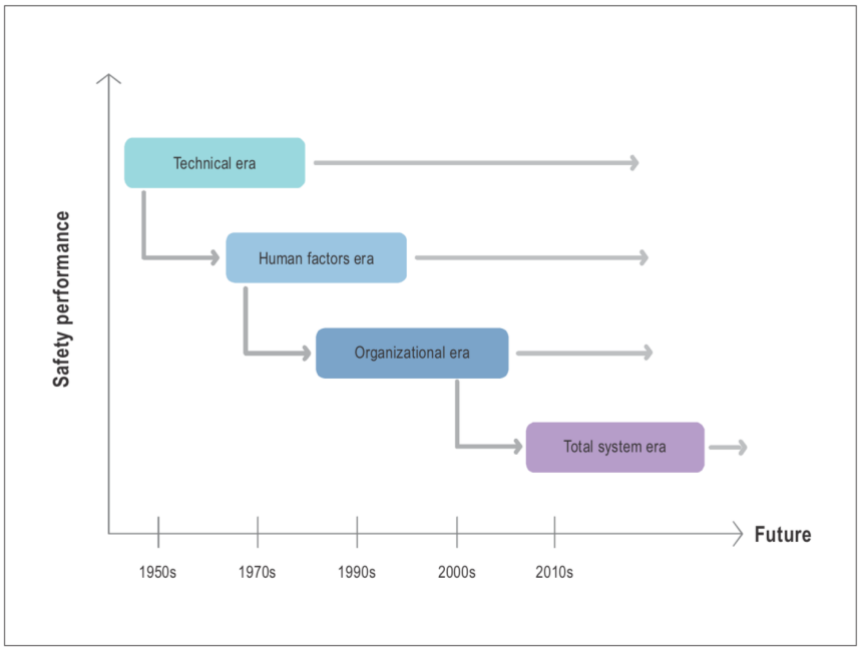


Figure 3 - The evolution of safety
Source: (ICAO, 2018, p.2-2)

The four approaches can be listed as follows (ICAO, 2018, p.2-1):

a) "Technical – From the early 1900s until the late 1960s, aviation emerged as a form of mass transportation in which identified safety deficiencies were initially related to technical factors and technological failures. The focus of safety endeavours was therefore placed on the investigation and improvement of technical factors (the aircraft,

for example). By the 1950s, technological improvements led to a gradual decline in the frequency of accidents, and safety processes were broadened to encompass regulatory compliance and oversight."

b) "Human factors – By the early 1970s, the frequency of aviation accidents had significantly declined due to major technological advances and enhancements to safety regulations. Aviation became a safer mode of transportation, and the focus of safety endeavours was extended to include human factors, including such things as the "man/machine interface". Despite the investment of resources in error mitigation, human factors continue to be cited as a reccuring factor in accidents. Human factors tended to focus on the individual, without fully considering the operational and organizational context. It was not until the early 1990s that it was acknowledged that individuals operate in a complex environment that included multiple factors which could affect behaviour".

c) "Organizational – During the mid-1990s, safety began to be viewed from a systemic perspective and began encompassing organizational factors as well as human and technical factors. The notion of an "organizational accident" was introduced. This perspective considered the impact of such things as organizational culture and policies on the effectiveness of safety risk controls. Additionally, routine safety data collection and analysis using reactive and proactive methodologies enabled organizations to monitor known safety risks and detect emerging safety trends. These enhancements provided the learning and foundation which lead to the current safety management approach".

d) "Total system – From the beginning of the 21st century, many States and service providers had embraced the safety approaches of the past and evolved to a higher level of safety maturity. They have begun implementing SSP or SMSs and are reaping the safety benefits. However, safety systems to date have focused largely on individual safety performance and local control, with minimal regard for the wider context of the total aviation system. This had led to growing recognition of the complexity of the aviation system and the different organizations that all play a part in aviation safety. There are many examples of accidents and incidents showing that the interfaces between organizations have contributed to negative outcomes".

To get an idea of the importance of investment in aviation safety, Figure 4 illustrates the progress of accident rate from 2008 to 2021.

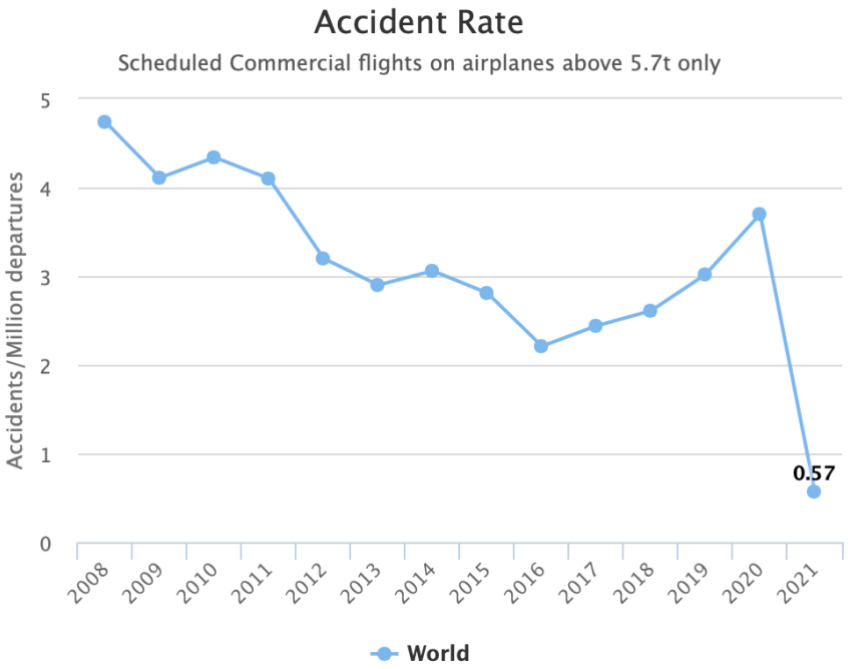


Figure 4 - Global Accident Rate
Source: (ICAO, 2022a)

From 2011 onwards, the overall accident rate had always remained below 4 accidents per million departures, compared to previous years when the rate was between 4 and 5 accidents per million departures. This decrease confirms that, over the years, the measures taken to improve the aviation safety made a difference and should continue to be improved.

It should be noted that in the years 2020 and 2021, the volume of world air traffic decreased dramatically due to the Covid-19 pandemic. This factor should be considered when treating the values obtained for the overall accident rates for those years.

3.1.2. Human factor

The human factor term is acquainted in the aviation industry as human error underlies a large percentage of aviation accidents and incidents. In the Federal Aviation Administration (FAA), Human Factors is defined as a "multidisciplinary effort to generate and compile information about human capabilities and limitations and apply that information to equipment, systems, facilities, procedures, jobs, environments, training, staffing, and personnel management for safe, comfortable, and effective human performance" (sic) (FAA, 2005, August 10, p.1).

Many models have been created to understand the relationship between human factors and safety performance. A well-known model used to illustrate the interaction of the different system components in the human is the SHELL Model, illustrated in Figure 5.

Figure 5 - SHELL Model
Source: (ICAO, 2018, p.2-5)

This model is a metaphor for the relationship between human and their workplace components. The human is represented at the centre of the model as is the main contributor and factor in aviation safety, and the workplace components are represented around the centre.

The components represented, according to ICAO (ICAO, 2018, p.2-4), are:

a) **"Software (S):** procedures, training, support, etc.";
b) **"Hardware (H**): machines and equipment";
c) **"Environment (E):** the working environment in which the rest of the L-H-S system much function; and"
d) **"Liveware (L):** other humans in the workplace".

The interfaces of the described components can be, according to ICAO (ICAO, 2018, p.2-5):

"Liveware – Hardware (L-H): The L-H interface refers to the relationship between the human and the physical attributes of the equipment, machines and facilities. This considers the ergonomics of operating the equipment by personnel, how safety information is displayed and how switches and operating levers are labelled and operated so they are logical and intuitive to operate".

"Liveware – Software (L-S): The L-S interface is the relationship between the human and the supporting systems found in the workplace, e.g., regulations, manuals, checklists, publications, processes and procedures, and computer software. It includes such issues as the recency of experience, accuracy, format and presentation, vocabulary, clarity and the use of symbols. L-S considers the processes and procedures- how easy they are to follow and understand".

"Liveware – Liveware (L-L): The L-L interface is the relationship and interaction between people in their work environment. Some of these interactions are within the organization (colleagues, supervisors, managers), many are between individuals from different organisations with different roles (air traffic controllers with pilots, pilots with engineers etc.). It considers the

importance of communication and interpersonal skills, as well as group dynamics, in determining human performance. The advent of crew resource management and its extension to air traffic services (ATS) and maintenance operations has enabled organisations to consider team performance in the management of errors. Also within the scope of this interface are staff/management relationships and organizational culture".

"Liveware – Environment (L-E): This interface involves the relationship between the human and the physical environment. This includes things such as temperature, ambient light, noise, vibration and air quality. It also considers the externally environmental factors, such as weather, infrastructure and terrain".

3.1.3. Accident causation

Accident causation refers to potential factors that may lead to accidents. For safety reasons, it is essential to determine the factors that can cause an accident, including human, mechanical and environmental factors, to prevent occurrences (ICAO, 2018).

Accident causation models were created to allow to better understand their root causes. These models enable to aid in creating useful approximations of the real environment and understanding the difference between hazards[10] and accidents (ICAO, 2018).

Accidents could be described as a culmination of a series of sequential events/circumstances or latent hazards and unsafe acts which continue to happen sequentially. It can be caused due to a variety of factors, such as organisational effects and the environment. Heinrich's domino model, illustrated in Figure 6, describes how an accident can occur due to a sequence of events (ICAO, 2018).

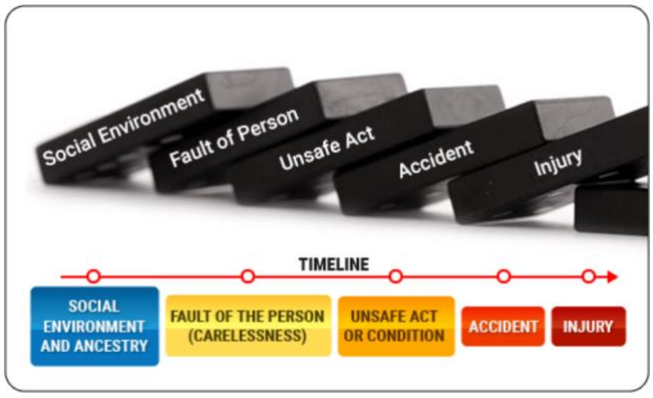


Figure 6 - Heinrich's domino model
Source: (Aviation Safety Platform, 2022)

[10] Hazards are defined as "A condition or an object with the potential to cause or contribute to an aircraft incident or accident" (sic) (ICAO, 2018, p.vii).

