Long Operations' Risk Assessment of an Airline Company

(Versão revista após defesa)

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Resumo

Desde o nascimento da indústria aeronáutica, a aviação comercial tem sofrido um crescimento exponencial devido à elevada procura no transporte de passageiros e carga. Este desenvolvimento só se tornou possível devido a todas as melhorias nos níveis de segurança operacional praticados ao longo das décadas.

Neste contexto, considerando todas as vantagens que advém de um Sistema de Gestão de Segurança Operacional integrado e a irregularidade em termos operacionais do operador de linha aérea euroAtlantic Airways (EAA) desenvolve-se neste trabalho um estudo de viabilidade do atual modelo de análise de risco operacional da companhia para as suas operações prolongadas.

Esta dissertação consiste num estudo de implementação de uma matriz de análise de risco de segurança operacional de operações continuadas. Com este intuito todas as áreas operacionais desta companhia aérea são, numa fase inicial deste projeto, essenciais na identificação dos perigos e medidas de mitigação inerentes a cada um dos setores. Todos os perigos elencados, e seus consequentes riscos são posteriormente classificados quanto à probabilidade e severidade e agregados numa matriz de análise de risco.

Num estágio final, de forma a garantir a viabilidade da matriz, a mesma foi introduzida e avaliada através do sistema integrado de gestão do risco operacional da companhia. Três das maiores operações prolongadas da companhia nos últimos dois anos foram utilizadas como exemplos para analise da viabilidade quer da matriz, quer de futuras operações da companhia.

Por fim, são propostas melhorias ao sistema que se encontra atualmente implementado na companhia de forma a garantir uma melhor compreensão e analise do risco e mitigações associadas de futuras operações prolongadas da companhia.

Palavras-chave

Safety, Safety Management System, Long-term Operations, Aviation Legislation, Risk Management, ACMI operations, Human Factors, Operations Based in Outstations.

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Resumo Alargado

Introdução

Este resumo alargado pretende sintetizar o enquadramento desta dissertação e os objetivos pelos quais este trabalho surgiu. Serão também mencionados os pontos mais importantes do caso de estudo, as principais conclusões e perspetivas de investigação futuras.

Enquadramento da Dissertação

A aviação comercial é considerada um sistema complexo e dinâmico. O mesmo se verifica com a sua segurança operacional, onde novos perigos e riscos surgem constantemente e a sua necessidade de mitigá-los é inerente. Nenhum perigo ou risco pode ser eliminado, no entanto podem ser reduzidos para o mínimo possível dentro de um contexto aceitável.

Esta dissertação enquadra-se na oportunidade de analisar o método de avaliação e gestão do risco operacional dentro de um operador de linha aéreo – euroAtlantic Airways (EAA), e através do seu sistema integrado de gestão de segurança operacional, que consiste numa abordagem sistemática apoiada em quatro pilares: i) uma política de segurança operacional bem definida refletindo o comprometimento do operador em considerar a segurança operacional acima de qualquer outra causa; ii) promoção da segurança operacional transversal a toda a empresa, onde cada membro deverá ser um elemento chave na promoção da segurança operacional; iii) avaliação continua dos seus procedimentos e mecanismos internos implementados de forma a garantir a efetividade de cada um através da monitorização e controlo desses processos internos assim como o ambiente operacional com o intuito de detetar mudanças ou desvios que possam introduzir perigos ou degradar os procedimentos mitigadores existentes; iv) gestão do risco de segurança operacional, através da idealização e avaliação de processos bem definidos para a gestão de todos os riscos identificados inerentes à operação da companhia.

A EAA possui um sistema de gestão de segurança operacional, contudo ele somente se encontra direcionado para a operação aérea e pessoal navegante, e nem faz especial atenção a operações continuadas fora da própria base de operação regular.

Objeto e objetivo

Neste estudo, o objeto de avaliação serão os perigos e riscos associados à operação de aeronaves comerciais em operações prolongadas baseadas em estações que não a base regular do operador.

O objetivo da mesma é compreender se os métodos atuais do sistema de gestão do risco do operador são adequados para os tipos de operação que possui. Com este intuito, serão escrutinados todos os perigos e riscos identificados por cada setor operacional da companhia, assim como as suas estratégias de mitigação dos mesmos de forma a garantir a efetividade dos procedimentos atualmente estabelecidos.