The initial point is social-environmental that could affect individual behaviour, leading persons to perform unsafe acts and then to accidents or injuries. The model says that if the sequence is broken by removing one of the events, the sequence is stopped, and the disaster is avoided (Aviation Safety Platform, 2022).

Heinrich's Domino theory, published in 1936, has been the foundation of many theories on accident prevention and knowledge of accident causation. Perhaps the most-known model developed on accident causation is the Swiss Cheese Model, proposed in 1990 by Professor James Reason. According to this theory, every step in a process has the potential for failure (Reason & Hobbs, 2003).

The Swiss Cheese Model illustrated in Figure 7 shows that accidents, as a rule, involve successive breaches of multiple defences. Each slice of Swiss cheese represents a layer of defence to prevent an accident from happening, and each hole can be either active failure or latent conditions. Once a sequence of holes in all the layers of cheese align, an accident can occur.

"The Reason Model proposes that all accidents include a combination of both active failures and latent conditions" (sic) (ICAO, 2018, p.2-6). Active failures can be errors or violations that directly contribute to accidents associated with front-line personnel (including pilots, aircraft maintenance engineers and air traffic controllers, among others). Latent failures are conditions that initially are not perceived as prejudicial, but under certain conditions, breaches of operational level defences could happen, and an accident can occur. Latent conditions can be inadequate training, equipment design that is less than optimal, or for example, incorrect or incomplete SOPs (ICAO, 2018).

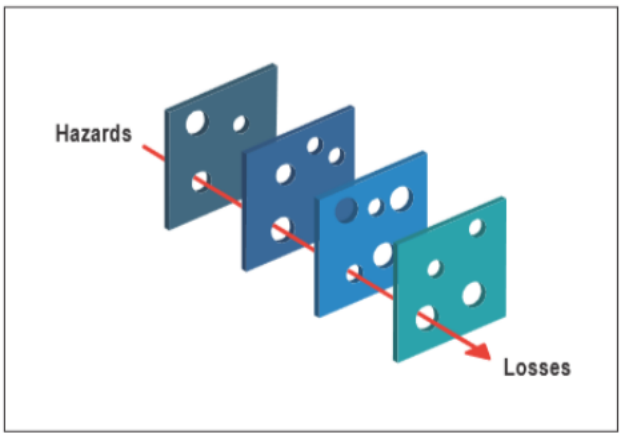


Figure 7 - Swiss Cheese Model
Source: (ICAO, 2018, p.2-7)

3.2. Introduction to SMS

3.2.1. Concept of SMS

A safety management system (SMS) is defined as "a systematic approach to managing safety, including the necessary organisational structures, accountability, responsibilities, policies and procedures" (ICAO, 2018, p.viii). Therefore, the focus of any SMS is to provide a feasible approach to achieving acceptable safety risk levels according to the established rules[11].

The implementation, developing, and sustaining of an SMS is the responsibility of top management. Essentially, an organisation, to ensure the efficiency of its safety management system (SMS), must have the following requirements (Scandlearn, 2022):

- **An accountable manager:** responsible for safety within the company and who sets the safety policy.
- **A safety policy:** defining the methods, processes and the organisational structure needed to meet safety goals.
- **A safety management manual (SMM):** containing documents covering all aspects of safety management within the company, including the safety policy, the objectives, the procedures and the safety responsibilities in the company.
- **A safety risk management (SRM):** providing hazard identification, safety risk assessment and mitigation.
- **An internal occurrence reporting scheme:** available to all personnel and non-punitive.
- **Training and safety communication:** includes a training programme and information should be easily available to all employees. The safety manager should regularly communicate information regarding safety trends.
- **Documentation of the management system:** everything must be documented and easily available to all personnel.
- **A compliance monitoring programme:** helps the Compliance Monitoring Manager to detect compliance and risk issues in an organisation.

The Safety Management System is a cyclical process which assists PHS Aviation, according to the PHS *Aviation Safety Management System Manual* (PHS Aviation, 2022, p.15), with:

- "Comply with regulations";
- "Controls losses";

[11] The rules and guidelines for SMS are published in ICAO-Doc9859, in EASA regulation (EC) 965/2012 ORO.GEN.200 and in EASA regulation (EC) 1321/2014 Annex Vc (Part-CAMO).

- “Encourage everyone to be predictive not reactive”;
- “Investigate accidents and incidents”;
- “Ensure safety is an integral part of everything we do”;
- “Ensure compliance”.

SMS is a compound of four functional components illustrated in Figure 8.

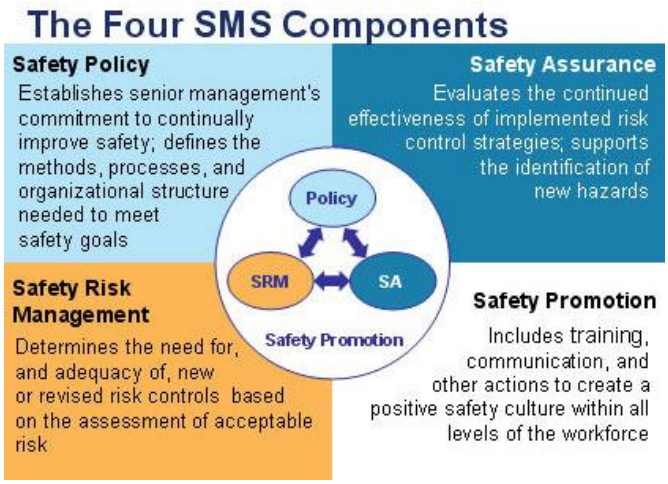


Figure 8 - The Four SMS Functional Components
Source: (FAA, 2022)

These four components of SMS will be explained in more detail in the next sub-chapter.

3.2.2.SMS at PHS Aviation

3.2.2.1. Safety policy and objectives

The safety policy is the formal documented commitment from PHS Aviation that outlines the organisation's safety values, expectations from employees and stakeholders, and the safety commitments the organisation is willing to make, as directed by the Accountable Manager's Safety Policy Statement. Furthermore, it includes resources such as policies, procedures, and accountabilities, that employees can use to perform their SMS responsibilities.

An organisation must have a safety policy as it reflects management's commitment to continually improve safety and the importance that the organisation places on the health and safety of its employees.

3.2.2.1.1 Safety policy

PHS Aviation embraces the following safety principles, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.18):

A. "Our people are expected to operate in the safest manner practicable".
B. "We will foster a culture of open reporting of all safety hazards in which management will not initiate disciplinary action against any person who, in good faith, due to unintentional conduct, discloses a hazard or safety incident".
C. "We will never take unnecessary risks".
D. "We understand that safe does not mean risk-free".
E. "Everyone is responsible for the identification and management of risk".
F. "We will all report hazards we find".
G. "We understand that familiarity and prolonged exposure without a mishap leads to a loss of appreciation of risk".

"We will accomplish this by:"

1. "Achieving the highest safety standards practical";
2. "Observing all applicable legal requirements, standards and best practices";
3. "Providing appropriate resources for safety";
4. "Ensuring management enforces safety as a primary responsibility";
5. "Ensuring that the safety policy is implemented and understood at all levels both internally and externally".

3.2.2.1.2 Safety objectives

PHS Aviation has as safety objectives, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.20):

- "An accident-free environment";
- "To improve and maintain the highest safety standards";
- "To continuously improve effective safety systems and safety culture";
- "To ensure safe operations by trained, qualified and competent personnel";
- "To increase knowledge and safety awareness among all department personnel";
- "To ensure compliance with current legislation and to conduct its business in a manner that meets the considered best practices and standards in business";
- "To ensure that a "Just Culture" is applied to the assessment of occurrences reports which would not otherwise have been discovered";

- “To provide necessary resources, both human and financial, for the implementation of the safety programme”;
- “To provide strategic and tactical guidance from the Safety Review Board to the Safety Action Group”;
- “To provide a safe working environment for all personnel, vendors, guests, and the public. This is accomplished through the PHS Aviation's Safety Policy”.

3.2.2.2. Safety Risk Management at PHS

Safety Risk Management (SRM) includes hazard identification, risk assessment, and mitigation. Figure 9 represents an overview of an organisation’s hazard identification and safety risk management process.

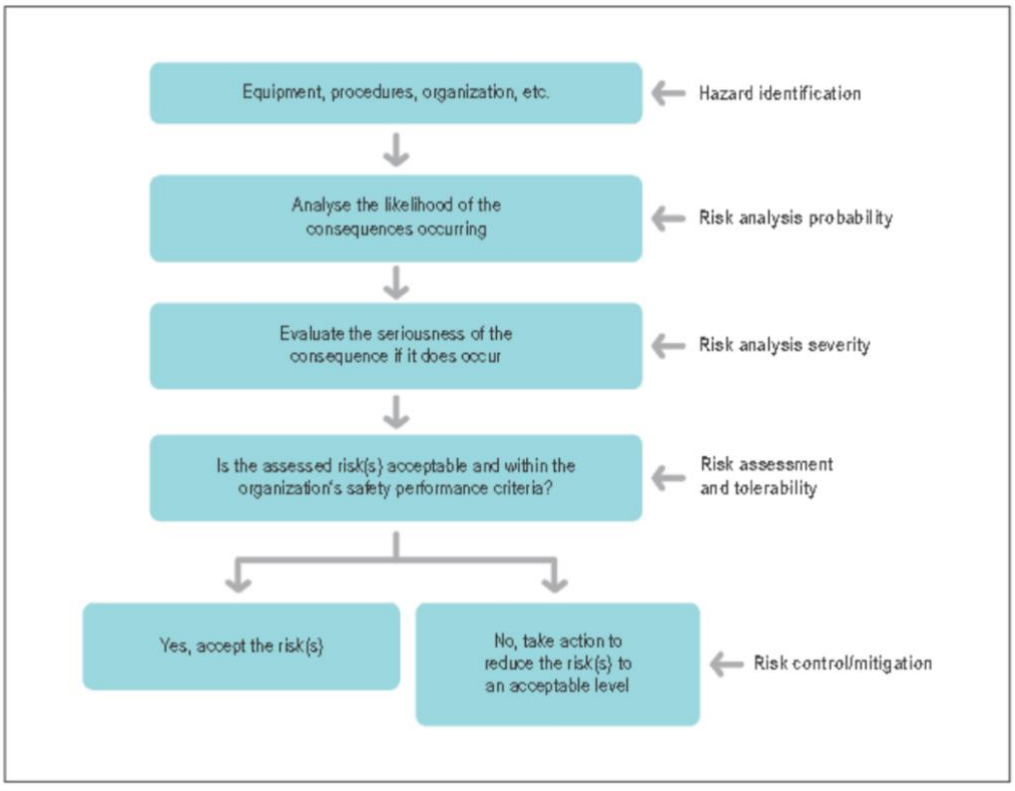


Figure 9 - Hazard identification and risk management process
Source: (ICAO, 2018, p.9-11)

The best way to prevent accidents in the workplace begins with identifying the hazards. There are several ways to inform the management of the location of potential hazards, and one of the principal sources is the safety reporting system. The reports can be voluntary and confidential. Once the administration receives the report, there must be a clear policy to protect safety data.

The success of SMS depends on the development of a positive safety culture and an open, non-punitive reporting system (ICAO,2018).

After collecting all data and reports, hazards are judged by severity, possible consequences, and by the likelihood of their occurrence. Then, are taken actions to eliminate/mitigate risks if they are not acceptable by the organisation's safety performance criteria (ICAO,2018).

3.2.2.2.1 Hazard identification

Hazards may be the result of systems that are deficient in their design, technical function, human interface or interactions with other processes and systems (ICAO, 2018). A hazard can be considered a latent error or threat that has some level of risk associated with it.
There are two methods used in aviation to identify hazards (ICAO, 2018):

- **Reactive:** Thorough analysis of past outcomes or events. Incidents and accidents are clear indicators of system deficiencies and can be used to determine hazards contributing to the event or/and latent conditions.
- **Proactive:** Thorough analysis of existing real-time situations. This method is used in SMS, which involves audits and evaluations of employee reporting, and includes continuously seeking hazards in existing processes.

According to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022), hazards can be identified from both internal and external sources. Internal sources include audits, safety investigations, voluntary or mandatory safety reporting systems, and standard operating monitoring. In the case of external sources, there are external audits, aviation accident reports, and State mandatory and voluntary safety reporting systems.

3.2.2.2.2 Safety Risk Assessment and Mitigation

Safety risk management does an objective categorization of a hazard. The first step is to determine the frequency of the event happening and the second is the severity of the outcome.

The probability of the event happening is categorized on a scale with five levels presented in Table 2.

Table 2 - Safety risk probability table
Source: (ICAO, 2018, p.2-14)

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

Once the probability assessment has been completed, the next step is to assess the severity, which is also determined on a scale with different values presented in Table 3.

Table 3 - Example safety risk severity table
Source: (ICAO, 2018, p.2-15)

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

The risk assessment is thus determined by crossing the severity with the probability presented in Table 4.

Table 4 - Example safety risk matrix
Source: (ICAO, 2018, p.2-16)

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

After determining the value of the assessed risk, the safety risk tolerability matrix is used to identify the risk as acceptable, tolerable or intolerable.

Table 5 - Example of safety risk tolerability
Source: (ICAO, 2018, p.2-17)

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

According to the PHS Aviation Safety Management System Manual (PHS Aviation, 2022), in the cases where the risk is identified by Table 5 as acceptable, continuous monitoring should be conducted to verify the impact of the risk in question on the organisation in the medium/long term. Subsequently, a follow-up of the assessed risks is carried out according to the interval for this follow-up defined in the respective risk assessment. In this follow-up, the status of the assessed risk and its current impact on the organisation is verified.

3.2.2.3. Safety Assurance at PHS

Safety Assurance consists of the processes to validate the effectiveness of Safety Risk Management according to requirements and the Safety Policy and Objectives of the organisation.

Assessing the effectiveness of SMS is essential, as its application does not always achieve the results intended. Safety Assurance helps to identify whether or not the proper safety risk control was selected and may result in applying a different safety risk control strategy.

3.2.2.3.1 Safety Performance Monitoring and Measurement

The most effective processes used to verify the effectiveness of SMS are a combination of internal audits and the establishment and monitoring of Safety Performance Indicators (SPIs).

Internal audits are conducted periodically and are an effective way of determining the presence of unsafe conditions. PHS Aviation's Safety Management System is audited annually through a plan defined at the beginning of each year. The plan consists of four audits carried out throughout the year and divided into the components of the SMS. Internal audits identify system deficiencies, lack of effectiveness of safety risk controls and opportunities for improvement. They also serve to identify non-compliance and monitor their progress in closing.

SPIs are used to monitor the safety data and safety information of the PHS Aviation and to measure the performance of its SMS. The ability to manage risks effectively is proved by the SPIs when they indicate that Safety Performance Targets (SPTs) have been achieved.

The SPIs defined by the PHS Aviation encompass a wide spectrum of indicators, which include, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.49):

- “Low probability/high severity events (e.g. accidents and serious incidents)”;
- “High probability/low severity events (e.g. non-conformities)”;
- “Process performance (e.g. training, system improvements, reporting system)”.

3.2.2.3.2 The Management of Change (MoC)

Changes in organisational structure, personnel, documentation, processes, or procedures can result in the inadvertent introduction of hazards and increased risk. Therefore, the Management of Change is a formal process to identify and manage the safety risks associated with the changes.

The following diagram in Figure 10 describes the process followed by PHS Aviation for the Management of Change (MoC).

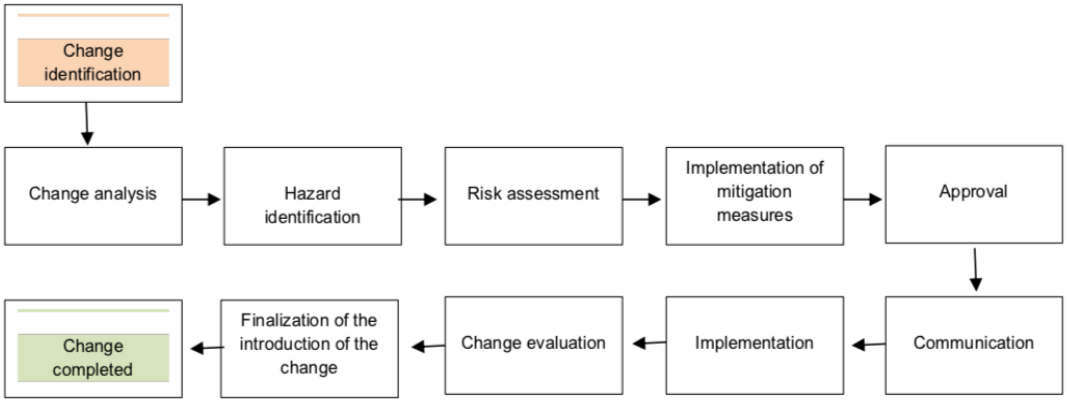


Figure 10 - Procedures for managing change
Source: (PHS Aviation, 2022, p.54)

The described MoC process should be performed when PHS Aviation experiences the following, but not limited, changes, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.53):

- "Organisational expansion or contraction";
- "Changes to the organisation's structure or operating environment";
- "External regulatory changes, economic changes and emerging risks";
- "Business improvements that may result in changes to internal systems, processes or procedures that support the safe delivery of services or products".

3.2.2.3.3 Continuous improvement of the SMS

It should be recognised that maintaining and continuously improving the SMS is an ongoing journey as the organisation and the operational environment are constantly changing.

In addition to the internal audits and the SPIs, PHS Aviation implemented other methods to determine the effectiveness of SMS. Such methods are, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022):

- Safety Assessments;
- Monitoring of Occurrences;
- Internal Safety Investigations;
- Safety Reviews;
- Safety Surveys;
- Annual Safety Reports.

3.2.2.4. Promotion of safety at PHS Aviation

The promotion of safety encourages a positive safety culture by ensuring that all employees of the organisation are aware of their responsibilities towards safety performance, which is done through training and education, effective communication and information-sharing.

3.2.2.4.1 Training and education

According to PHS Aviation, all staff receives safety training appropriate for their safety responsibilities. There are four main reasons why training is needed, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.58):

1. "**Required by Law -** Certain training is required by the governing organization".
2. **"Hazards in Our Workplace -** Hazards must be identified and found in all the organisation's systems".
3. **"Dangerous Work Practices on the Job -** Observations may reveal actions and practices in the workplace that could be a danger to some individuals".
4. **"Introduction of New Equipment or Procedures -** Training should be provided whenever new equipment arrives or changes are made in operations".

3.2.2.4.2 Safety communication

An effective communication system helps to create the safest possible work environment. The PHS Aviation's system for communicating with personnel on safety issues includes, according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.60):

A. **"The Safety Management System Manual:** A copy of this manual has been distributed to each manager and supervisor for review, and additional copies are available from the Safety Manager".
B. **"Safety Meetings:** The Safety Manager or Area managers will conduct periodic safety meetings and briefings".
C. **"Anonymous Notification Procedures:** The company has a system of anonymous notification whereby personnel who wish to inform the Safety Manager of safety hazards may do so anonymously by sending a written notification to the Safety Manager using a Hazard Report Form".
D. **"Safety Bulletins:** From time to time, it may become necessary to inform flight and/or ground crews of critical safety information".
E. **"Bulletin boards:** The Safety Manager will maintain a safety bulletin board in an area accessible to flight, maintenance, and ground personnel. Topics will be posted periodically and then archived after removal".

3.2.2.4.3 Safety culture

“Safety culture is the natural consequence of having humans in the aviation system. Safety culture has been described as how people behave in relation to safety and risk when no one is watching” (sic) (ICAO, 2018, p.3-1).

To promote a safe and healthy work environment, PHS Aviation has approved the implementation of a "Just Safety Culture," which aims to promote an atmosphere of trust in which people are encouraged to provide essential information related to safety issues.