Um método diferente do atual para a gestão do risco operacional será elaborado agregando todos os perigos e consequentes riscos e ações mitigadoras numa só matriz, com o objetivo de avaliar os riscos inerentes a cada operação prolongada e a todos os aeroportos operados durante a mesma. Essa matriz será então inserida no programa de gestão da segurança operacional da companhia– IQSMS, onde será testada através da realização de análises de risco a três das mais importantes operações nos anos civis de 2019 e 2020.

Principais Conclusões

A segurança operacional sempre teve bastante relevo no setor da aviação, fazendo jus a toda a sua importância na prevenção de acidentes e quaisquer outros eventos não desejados. No entanto, certos temas ainda carecem de mais regulamentação que seja aplicável a vários setores operacionais que têm influência direta na segurança operacional de qualquer operador aéreo.

Através do estudo elaborado concluiu-se que diversos setores requerem mais regulamentação inerente aos fatores humanos e ao próprio SMS, dado que atualmente esta temática é somente focada nas áreas relativas às operações de voo. Setores de operações de terra, desde a manutenção ao handling das aeronaves, não possuem diretivas para um SMS eficiente para a sua área de operação.

Na presente dissertação concluiu-se que o SMS implementado na EAA é passível de ser melhorado. É notória uma cultura de segurança operacional transversal à empresa, contudo a de gestão do risco é deficiente na medida que é verificado um volume bastante reduzido de análises de risco. Numa empresa onde a maioria das suas operações são realizadas fora da sua base, o aeroporto Humberto Delgado (LIS/LPPT), as condicionantes que afetam a análise de risco de qualquer perigo, assim como a eficácia das suas medidas mitigadoras só são verificados in-loco pelos próprios intervenientes.

Só quando ocorre algum evento indesejável e um reporte é realizado é que o pessoal gestor da companhia tem conhecimento. Com isto, uma cultura de reporte também se verifica essencial na prevenção e gestão do risco operacional visto que é considerada a principal fonte de informação do SMS.

Quanto ao sistema de gestão do risco operacional da empresa (IQSMS), com o trabalho realizado pode-se concluir que o Flight Risk Module, mais precisamente o Airport Evaluation, apresenta resultados incoerentes relativamente à quantificação dos próprios riscos, assim como do risco geral do próprio aeroporto operado. Outro inconveniente deste módulo é que quantifica o risco inerente a qualquer perigo numericamente, ao invés de o quantificar quanto à severidade e probabilidade, conforme a matriz e diretivas da EASA e ICAO.

De forma a realizar análises de risco de aeroportos assim como de operações, num ponto de vista de eficiência de custos, a EAA poderia recorrer a um modelo construído internamente. Qualquer modelo que seja implementado deverá quantificar o risco de acordo com as instruções das autoridades reguladoras.

Perspetivas de Investigação Futuras

Verificando os mais variados tipos de operação que a empresa pratica, a EAA deveria realizar uma análise de risco de segurança operacional aprofundada ao início de cada operação. Este procedimento poderia identificar vários perigos cuja mitigação seria logo realizada aquando da assinatura do contrato. Alguns procedimentos deveriam também ser implementados para revisão da mesma análise de risco ao longo da operação de modo a garantir a efetividade das medidas mitigadores e que nenhum perigo não seja identificado. Os novos perigos identificados deveriam ser introduzidos na matriz de forma que se mantivesse atualizada.

Uma norma organizacional deveria ser criada com o intuito de definir procedimentos para analise de risco de operações prolongadas, assim como responsabilidades ao longo das operações. Essa norma deveria também estabelecer medidas de debriefing no fim de cada operação, com intervenção de todos os participantes na operação. Através desta medida, seria mais fácil tomar perceção do que poderia ser melhorado no futuro, não só para evitar erros e perigos recorrentes, mas também estabelecer níveis de melhoria continuada que se enquadrassem com os objetivos da empresa.

Numa perspetiva de continuar com o Flight Risk Module, consideramos que a EAA deveria considerar implementar uma matriz de analise de risco melhorada quer no

Airport Evaluation, quer no Flight Risk de forma a abranger mais perigos para além dos listados. Quanto à avaliação do risco operacional dos aeroportos poderia usar-se a matriz criada ao longo desta dissertação. Já quanto à avaliação do risco em voo, os dados extraídos do FDM relativos a eventos analisados poderiam ser incluídos, assim como reportes realizados para melhorar a matriz.

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Abstract

Since the beginning of aviation industry, commercial aviation is being facing an exponential growth due to the huge demand in passenger and cargo transport. This overdevelopment was only possible thanks to the continuous improvements of safety levels all over the decades.

In this context, considering all advantages of an integrated Safety Management System along with the irregularity, in operational terms, of the airline operator euroAtlantic Airways (EAA) in this work is developed a study of feasibility of the current model for assessing operational risks of this company for its long-term operations.

This dissertation consists in an implementation study of a long-term operations' safety risk assessment matrix. With this purpose, all operational areas of this airline company are essential in the first phase of this project for identification of each sector's hazards and respective mitigation measures. All listed hazards and consequent risks are then classified into likelihood and severity and encompassed in a risk assessment matrix.

In a final stage, the matrix is uploaded in company's integrated Safety Management System in order to guarantee its feasibility. Three of the most demanding long-term operations of the last two years were then used as examples to analyse matrix's viability for future operations' assessment.

Finally, improvements for the company current risk assessment system are proposed in order to guarantee a better comprehension and analysis of future long-term operations risks and associated mitigations.

Keywords

Safety, Safety Management System, Long-term Operations, Aviation Legislation, Risk Management, ACMI operations, Human Factors, Operations Based in Outstations.

Folha em Branco

Contents

Folha em Branco

List of Figures

Folha em Branco

List of Tables

Folha em Branco

Acronyms List

AAL	Above Airport Level
ABV/DNAA	Nnamdi Azikiwe Abuja International
ACMI	Aircraft, Crew, Maintenance and Insurance
ACN	Aircraft Classification Number
AD	Aerodromes
AMC	Acceptable Means of Compliance
AMO	Approved Maintenance Organization
AMS/EHAM	Amsterdam Schiphol Airport
ANAC	Autoridade Nacional de Aviação Civil
ANSP	Air Navigation Services Provider
AOC	Air Operator Certification
AOG	Aircraft on Ground
APU	Auxiliary Power Unit
ARMS	Aviation Risk Management Solutions
ARO	Authority Requirements for Air Operators
ASQS	Advanced Safety and Quality Solutions
ATC	Air Traffic Control
ATS	Air Traffic Services
BOS/KBOS	Boston Logan International Airport
CASA	Civil Aviation Safety Authority
CAT	Commercial Air Transport Operations
CC	Cabin Crew
CDG/LFPG	Charles de Gaulle International Airport
COO	Chief Operating Officer
CPH/EKCH	Copenhagen Kastrup Airport
CRM	Crew Resource Management
DA	Decision Altitude
DCM	Direção de Compliance Monitoring
DG	Dangerous Code
DH	Decision Height
DME	Direção, Manutenção e Engenharia
DOT	Departamento de Operações de Terra
DOV	Departamento de Operações de Voo
EAA	euroAtlantic Airways
EASA	European Aviation Safety Agency
EFB	Electronic Flight Bag
EGPWS	Enhanced Ground Proximity Warning System
ENR	Enroute
ERC	Event Risk Classification
ETOPS	Extended Range Operations with Two-Engine Aeroplanes
EWR/KEWR	Newark Liberty International Airport
FAA	Federal Aviation Administration
FAOC	Foreign Air Operator Certificate
FC	Flight Crew