The safety culture adopted by the company is a combination of five elements described according to the PHS Aviation *Safety Management System Manual* (PHS Aviation, 2022, p.63):

1. “An “Informative” culture, which requires the management of all systems to have a positive knowledge view concerning human, technical, organizational and environmental factors with impact/contribute to the organization, allowing for errors to occur”;
2. “A “Learning” culture willing to perform proactive and corrective actions, and take appropriate action and decisions based on conclusions from relevant information. Willing to implement major reforms where deemed necessary”;
3. “A “Flexible” culture open for changes based on “learning from experiences” and a solid safety culture with priorities on SAFETY”;
4. “A “Just” and non-punitive culture where people are aware of the line between acceptable and unacceptable behavior. A fair operational safety culture must understand that human error is recognized as normal and non-repetitive and that punishment can lead to widespread inhibition of internal communication. However, it is important to keep in mind that intentional violations are not tolerated”;
5. “A “Reporting” culture based on an open organizational climate where all involved are encouraged to report all occurrences deviating from known standards and requirements, hazards and errors without any retribution”.

3.2.3. PHS Aviation Safety Reporting System

All employees of PHS Aviation are encouraged to identify and report hazards and other safety issues through the Safety Reporting System. After submitting the safety report, the person that reported receives feedback from the Safety Manager on what decisions or actions have been taken to encourage future reporting and promote a positive safety culture (PHS Aviation, 2022).

If an individual finds a hazard, they complete the company's Hazard Report form (A.1Hazard Report Form).

For the reporting of occurrences by employees to the Safety Department, PHS Aviation has two forms (A.2Voluntary Occurrence Report and A.3- Mandatory Occurrence Report), one voluntary and the other mandatory, respectively, following Regulation (EU) No. 376/2014 (EASA, 2014, April).

In order to report a voluntary or mandatory occurrence, the corresponding company form must be completed and submitted to the appropriate Safety Department or Safety Representative. Any forms may be submitted by email, phone call, online reporting or placed in the notification box that is physically located on PHS Aviation facilities. If the person that made the report wishes to remain anonymous, he/she can report without identification (PHS Aviation, 2022).

"Mandatory reports must be made within 72 hours of becoming aware of them. The preliminary results of the analysis must be reported to ANAC within 30 days, and the final results, once completed, within three months from the date of the occurrence report. In the case of very urgent communications, namely in the case of accidents, it is acceptable, in order to facilitate compliance with the provisions of Article 9 of Regulation (EU) No. 996/2010, to send a notification to the ANAC within a maximum period of 6 hours. In the case of voluntary occurrence reports, there is no deadline, but they must be made as soon as possible after the occurrence" (sic) (PHS Aviation, 2022, p.36).

In addition to the forms listed above, PHS Aviation also has an Occurrence Registration System to register all occurrences that have arisen. This system facilitates data collection to help identify root causes and monitor operational safety, so control measures can be implemented to safeguard flight safety (PHS Aviation, 2022).

3.3. Introduction to Part-CAMO

In 2003 became mandatory for all EU-registered aircraft to be supported by a Part-M Subpart G approved company. In June 2020, EASA released a new Annex revision directive - Annex Vc of (EU) 1321/2014 (Part-CAMO) - to replace by March 24, 2022, gradually, the current Subpart G of Annex I (Part M) to align with the general authority and organisational requirements adopted in the other domains (Aircrew, Air Operations, Aerodromes, ATM/ANS[12]).

Part-CAMO approval is a certification awarded by the EASA to Aviation Management companies. It contains the requirements to be met by an organisation to manage the continuing airworthiness of an aircraft and plan/coordinate all maintenance activities.

[12] ATM/ANS stands for Air Traffic Management/Air Navigation Services.

In Figure 11, we can observe the framework of the mentioned Annex Vc highlighted in green in the current legislation. The Basic Regulation 2018/1139, which is an act of the European Parliament establishing the requirements of EASA as a European Regulator, is divided into two regulations concerning airworthiness: Commission Regulation No 748/2012 concerning initial airworthiness and Commission Regulation No 1321/2014 concerning continuing airworthiness.

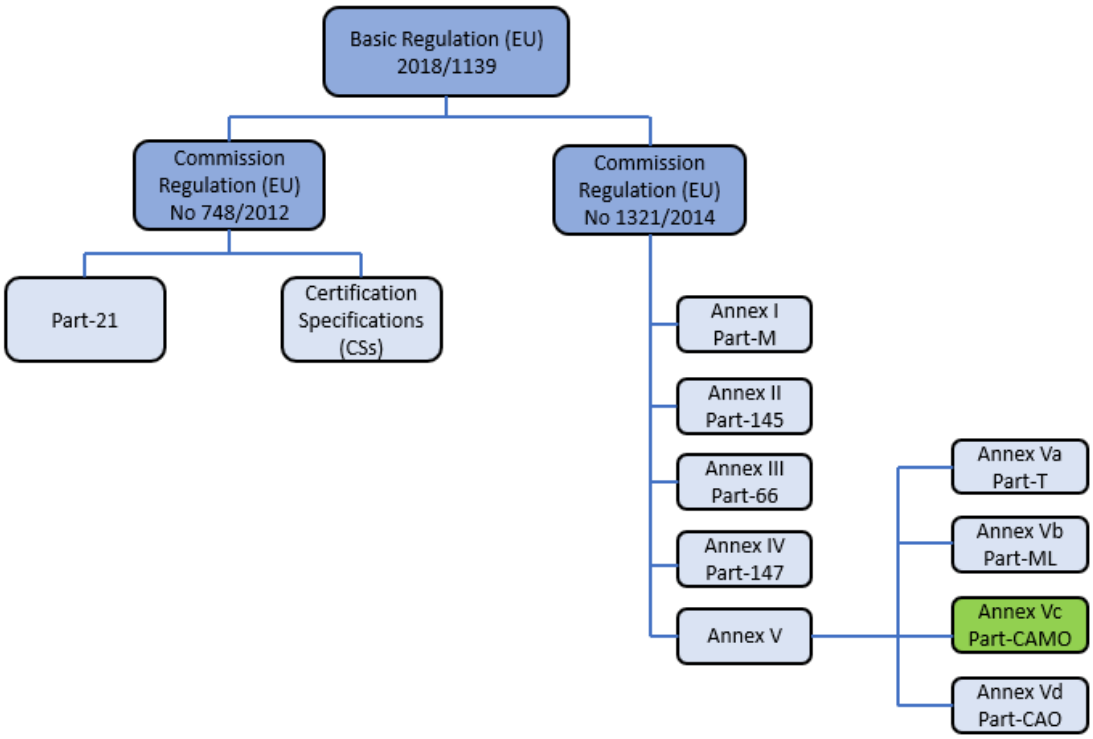


Figure 11 - Scheme of the current EASA airworthiness regulations
Source: (Author, 2022)

The Annex Vc of (EU) 1321/2014 'Part-CAMO' is based on Subpart G of Annex I (Part-M) requirements, with the main difference being the introduction of SMS principles. "However, Subpart G of Annex I does not currently contain any requirements for safety risk management within the CAMO. Therefore, a management system of CAMOs, including safety risk management for organisations that manage the continuing airworthiness of aircraft used by AOC holders, should be introduced. That management system should apply to all CAMOs that manage the continuing airworthiness" (sic) (EASA, 2019, July, p.2).

Another change in the transition from Subpart G of Annex I to 'Part-CAMO' was the evolution from a Quality System (QS) to a Management System (MS), as depicted in Figure 12.

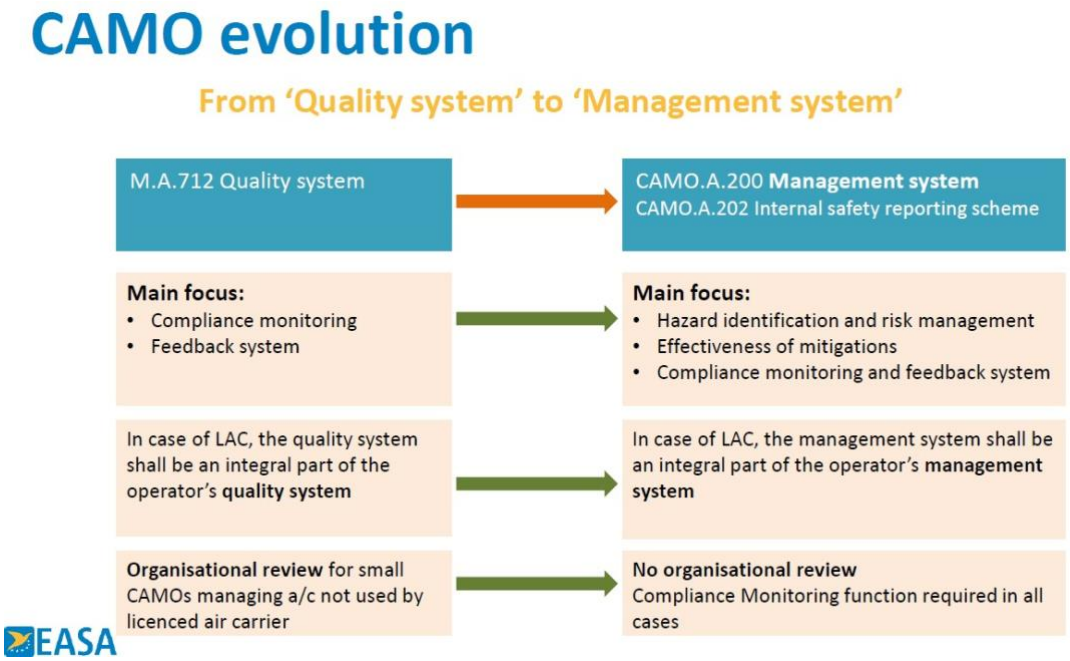


Figure 12 - CAMO evolution
(EASA, 2020, p.8)

As shown in Figure 12, the goal of the 'Part-CAMO' transition was to move from the Quality system to the Management system, which itself already includes the Quality system as one of the main focuses.

Therefore, according to the EASA Regulation and the level of SMS integration in PHS Aviation, the main objective of CAMO is to implement "one single Safety Management process common to both the Operator and the CAMO, with one Safety Manager needing different skills and knowledge" (sic) (EASA, 2020a, p.10).