FCO/LIRF	Rome Fiumicino Leornardo da Vinci Airport
FDM	Flight Data Monitoring
FDP	Flight Duty Period
FOD	Foreign Object Debris
FTL	Flight Time Limitations
GEN	General
GNSS	Global Navigation Satellite System
HR	Human Resource
IAP	Instrument Approach Procedures
IATA	International Air Transportation Association
ICAO	International Civil Aviation Organization
IDE	Instruments, Data, Equipment
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IOSA	IATA Operational Safety Audit
IQSMS	Integrated Quality and Safety Management System
JFK/KJFK	John F Kennedy International Airport
KAN/DNKN	Mallam Aminu Kano International Airport
KEF/BIKF	Reykjavík–Keflavík Airport
LOC	Localizer
LOG	Logistics Department
LOS/DNMM	Lagos Murtala Muhammed International Airport
LVO	Low Visibility Operations
MLR	Manual, Logs and Records
MOP	Departamento de Manutenção Operacional
MRW	Maximum Ramp Weight
MTOW	Maximum Take-off Weight
NCC	Non-commercial Operations with Complex-Motor-Powered Aircraft
NCO	Non-commercial with other than Complex-Motor-Powered Aircraft
NOTAM	Notice To Airmen
NPA	Non-Precision Approach
OBO	On Behalf Of
OCC	Operational Control Center
OP	Operating Procedures
ORO	Organization Requirements for Air Operators
OSL/ENGM	Oslo Gardermoen Airport
PA	Precision Approach
PBN	Performance Based Navigation
PCN	Pavement Classification Number
PHC/DNPO	Port Harcourt International Airport
POL	Aircraft Performance and Operating Limitations
QOW/DNIM	Sam Mbakwe International Cargo Airport
RFFS	Rescue and Fire Fighting Services
RFL	Reference Field Length
RM	Risk Management
RVR	Runway Visual Range
RVSM	Reduced Vertical Separation Minima
RWY	Runaway
SAF	Safety Department

SARP's	Standards and Recommended Practises
SEC	Security Department
SHELL	Software, Hardware, Environment, Liveware
SIRA	Safety Issues Risk Assessment
SMM	Safety Management Manual
SMS	Safety Management System
SOP	Standard Operating Procedures
SPA	Operations Requiring Specific Approvals
SPI	Safety Performance Indicator
SPO	Specialized Operations
SPT	Safety Performance Targets
SRM	Safety Risk Management
SSP	State Safety Programme
TCAS	Traffic and Collision Avoidance Systems
TWY	Taxiway
UN	United Nations
USA	United States of America
VFR	Visual Flight Rules
VISA	Visitors International Stay Admission
VOR	Omnidirectional Radio Range
YOL/DNYO	Yola Airport
YYZ/CYYZ	Toronto Lester B Pearson International Airport

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Chapter 1 – Introduction

1.1 Motivation

During its early years, commercial aviation was a loosely regulated activity characterized by underdeveloped technology; lack of a proper infrastructure; limited oversight; an insufficient understanding of the hazards underlying aviation operations; and production demands incommensurate with the means and resources actually available to meet such demands (Distefano & Leonardi, 2014).

However, during the last decades, to meet those requirements, there was a development of technology and appropriate infrastructure, implementation of new regulations and a continuous training of all industry's operators, which were crucial to the improvement of aviation industry and its safety.

In order to maintain the safest record, aviation needs a deep symbiosis between a safety culture and all other departments. An active safety culture is considered to be the heart of and vital to the continuing success of this industry. It has been described as "the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (CAE Oxford Aviation Academy (UK), 2014: 10).

Safety culture is defined as the enduring value and prioritization of worker and public safety by each member of each group in every level of an organization (Campbell & Bagshaw, 2002). Personal responsibility for safety must be committed by individuals and groups in order to enhance and communicate safety concerns, strive for an active learning and adapt/modify behaviours based on lessons learned from mistakes. A good example, leadership and commitment must be performed by every individual concerning a promotion of a good safety culture.

Due to an increasing demand for civil aviation since the Second World War, as it is proved in the graphic on the next page (Figure 1), there was the need to carry out preventive and corrective regulations aiming to ensure operation's safety. With this purpose there were created different entities responsible for the preparation of those standards.