Annex VC is further divided into sections A for organisation requirements and B for authority requirements. This division is represented in Figure 13, where the requirements added to cover the SMS principles are selected in yellow.

Annex Vc (Part-CAMO) to Commission Regulation (EU) No 1321/2014	
SECTION A — ORGANISATION REQUIREMENTS	**SECTION B — AUTHORITY REQUIREMENTS**
CAMO.001 General	
General requirements	**General requirements**
CAMO.A.005 Scope	CAMO.B.005 Scope
CAMO.A.105 Competent authority	CAMO.B.115 Oversight documentation
CAMO.A.115 Application for an organisation certificate	CAMO.B.120 Means of compliance
CAMO.A.120 Means of compliance	CAMO.B.125 Information to the Agency
CAMO.A.125 Terms of approval and privileges	CAMO.B.135 Immediate reaction to a safety problem
CAMO.A.130 Changes to the organisation	
CAMO.A.135 Continued validity	
CAMO.A.140 Access	
CAMO.A.150 Findings	
CAMO.A.155 Immediate reaction to a safety problem	
CAMO.A.160 Occurrence reporting	
Management	**Management**
CAMO.A.200 Management system	CAMO.B.200 Management system
CAMO.A.202 Internal safety reporting scheme	CAMO.B.205 Allocation of tasks to qualified entities
CAMO.A.205 Contracting and subcontracting	CAMO.B.210 Changes in the management system
CAMO.A.215 Facilities	CAMO.B.220 Record-keeping
CAMO.A.220 Record-keeping	
CAMO specific requirements	**Oversight**
CAMO.A.300 Continuing airworthiness management exposition	CAMO.B.300 Oversight principles
CAMO.A.305 Personnel requirements	CAMO.B.305 Oversight programme
CAMO.A.310 Qualification of airworthiness review staff	CAMO.B.310 Initial certification procedure
CAMO.A.315 Continuing airworthiness management	CAMO.B.330 Changes
CAMO.A.320 Airworthiness review	CAMO.B.350 Findings and corrective actions
CAMO.A.325 Continuing airworthiness management data	CAMO.B.355 Suspension, limitation and revocation
Appendix I: Continuing Airworthiness Management Organisation Certificate referred to in Part-CAMO	

Figure 13 - Table of contents of the new Part-CAMO
Source: (EASA, 2016, p.18)

The proposed change is expected to improve the level of safety in continuing airworthiness management and maintenance of aircraft and facilitate the implementation of single management systems. In order to ensure that the approved CAMO continues to meet the requirements[13] of Subpart G, it is necessary to continue with a compliance system with a compliance manager and it is necessary to implement a management system responsible for the organisation's safety and compliance system.

PHS Aviation being Part-CAMO certified, must have an SMS to control the risks proactively. PHS Aviation already has an SMS implemented regarding "Part-CAMO"; however, as this implementation is still recent (as Annex Vc "Part-CAMO" was published in June 2020), there is a need to improve its SMS.

Therefore, a tool used in this work to monitor and consequently improve the performance of the SMS already existing in Part-CAMO is the definition of Safety Performance Indicators (SPIs). SPIs are the parameters that provide the organisation with a view of its safety performance:

[13] Requirements of Subpart G (Continuing Airworthiness Management Organisation) section A of Annex I (Part-M) Regulation 1321/2014 (includes requirements M.A.701 to M.A.7016) (EASA, 2021).

where it has been; where it is now; and where it is headed, in relation to safety. The identification of SPIs should therefore be realistic, relevant, and linked to safety objectives, regardless of their simplicity or complexity (ICAO,2018).

3.4. Conclusion

In summary, this chapter has described how safety management in aviation is an exceptional tool for States and aeronautical service providers to mitigate proactively safety risks that can generate accidents and incidents.

From a regulatory authority's point of view, most aircraft accident causes are associated with human failures in maintenance activities, design or operation issues. For that reason, it was established that all organisations in the aeronautical sector must adopt and implement an SMS to manage and maintain operational safety procedures.

From a PHS Aviation point of view, the effectiveness of the SMS in a company is built on four pillars or components: Policy and Objectives, Safety Risk Management, Safety Assurance and Safety Promotion. The implementation of these components in an organisation allows those in charge to plan and implement a safety programme that is effective and comprehensive. The most important aspects that can prevent accidents in an organisation are the training of employees to identify hazards and positive operational safety culture, which encourages reporting occurrences and communication between the people involved.

4. Case of study

4.1. Methodology

Since PHS Aviation is Part-CAMO certified to manage continuing airworthiness, it must have an effective SMS following the regulations. At this phase, PHS Aviation has already adapted the SMS to the Annex Vc 'Part-CAMO' proposed by EASA; however, it is the organisation's objective to continue improving the SMS's process efficiency, namely the safety requirements related to Part-CAMO activities.

As mentioned in subchapter 3.3, the Annex Vc of (EU) 1321/2014 (Part-CAMO) came to replace the Subpart G of Annex I (Part-M), introducing the Safety Management in Continuing Airworthiness Management organisations.

This alteration proposal emerged with the intent, according to EASA (EASA, 2016, p.1), of:

- "increase the level of safety in continuing airworthiness management and maintenance of aircraft operated by licensed air carriers and of CMPA[14];and
- facilitate the implementation of single management systems by multiple-approved organisations and streamline the related oversight".

Annex VC (Part-CAMO) has sections A and B, but this study is only based on section A[15], as it is the section with current organisational procedures and requirements. The referred sections A and B are represented in Figure 13.

Therefore, to improve the SMS process at EASA Part-CAMO within the company, the presented work proposed an implementation process consisting of creating SPIs to monitor certain hazards. The process is based on creating SPIs because the company considers it the most advantageous and accessible option[16] to ensure and monitor its safety level.

The process described in this chapter starts with the identification by the company of hazards related to PHS Aviation's continuing airworthiness management activities and which the company has a priority to control. The identification of these hazards was performed using the PHS Aviation risk assessment ("RA 01/2022"), already carried out by the company during the transition from Part-M Subpart G to Part-CAMO. Subsequently, an implementation process

[14] CMPA is defined in Regulation (EU) 216/2008 article 3(j) as follows: "complex motor-powered aircraft" shall mean: (i) an aeroplane: with a maximum certificated take-off mass exceeding 5700 kg; or certificated for a maximum passenger seating configuration of more than nineteen; or certified for operation with a minimum crew of at least two pilots; or equipped with (a) turbojet engine(s) or more than one turboprop engine" (sic) (Official Journal of the European Union, 2008).

[15] Section of the Annex VC (Part-CAMO) to Commission Regulation (EU) No 1321/2014 with the requirements applicable to CAMOs.

[16] There are other possible options to improve the SMS in CAMO activities, which can be found in section 3.2.2.3.3.

consisting of SPIs was proposed to monitor the hazards identified and therefore measure the existing operational safety performance in the company.

4.2. Identification of the hazards to be addressed

As an approved Part-CAMO organisation, PHS Aviation carries out the following activities (PHS Aviation, 2022a):

- Development, updating and monitoring of the aircraft maintenance programme (AMP);
- Analysis of the effectiveness of the AMP;
- Development of the aircraft airworthiness assessment process;
- Control of the continuing airworthiness management records;
- Analysis of the applicability of airworthiness directives and service bulletins and the incorporation of modifications;
- Control of the list of pending anomalies;
- Planning and contracting maintenance tasks for repairs and malfunctions/ anomalies;
- Planning and contracting maintenance tasks, including compliance with ADs, SBs and/or necessary modifications incorporating;
- Management of contracted maintenance;
- Verification and archiving of maintenance processes;
- Planning of maintenance check flights;
- Recording of aircraft hours and cycles;
- Management of technical logbooks;
- Management of the aircraft phase-in and phase-out process.

According to EASA CAMO.A.200 (a) 3) of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), "the CAMO shall establish, implement, and maintain a management system that includes the identification of aviation safety hazards entailed by the activities of the organization" (sic) (EASA, 2021, p.961).

For the above-listed activities that PHS Aviation performs as a Part-CAMO organisation, the company has identified through the PHS Aviation risk assessment ("RA 01/2022"), already performed by the company during the transition from Part-M Subpart G to Part-CAMO, the following hazards associated with these activities:

- Incomplete/incorrect CAMO work orders;
- Incorrect use of CAMO procedures;
- Incomplete/incorrect continuing airworthiness record;
- Incomplete/incorrect assessment of the airworthiness;
- Not customised/incomplete MEL;

- Missed planned maintenance tasks;
- Incomplete maintenance work processes;
- Incorrectly evaluated AD/AD compliance failure;
- Communication failure between CAMO and other departments;
- Not clearly defined roles and responsibilities between CAMO and other parties;
- Insufficient control/evaluation of contracted organisations;
- Insufficient Hold Item List control;
- Incorrect assessment of defect;
- New A/C model phase-in and employees without the familiarisation course;
- Change in the CAMO reporting procedure;
- Internal communication procedure failure;
- Slow response to safety issues;
- Unawareness of changes made to the organisation with an impact on safety before their implementation;
- Lack of competence assessment;
- Lack of initial/recurrent training;
- Lack/unclear job description;
- Lack/unclear procedures;
- Hazards arising from contracted maintenance organisations;

It should be noted that each hazard identified can be common to several CAMO activities. For example, the case of the hazard identified as "Lack of initial/recurrent training" is a hazard common to all identified CAMO activities that PHS Aviation performs. Any employee without recurrent training is unaware of the CAMO procedures in force and, therefore, airworthiness activities performed under these circumstances can lead to errors and/or, eventually, tasks not efficiently done.

Each hazard identified above constitutes a safety risk to CAMO activities in the organisation. For example, the hazard “Incorrect use of CAMO procedures” can impact the performance of tasks leading to them being performed incorrectly and not following applicable requirements, which can lead to personal injury and failure of a system essential to the operation or even catastrophic failures. In addition to this hazard, other hazards such as “Communication failure between CAMO and other departments”, “Lack/unclear job description”, and “Internal communication procedure failure” can also contribute to a negative impact on task performance and, in turn, have more severe consequences.