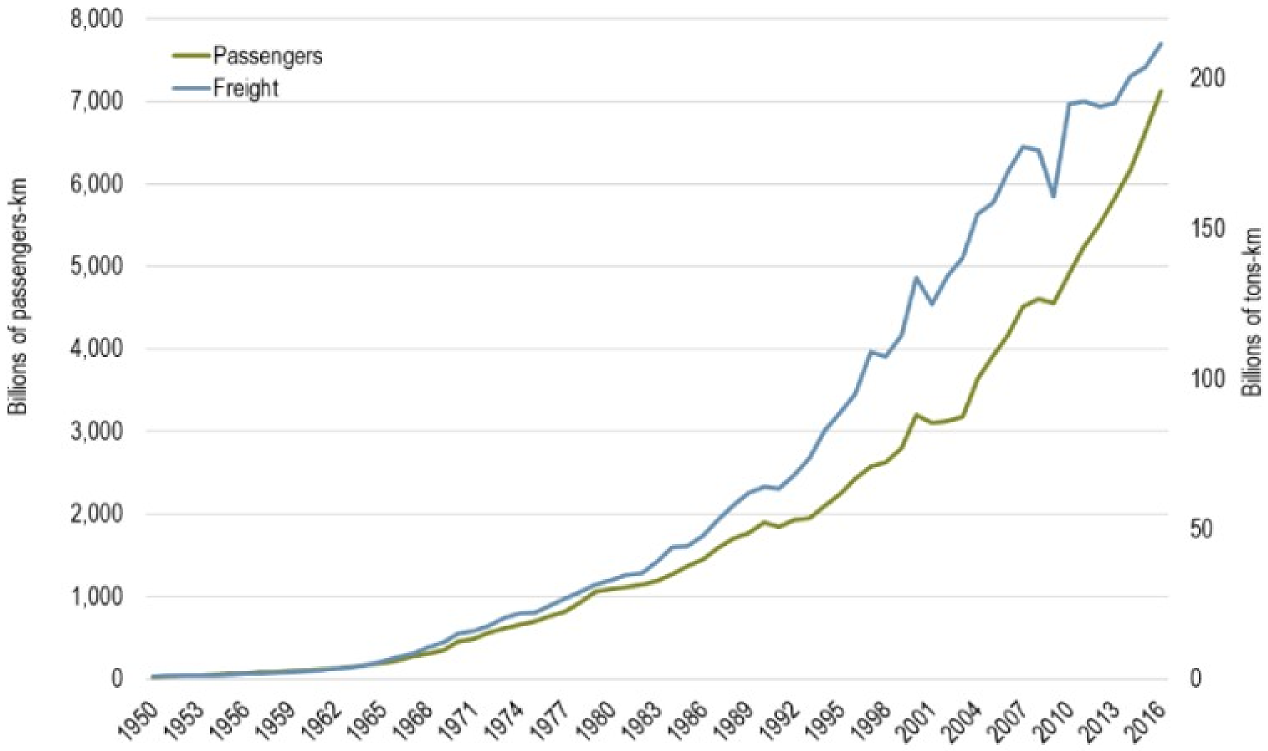

Figure 1 - World Air travel and World Air Freight Carried, 1950-2016 (Rodrigue et al., 2017).

Herewith there are distinct agencies and organizations responsible for regulation, implementation of safety procedures and its supervision.

The *International Civil Aviation Organization* (ICAO) is a specialized agency of United Nations (UN), eestablished in 1944 during the Convention on International Civil Aviation, also known as Chicago Convention, with the purpose of coordinating and regulating international air travel. This organization aims to develop general operational guidelines and procedures for its member states through *Standards and Recommended Practises* (SARP's), (ICAO, 1944). These documents are branched into nineteen annexes divided by distinct fields, complemented by manuals.

In the European Union, the agency responsible for regulatory and executive tasks of civil aviation is the *European Aviation Safety Agency* (EASA), aiming to ensure the highest common level of safety and environmental protection. Some EASA's tasks are (i) drafting implementing rules in all pertinent fields; (ii) certify and approve products and organizations, in fields where EASA has exclusive competence (e.g. airworthiness); (iii) provide oversight and support to member states in fields where EASA has shared competence (e.g. Air Operations and Air Traffic Management), (European Aviation Safety Agency (EASA), 2017).

Lastly, for the national region, *Autoridade Nacional de Aviação Civil* (ANAC) has the responsibility to regulate all civil aviation activities on behalf of the Portuguese State, including the legislation of the guidelines provided by ICAO (ANAC, 2015).

An airline operator's organization was also founded, named *International Air Transportation Association* (IATA), which is an agency who recommends the accomplishment of the standards for its members in view of promoting a safety operation. *IATA Operational Safety Audit* (IOSA) is an internationally recognized and accepted assessment system designed to evaluate the operational management and control systems of an airline.