Another essential hazard that impacts the correct execution of the tasks is “Unawareness of changes made to the organisation with an impact on safety before their implementation”. This hazard increased the probability of its occurrence in the organisation with the transition from Subpart G of Annex I to “Part-CAMO” since there were changes such as, for example, the change in the CAMO reporting procedure. The fact that the CAMO reporting procedure has changed

may have consequences, such as the non-reporting of detected occurrences, which can lead to other severe consequences.

Another change that constitutes a hazard is introducing a new aircraft model-whose CAMO employees do not have a familiarisation course in that model or similar model ("New A/C model phase-in and employees without familiarisation course"). The fact that the employees do not have the familiarisation course can create risks because they do not have sufficient and adjusted knowledge of the new model.

Regarding contracted organisations, there are also several hazards associated, such as: "Insufficient control/evaluation of contracted organisations", "Missed planned maintenance tasks" and "Incomplete maintenance work processes". This set of hazards can constitute several risks for the organisation, such as the aircraft's incomplete airworthiness records, which can lead to the aircraft not being airworthy.

Finally, reference should be made to hazards that impact safety as they are points of non-compliance with the mandatory or applicable airworthiness requirements, which could also lead to the aircraft not being airworthy. Some examples are: " Not customised/incomplete MEL ", "Incorrectly evaluated AD/AD compliance failure", " Insufficient Hold Item List control", and " Incorrect assessment of defect".

Within these hazards identified above, PHS Aviation, for the development of this study, has decided to establish four main hazards that it intends to control, having as a criterion of choice the level of impact they have on the safety of its continuing airworthiness management activities:

I. Incorrect use of CAMO procedures (“RA 01/2022- Hazard nº 7”);
II. Unawareness of changes made to the organisation with an impact on safety before their implementation (“RA 01/2022- Hazard nº 15”);
III. Change in the CAMO reporting procedure (“RA 01/2022- Hazard nº 14”);
IV. Incomplete maintenance work processes (“RA 01/2022- Hazard nº 9”).

The selection of these four hazards was made as stated through the PHS Aviation risk assessment “RA 01/2022”, considering the tolerability level presented and the organization’s priorities at the time. In this way, the PHS Aviation risk assessment results corresponding to the four hazards intended to be controlled were selected and presented in Table 6 to understand each hazard’s degree of risk, probability of occurrence, level of tolerability and mitigation actions defined.

Table 6 - Risk assessment

Source: (PHS Aviation, 2022b, p.1)

Nº	Operation phase	Hazard	Causes	Consequences (Risks)	Outcome (Pre-Mitigation)			Mitigation actions required
					L	S	R	
7	CAMO activities	Incorrect use of CAMO procedures	Lack of training	Tasks performed incorrectly and not in accordance with applicable requirements which could lead to personal injuries, failure of a system essential for the operation, or catastrophic failure.	Remote (3)	Catastrophic (A)	**Intolerable (3A)**	Revision of training requirments; Customatize training to the departments needs.
9	CAMO activities	Incomplete maintenance work processes	Failure to close maintenance work processes by contracted MROs	Airworthiness record of the aircraft not complete, which may lead to the aircraft not being airworthy and which could lead to personal injuries, failure of a system essential for the operation of an aircraft, or catastrophic failure.	Remote (3)	Catastrophic (A)	**Intolerable (3A)**	Increased level of supervision of contracted MROs.
14	CAMO activities	Changes in the reporting procedure	Lack of training and failure to communicate the procedure update	Occurrences detected by CAMO not reported, which could lead to personal injuries, feature of a system essential for the operation of an aircraft, or catastrophic failure.	Remote (3)	Hazardous (B)	**Tolerable (3B)**	Occurrence reporting system training; Communication with the employees about the new reporting procedure.
15	CAMO activities	Unawareness of changes made to the organisation with an impact on safety before their implementation	Failure in the management communication procedure	Tasks carried out not taking into account the aspects resulting from the changes made to the organisation, which could lead to personal injuries, failure of a system essential for the operation of an aircraft, or catastrophic failure.	Improbable (2)	Hazardous (B)	**Tolerable (2B)**	Greater presence of management and improvement of the internal communication procedure.

L = Likelihood
S= Severity
R = Risk Tolerability

In order to verify if the mitigation actions exposed in Table 6 manage to decrease the probability and the severity of occurrence of the associated risk, an implementation process consisting of SPIs is presented.

In this manner, this study was motivated to improve the efficiency of SMS in EASA Part-CAMO of PHS Aviation through the creation of SPIs for monitoring these four hazards identified, following the new Annex Vc 'Part-CAMO' to Commission Regulation (EU) 1321/2014.

4.3. Proposed implementation process

The implementation process suggested in this work is proposed to the safety department and aims to improve the SMS process at Part-CAMO.

This process was based on the hazards identified in the PHS Risk Assessment “RA 01/2022” and is composed of the implementation of four safety performance indicators.
The described implementation does not ensure that the intended results will be obtained; for that matter, the management must monitor its development. The validation of this process will be decided during the next company's Safety Review Board.

4.3.1. Safety Performance Indicators

A safety performance indicator observes data on occurrences in a chosen monitoring period and permits the organisation to set desired targets under its previously defined operational safety objectives (ICAO,2018).

To monitor the four hazards identified in the PHS Aviation risk assessment "RA 01/2022" and consequently improve the SMS process, the following aspects were selected by the PHS Aviation safety department:

- Missing training (related to “RA 01/2022- Hazard nº 7”);
- Communications to the employees regarding management of change (related to “RA 01/2022- Hazard nº 15”);
- Reports made by the CAMO (related to “RA 01/2022- Hazard nº 14”);
- Status of maintenance work processes (MRO CONTRACTED) (related to “RA 01/2022- Hazard nº 9”).

The SPIs presented in Table 7 were created through these four identified aspects.

Therefore, this chapter presents Table 7 with each SPI's identification, description, periodicity, target and associated CAMO hazard. It should be noted that all these performance indicators presented are related to hazards associated with continued airworthiness management.

Table 7 - SPIs to implement
Source: (Author, 2022)

SPI	Designation	Description	Periodicity	Target	Hazard associated with CAMO
1	Missing Training	Number of CAMO employees with missing training	Every quarter	0	Incorrect use of CAMO procedures
2	MoC Communications	Number of MoCs communicated in advance to employees per changes impacting the safety of CAMO activities at PHS Aviation	Annually	1	Unawareness of changes made to the organisation with an impact on safety before their implementation
3	Reports made by the CAMO	Number of reports made by CAMO per 100 flights	Annually	1,2	Change in the CAMO reporting procedure
4	Maintenance work processes (Contracted MROs)	Number of maintenance work processes received initially incomplete per number of maintenance work processes carried out (this rate is calculated independently for each contracted MRO)	Annually	0,1	Incomplete maintenance work processes

To understand the safety objective of each presented SPI and its connection to CAMO activities and to be aware of how it should be applied and interpreted, each one will be analysed individually in this section.

4.3.1.1. SPI proposed nº1

According to AMC5 CAMO.A.305(g) a) of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), "adequate initial and recurrent training should be provided and recorded to ensure that staff remain competent" (sic) (EASA, 2021, p.993).

Therefore, the training of Part-CAMO employees is a fundamental issue since, if it is missing or expired can lead to a lack of knowledge on the techniques, standards, and CAMO procedures currently in force to perform airworthiness activities.

A clear example of the consequences of missing training is the case of a CAMO employee who, when planning the scheduled maintenance of an aircraft, used the wrong form to record the maintenance tasks to be carried out by the Part-145 maintenance organisation.

This situation arises when the document used for the scheduled maintenance planning has been modified, and the CAMO employee has not completed the training to be aware of the CAMO forms in force. Information regarding all forms in force at CAMO is provided during internal CAME procedures training, including a list of all approved and current CAMO forms. Failure to complete this periodic training can lead to non-compliance with the procedures in force and

failure of the CAMO employee to perform the task correctly, which can lead to delays in maintenance planning and even its performance.

PHS Aviation already conducts a continuing competency assessment for all CAMO employees at the beginning of each year for the previous year to maintain the effectiveness of the Continuing Airworthiness activities and Compliance Assurance system. The results of the assessments are always reported to the respective employee to allow improvement of his/her performance. The company also ensures initial training whenever a new employee is hired within two months from the date of admission and recurrent training for all employees every two years.

The table below gives a general idea of the company's training records to date.

Table 8 - Records of recurrent training for CAMO employees
Source: (PHS Aviation, 2022)

Recurrent training (2022) - CAMO employees	**Percentage of employees with expired training**
Human Factors	0,29 %
CAME procedures	0,14 %
Fuel Tank Safety	0,14 %
EWIS – Electrical Wiring Interconnection System	0,14 %
EASA Part-CAMO + EASA Part-M	0,86 %
SMS	0,57 %

Table 8 shows a high percentage of CAMO employees with expired recurrent training courses, reinforcing the need for stricter monitoring.

The leading causes of this situation are linked to the fact that, sometimes, there are difficulties in planning/scheduling training sessions, with the possible increase in the workload and the failure to monitor the legislation in force.

In Table 8, a high percentage of employees did not perform the "EASA Part-CAMO + EASA Part-M", and "SMS" training due to a lack of schedule as other activities led the organisation to postpone the training action. Currently, this case is already being solved, as the training is already available online to be performed.

The company already has the SPI- "Safety Training" in place; however, it only averages the number of SMS training hours per person per year and cannot inform if all employees completed the stipulated training plan. Additionally, this existing SPI only controls safety-related activities and does not control CAMO activities.

Therefore, SPI number 1- "Missing Training" was created to monitor the number of CAMO employees with missing training per trimester, according to the annual training plan stipulated by PHS Aviation and the applicable legislation. The SPI measuring should be done by resorting to the PHS Aviation document - "IQ.315 Control of Individual Training"- used by the training department to plan and control the training programmes[17].

As the target associated with this indicator is the lack of completion of the CAMO training courses stipulated in the PHS Aviation annual training plan, the result obtained from the monitoring is expected to be 0. It should be noted that only training required by PHS Aviation CAME under applicable legislation is counted. If the target is greater than or equal to 1, the company follows the respective procedure to alert the person concerned. Subsequently, the organisation must ensure that the training is done effectively and periodically reviewed and updated.