In terms of Safety legislation, ICAO composed a manual, the Safety Management Manual (SMM), which is intended to provide the States with guidance on the development and implementation of a *State Safety Programme* (SSP), in accordance with the International *Standards and Recommended Practices* (SARPs) contained in:

- Annex 1 — Personnel Licensing;
- Annex 6 — Operation of Aircraft;
- Annex 8 — Airworthiness of Aircraft;
- Annex 11 — Air Traffic Services;
- Annex 13 — Aircraft Accident and Incident Investigation;
- Annex 14 — Aerodromes, Volume I — Aerodrome Design and Operations;
- Annex 19 — Safety Management.

It should be noted that SSP provisions are incorporated into the Annex 19. This manual also provides guidance material for the eestablishment of *Safety Management System* (SMS) requirements by States, as well as for SMS development and implementation by affected product and service providers (Stolzer et al., 2010).

A SMS is defined as a systematic approach to manage safety, including the necessary organizational structures, accountabilities, policies and procedures. Its objective is to provide a structured management approach to control safety risks in operations. Effective safety management must consider the organization's specific structures and processes related to safety operations. This regulation encompasses all approved training organizations that are exposed to operational safety risks during the provision of their services, aircraft operators, approved maintenance organizations, air traffic service providers and certified aerodromes. Every aviation service provider shall have a SMS which addresses four high-level safety objectives (Stolzer et al., 2010):

i) identifies safety hazards;

ii) ensures the implementation of the remedial action necessary to maintain agreed safety performance;

iii) provides for continuous monitoring and regular assessment of safety performance;

iv) aims at a continuous improvement of the overall performance of the safety management system.

Today's global aviation system demands a constant around-the-clock operational structure. While sophisticated technology is utilized in aircraft, airport infrastructures, air traffic control, maintenance, and other parts of the system, the human operator remains central to all those activities. Human physiological capabilities and limitations are therefore critical factors in maintaining safety and productivity in the air transport industry (Rosekind et al., 2000). Pilots, cabin crew, maintenance personnel and ATC staff must strive for safety in an endless conjunction.

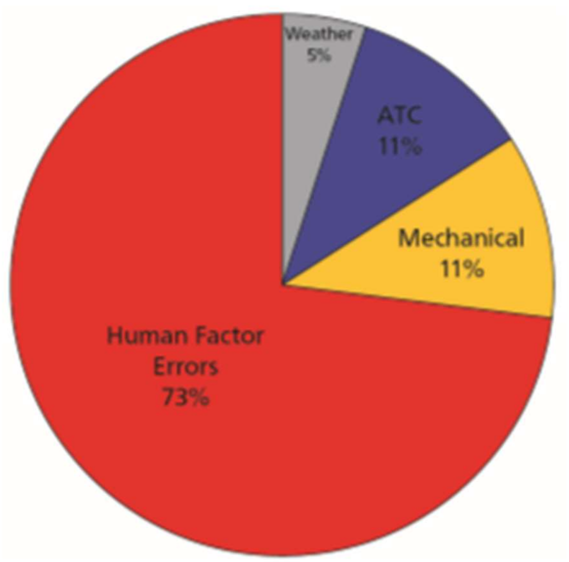

Figure 2 - Causes of Accident (CAE Oxford Aviation Academy, 2014).

As it can be analysed by the previous image (Figure 2), approximately 73% of all accidents are caused by Human factors. Historically this graphic has not changed since the 1950's (Campbell & Bagshaw, 2002).

However, the aviation industry provides one of the safest modes of transportation in the world, a safety critical culture must actively manage hazards with the potential to impact safety. The importance of Safety arises from this need. Hazards along with their related risks, that can jeopardize organization's safety and at a major level, the organization itself, shall be assessed and analysed. After this analysis, all risks that could cause any safety impact must be mitigated in order to guarantee a comfortable level of safety assurance. This concept of safety assurance was born right on the beginning of the aviation history (Canale & Distefano, 2014). Due to this perception of safety assurance, risk management started to be one of the key points to control and guarantee safety standards. National Air Forces were the pioneers of risk management and assessment concepts (Camm et al., 2009). United States of America Air Force, during the Cold War, started to introduce the analysis and definition of mitigation procedures for each operational risk. Nowadays each organization has its methods to assess and mitigate the operational risks that could turn to hazards (Camm et al., 2009).