4.3.1.2. SPI proposed nº2

According to AMC2 CAMO.A.130 of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), “the organisation should manage the safety risks related to any changes to the organisation in accordance with AMC1 CAMO.A.200(a)(3) point (e)” (sic) (EASA, 2021, p.956).

According to AMC1 CAMO.A.200(a)(3) e) of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), “the organisation should manage the risks related to a change. The management of change should be a documented process to identify external and internal changes that may have an adverse effect on the safety of its continuing airworthiness management activities. It should make use of the organisation’s existing hazard identification, risk assessment and mitigation processes” (sic) (EASA, 2021, p.967).

Some examples of changes that may affect the safety of PHS Aviation’s CAMO activities and refer to in the GM2 CAMO.A.200(a)(3) (d), (EASA, 2021, p.969, 970):

- Changes to the organisational structure;
- The inclusion of a new aircraft type in terms of approval;
- The addition of aircraft of the same or a similar type;
- Significant changes in personnel;
- New or amended legislation;
- Changes in the economic situation of the organisation;
- New contracted maintenance organisations;

[17] The training plans and any changes are always submitted to the ANAC for its knowledge.

- New facilities;
- New equipment;
- New equipment; technologies; procedures;
- Changes in personnel, procedures; technologies; work processes and planning.

The changes identified above, as an example, unless properly managed, can lead to the emergence of new hazards and consequently associated risks that the organisation may never have been exposed to before.

As a CAMO, it is PHS Aviation's objective to have a good process to manage the changes before they are implemented, to have advanced knowledge of the hazards that the organisation will be exposed to and consequently work to create mitigation actions to mitigate the associated risks.

For example, a change regarding the inclusion of a new aircraft type in terms of approval in the PHS Aviation CAMO is not managed in advance. In that case, there may be exposure to certain hazards that affect the organisation's ability to be appropriately prepared for the inclusion of a new aircraft type. An example of a hazard associated with this type of change is if the CAMO employees responsible for managing this aircraft do not have a familiarization course on the new aircraft type to be included in the scope. Therefore, without a thorough knowledge of the new aircraft, the AMP could not be prepared adequately, which could lead to consequences such as incorrect maintenance planning and execution.

In addition to effective management of change, according to GM2 CAMO.A.200(a)(3)(b) of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), “a change can only be successfully implemented if all the personnel affected by the change are engaged, are involved and participate in the process” (sic) (EASA, 2021). In other words, if the change is not communicated in advance of its implementation to all the personnel involved, they are not aware of the hazards to which they will be subject nor how this change will affect their work and daily activities.

According to PHS Aviation records, in the last year, there have been seven changes in the organisation (internal and external changes[18]) that were considered to have an impact on the safety of their CAMO activities. Two of those seven changes were not communicated adequately or in advance to employees.

Therefore, SPI number 2- " MoC Communications" was created to monitor the number of MoCs communicated in advance to employees per changes (internal and external) with an impact on the safety of CAMO activities at PHS Aviation. A target rate of 1 has been proposed to ensure

[18] Internal changes are related to the organisation, such as changes in procedures, organisational structure, and entry of a new aircraft. External changes are changes that the organisation does not have complete control over, driven by external factors that impact the organisation. Some examples are changes in regulation and changes in contracting organisations.

that for every change that impacts safety in CAMO activities at PHS Aviation, an advanced MoC communication is made to the employees.

4.3.1.3. SPI proposed nº3

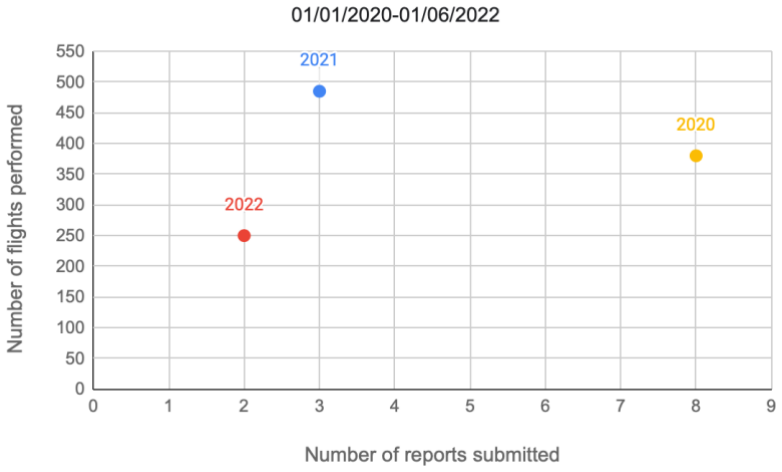
According to GM1 CAMO.A.202 a) of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), "the overall purpose of the internal safety reporting scheme is to collect information reported by the organisation personnel and use this reported information to improve the level of compliance and safety performance of the organization" (sic) (EASA, 2021, p.975).

With the changes made to the CAMO reporting procedure due to the transition from Part-M Subpart G to Part-CAMO, employees are still adjusting to the new procedures. Consequently, there may be a failure to report some verified occurrences due to insufficient practice or lack of knowledge of the correct application of the reporting procedure in force. This failure may impact the reporting of verified occurrences in the CAMO, mainly in the brevity with which these reports are made, taking into account the moment in which the occurrence occurs.

These situations, triggered by interference from the reporting procedure update, can cause a change in the number of CAMO occurrence reports and, in turn, have consequences for continued airworthiness. An example of these situations that can jeopardize continued airworthiness is related to the lack or delay in reporting occurrences related to the physical condition of the aircraft and its maintenance. If these occurrences are not reported as soon as possible and correctly, they can cause the identified problem to drag on in time and lead to a flight failure with the need for an emergency landing.

PHS Aviation already has a performance indicator to monitor the number of reports per year. However, this indicator does not allow for any exact conclusion to be drawn, given that if there is a significant increase in the number of flights, there is a higher probability of a significant volume of occurrences and, for this reason, a possibly higher number of reports. Therefore, it was proposed to redefine the current indicator so that the target is not defined by the number of reports per year but by a rate where the number of reports made by CAMO per 100 flights per year is determined. In accordance, a rate of 0.8 (recorded between 01/01/2022 and 01/06/2022) means that there were 0.8 reports for every 100 flights made in that period. It is possible to observe the effectiveness of the proposed rate (number of reports per 100 flights) on the current indicator by analysing the following graph in Table 9 with data from the last years.

Table 9 - Comparison of the number of flights and reports submitted per year
Source: (Author,2022)



Although the number of reports was higher in the year 2021 than by the date of 01/06/2022, the proposed rate for 2022 was higher, as the number of flights was considerably lower. Considering that in the year 2020, the rate was 2.1, in 2021, it dropped to 0.6, and in the current year to date, it ascended to 0.8, there was an improvement this year. It should be noted that in 2020 more procedures were implemented to report and perform investigations, justifying that the rate was higher than in other years.

Accordingly, with the information analysed, SPI number 3 – " Reports made by the CAMO" was created to continue measuring the development of the reporting culture in the company. A target rate of 1.2 has been proposed, which would be higher than last year's rate. In addition, a limit of 25% below and 25% above the stipulated rate was also established. These limits have been stipulated as it may sometimes be the case that reports are submitted only to achieve the respective goal; therefore, their content does not put flight safety at risk.

After monitoring the first year's results, this target and limits will be reviewed and adjusted according to the needs that will be verified.

4.3.1.4. SPI proposed nº4

According to M.A.201 (e) (3) of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), “In the case of aircraft used by air carriers licensed in accordance with Regulation (EC) No 1008/2008 the operator shall be responsible for the continuing airworthiness of the aircraft it operates and shall: take the necessary steps to ensure its approval

in accordance with Annex II (Part-145) or conclude a written contract in accordance with point CAMO.A.315(c) of Annex Vc (Part-CAMO)" (sic) (EASA, 2021, p.35).

Therefore, as the company holds an air operator certificate (AOC), it is responsible for the airworthiness management of the aircraft and, consequently, must celebrate a contract with a Part-145 to perform maintenance.

According to Appendix IV to AMC1 CAMO.A.315 (c) 2.20 of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), "the release to service has to be performed by the maintenance organisation in accordance with its maintenance organisation procedures. The contract should, however, specify which support forms have to be used (aircraft technical log, maintenance organisation's release format, etc.) and the documentation that the maintenance organisation should provide to the CAMO upon delivery of the aircraft" (sic) (EASA, 2021, p.1048).

As stated above, the maintenance organisation must send specific documentation to the CAMO after the release to service.

According to AMC1 CAMO.A.305 (a)(4); (a)(5) (b) (1) (ii) of Easy Access Rules for Continuing Airworthiness (Regulation (EU) No 1321/2014), "any contracted maintenance is monitored for compliance with the contract or work order" (sic) (EASA, 2021, p.987).

As a result, CAMO compliance is required during the annual audit plan to monitor and control contract/work order compliance by contracted maintenance organisations.

Briefly, PHS Aviation, as CAMO, is responsible for verifying the aircraft maintenance processes received from the maintenance organisation with which it has signed a contract to perform maintenance on the aircraft. All received maintenance processes must be complete with all required documentation duly completed and signed as stipulated in the signed contract.

PHS Aviation has recently verified failures in these maintenance work processes received, namely in the failure of some documents and the inability to close the verification of the maintenance process as soon as possible.

Therefore, it is in the interest of PHS Aviation to monitor how the maintenance work processes of contracted MROs are received and to consider the results obtained from this monitoring in the audits carried out annually to these organisations.

In Table 10, we can verify for the last year the rate that translates the number of maintenance work processes received initially incomplete per the number of maintenance work processes performed for each MRO contracted by PHS Aviation.

Table 10 - Rate of maintenance work processes received initially incomplete per the number of maintenance work processes performed for each contracted MRO
Source: (Author,2022)

Contracted MROs[19] (Last year)	Number of maintenance work processes received initially incomplete per number of maintenance work processes carried out
X	0,125
Y	0,237
Z	0,333

The company's objective is to achieve a rate less than or equal to 0.1 per year, i.e. for every ten maintenance work processes received, the objective is to have only one or zero initially incomplete maintenance work processes received. However, as shown in Table 10, in the last year, all contracted MROs exceeded the rate of 0.1.

Therefore, SPI number 4 - "Maintenance work processes (Contracted MROs)" was created to achieve that target of 0.1.

[19] No identification of the contracted MRO is made for confidentiality reasons.

5. Conclusions and Future Work

5.1. Conclusions

Implementing SMS in a company is one of the most effective ways to control risks and consequently increase operational safety in aviation organisations by promoting a more proactive approach to managing the risks.

Since the SMS principles were only introduced to "Part-CAMO" in June 2020 through the new Annex Vc, PHS Aviation's SMS related to airworthiness activities is relatively recent. Therefore, the organisation aims to improve its adaptation and consequent efficiency.

Accordingly, this dissertation was motivated to improve the efficiency of the SMS process in EASA Part-CAMO of PHS Aviation through the creation of SPIs for monitoring four hazards selected by the organisation. The company's selection of these four hazards was made through the PHS Aviation risk assessment ("RA 01/2022"), already performed by the company during the transition from Subpart G of Annex I (Part-M) to Annex Vc (Part-CAMO) to Commission Regulation (EU) 1321/2014.

The four hazards were selected by the company having as a criterion of choice the level of impact they have on the safety of its continuing airworthiness management activities, and they are the following:

I. Incorrect use of CAMO procedures ("RA 01/2022- Hazard nº 7");
II. Unawareness of changes made to the organisation with an impact on safety before their implementation ("RA 01/2022- Hazard nº 15");
III. Change in the CAMO reporting procedure ("RA 01/2022- Hazard nº 14");
IV. Incomplete maintenance work processes ("RA 01/2022- Hazard nº 9").

After identifying the hazards, an SPI was created for each hazard to monitor the effectiveness of the mitigation measures proposed in the PHS Aviation risk assessment (presented in Table 6) and to provide information to the organisation about the status of its operational safety. The indicators for monitoring the identified hazards that were established were as follows:

- Missing training (related to "RA 01/2022- Hazard nº 7");
- MoC Communications (related to "RA 01/2022- Hazard nº 15");
- Reports made by the CAMO (related to "RA 01/2022- Hazard nº 14");
- Maintenance work processes (Contracted MROs) (related to "RA 01/2022- Hazard nº 9").

All these SPIs will monitor certain events, and depending on the indicator, values will be collected every quarter or annually, which should then be compared against the established metric. The validation of this process consisting of SPIs will be decided at the next company's Safety Review Board.

5.2. Future Work

The SMS process in the company must constantly evolve to minimize potential damage and improve the continuous monitoring of aspects that negatively affect the safety of its continuing airworthiness management activities. According to what was proposed in this work, PHS Aviation is advised to perform for future work:

- Evaluate the effectiveness of the mitigation actions proposed for each hazard identified;
- Evaluate the results obtained in the proposed new SPIs, if they are approved, to define if the targets were well defined;
- Verify the effectiveness of training regarding hazard reporting to ensure that all employees know how to report and, if necessary, reinforce it.

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Annexes

Annex A. PHS Aviation Safety Reporting System forms

A.1. Hazard Report Form

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HAZARD REPORT FORM Reference # Assigned by Safety Manager
DESCRIPTION OF THE HAZARD: **LOCATION (IF APPROPRIATE):** **POTENTIAL CONSEQUENCES: (Check your assessment of the consequences to the company)** Injury ☐ Damage ☐ Cost ☐ **SEVERITY OF THE POTENTIAL CONSEQUENCES:** _____ (See Table 1 of Annex I. Assign a Letter A-E) E=Negligible D=Minor C=Major B=Hazardous A=Catastrophic **PROBABILITY OF THE POTENCIAL CONSEQUENCES:** _____ (See Table 2 of Annex I. Assign a Number 1-5) 1=Extremely Improbable 2=Improbable 3=Remote 4=Occasional 5=Frequent
CAUSE OF HAZARD IF KNOWN: WHY DO YOU THINK THIS HAZARD EXISTS?
Forward to Safety Manager or Appropriate Safety Representative: Log the Document
Safety Manager/Safety Representative forward to Responsible Party for evaluation:
HAZARD OWNER: RESPONSIBLE PARTY(S): Fill out Side 2.

Side 1

Model nº PHS SMSM_01

IQ.020/1

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RISK ASSESSMENT: Use the approved company risk assessment process.

POTENTIAL CONSEQUENCES: (Check you assessment of the consequences to the company)

Injury ☐

Damage ☐

Cost ☐

SEVERITY OF THE POTENTIAL CONSEQUENCES: _____ (See Table 1 of Annex I. Assign a Letter A-E)

E=Negligible D=Minor C=Major B=Hazardous A=Catastrophic

PROBABILITY OF THE POTENCIAL CONSEQUENCES: _____ (See Table 2 of Annex I. Assign a Number 1-5)

1=Extremely Improbable 2=Improbable 3=Remote 4=Occasional 5=Frequent

SAFETY RISK INDEX: Severity x Probability = _____ (See Table 3 of Annex I)

OTHER EVENTS: List other actual incidents or events associated with this hazard if known.

RISK TOLERABILITY STATEMENT: _____ (See Table 4 of Annex I)
(If risk is acceptable, state so.)

☐ I accept this level of risk.

☐ I intend to initiate the corrective actions above.

Proposed Date for Corrections: _____

RECOMMENDED RISK CONTROLS OR ACTIONS TAKEN:

☐ I recommend this hazard be reviewed by the Safety Action committee.

☐ I will take the following actions. (Attach separate sheet if necessary.)

Responsible Party Signature: _____ **Position:** _____

Forward to Safety Manager for review or recommend Safety Committee action/review.

Safety Manager Review & Comments:

Signature: _____ **Date:** ___ / ___ / _____

Distribution: Originator, Responsible Party, Safety Action committee, SMS File

Side 2

Model nº PHS SMSM_01

ANNEX I

Table 1: Severity of the potential consequences.

Severity	Description	Value
Catastrophic	- Equipment destroyed. - Multiple deaths.	A
Hazardous	- A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely. - Serious injury. - Major equipment damage.	B
Major	- A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency. - Serious incident. - Injury to persons.	C
Minor	- Nuisance. - Operating limitations. - Use of emergency procedures. - Minor incident.	D
Negligible	- Few consequences.	E

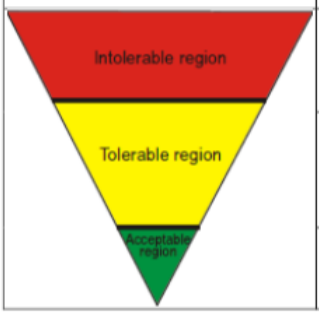
Table 2: Probability of the potential consequences.

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

Table 3: Safety Risk Assessment Matrix.

SEVERITY → / PROBABILITY ↓	Catastrophic (A)	Hazardous (B)	Major (C)	Minor (D)	Negligible (E)
Frequent (5)	5A	5B	5C	5D	5E
Occasional (4)	4A	4B	4C	4D	4E
Remote (3)	3A	3B	3C	3D	3E
Improbable (2)	2A	2B	2C	2D	2E
Extremely improbable (1)	1A	1B	1C	1D	1E

Table 4: Safety Risk Tolerability Matrix.

Tolerability description	Assessed risk index	Suggested criteria
	5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under existing circumstances. Management action required.
	5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 3B, 2C, 1A	Acceptable based on cost benefit or risk mitigation. It might require management decision.
	3E, 2D, 2E, 1B, 1C, 1D, 1E	Acceptable.

A.2. Voluntary Occurrence Report

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VOLUNTARY OCCURRENCE REPORT

This report is related to:
☐ A safety occurrence
☐ A safety incident /accident

Occurrence Data:
Date:
Time:
Location:
Description:

Aircraft Data (if applicable):
Type / Model:
Serial Number:
Registration:
Route:
Crew (if applicable):

Submitter details (Please provide your details if you require feedback from PHS Aviation. (If you prefer to report anonymously, do not fill in this field):
Name:
Phone:
Email:
Address:
Position in the company:

IQ.336/0

Submission details:
Date:
Time:

Attachments (if applicable) (to attach to the report):
Document identification:

Send to Safety Department

To be filled by Safety Department:
Report Reference:
Receiver Name:
Position in the company:
Date:
Is analysis of the incident report required?? ☐ YES ☐ NO *If **YES**, procede to the Analysis of the Occurrence Report – IQ.337.*
Signature:

A.3. Mandatory Occurrence Report

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REPORTE MANDATÓRIO DE OCORRÊNCIA
MANDATORY OCCURRENCE REPORT

(Regulation (EU) 2015/1018 of 29 June)

- Entidade Responsável / Responsible entity: _____
- Número do dossier / File number: _____
- Estatuto da ocorrência / Occurrence Status: _____

- Data UTC da ocorrência / UTC date of the occurrence: _____/ _____/ _____

- Estado/Zona de Ocorrência / State / Area of occurrence: _____
- Local da ocorrência / Location of occurrence: _____

- Classe da ocorrência / Occurrence Class: _____
- Categoria da ocorrência / Occurrence Category: _____

- Língua da narrativa / Narrative Language: _____
- Narrativa / Narrative:

_____
_____
_____
_____
_____

- Tipo de evento / Events: _____

- Classificação do risco/ Risk classification: _____

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REPORTE MANDATÓRIO DE OCORRÊNCIA
MANDATORY OCCURRENCE REPORT

(Regulation (EU) 2015/1018 of 29 June)

Identificação da aeronave / Aircraft Identification:

Estado de matrícula/State of registry: _____

Marca - Modelo - Série / Make – Model - Series: _____

Número de série da aeronave / Aircraft Serial Number: _____

Matrícula da aeronave / Aircraft Registration: _____

Indicativo /Call sign: _____

Operação da aeronave / Aircraft Operation:

Operador / Operator: _____

Tipo de operação / Type of operation : _____

Descrição da aeronave / Aircraft Description:

Categoria da aeronave / Aircraft Category: _____

Tipo de propulsão / Propulsion Type: _____

Grupo de massa / Mass Group: _____

Descrição da aeronave / Aircraft description:

Último ponto de partida / Last departure point: _____

Destino previsto / Planned Destination: _____

Fase do voo / Phase Flight: _____

Meteorologia / Weather:

- Condições meteorológicas / Weather relevant:

_____

_____

Reportado por / Reported by:

Nome / Name: _____

Cargo na organização / Position on the organization: _____

Data de reporte / Reporting date: _____ / _____ / _____