Operations' quantitative risk assessment is especially challenging in domains where undesired events are infrequent, and the original causes are arduous to quantify and non-linearly related (Hadjimichael, 2009). In case of the flight safety itself, the risk of accident during approach and landing is the major concern to the commercial aviation community (Flight Safety Foundation, 2003). However, as previously stated, these are not the only concerns regarding to operations' safety.

Planning and managing a new operation with any client involves a huge effort from each operationally related department, not only to assure that everything will be set up for its beginning, but also in order to secure that each service will be provided in accordance with company's and authorities' safety and compliance requirements, aiming to guarantee all the conditions for a safety compliant and, at the same time, profitable operation (Adler & Gellman, 2012). When the operation base is a station where the company has no equipments and facilities, its set up planning is even more challanging, due to the fact that each related department must ensure that all the required services and equipments will be set for the beginning of the operation. Depending on the operation's stations the company must decide if they contract any service providers, or use their own. Once any operation starts it must also be managed on a daily basis, not only in a financial view, but also on a risk management view.

Risk management for ACMI (Aircraft, crew, maintenance and insurance) or, as also known as wet-lease operators, whose business model is based on providing flexibility and expertise in order to focus on the customer needs and satisfaction by accomplishing tailor-made solutions for the client operational demands, is even more challenging. Those challenges arise due to need to start an operation, at anytime, anywhere. This type of business demands a huge effort in each department aiming to make sure every involved personnel will be trained, the service providers will be contracted and, if required audited, as well.

Taking the line maintenance as an example of a service that must be ready at the beginning of an operation, otherwise the operation cannot go further, there are several risks concerned. Firstly, the company shall strategically evaluate between contract another EASA Part-145 organization with capability for the aircraft(s) involved in the operation, or allocate an internal maintenance team in case the company is also an EASA Part-145 approved organization as well. This choice must take into account, not only operation's profitability, but also aircraft(s)' airworthiness in accordance with EASA Part-145 Acceptable Means of Compliance (AMC), (EASA, 2015). Afterwards, there are also different operational production-related concerns that must be taken into account once an operation is being prepared. Training to the involved personnel, audits to the facilities and equipments of the maintenance providers in all stations must be conducted to minimize any maintenance-related risk likelihood and severity, which could turn into delays or cancelled flights if the aircraft is AOG (Aircraft on Ground) due to any technical problem, causing profit losses to the lessor/company. All of those risks shall be diminished to guarantee operation's safety, client and passenger's satisfaction with the service, and, at the end of the day, company's profit.

With this, each service provider, such as fuel, catering, handling, line maintenance, must also be evaluated in order to ensure their safety compliance (EAA, 2019a).

An effective safety culture among the entire organization is also crucial for the operations, not only in the beginning, but also during the entire period. A highly reliable level of safety assurance in each operational sector during any operation must be guaranteed, by managing their risks, coming with mitigation procedures to each risk with the purpose of minimizing it. An active safety culture is vital for the risk management during these operations; however, this can only be achieved through a dynamic safety assurance.

Since long-term operations based in outstations are one of the major threats to commercial aviation safety, mainly to ACMI operators, an opportunity to assess and analyse and mitigate the operational risks of an airline company has arised in cooperation with euroAtlantic Airways (EAA) safety department, where a study regarding operations risk assessment must be performed in order to accomplish organization's requirements. This study accrues from company's need to develop operational risk assessment evaluation and review if the current risk assessment method complies with the inherent regulation.

1.2 Object and Objectives

The object of this dissertation is the operational sector of an airline company. In the meantime, the main objective of this master thesis is to assess and analyse each operational sector of an airline company regarding its operational hazards and respective risk management strategies aiming to mitigate the associated risks.

Taking into consideration this airline company (EAA), it nowadays separates the risk assessments for each department's related risks, however has a small number of samples to understand if this is the most suitable way to evaluate and manage the operational risks. With this, a deep analysis must be performed in order to understand if performing a separate risk assessment for each risk is more appropriate than performing a general risk assessment encompassing all risks.

These assessments of each risk and mitigation approaches will be performed in cooperation with each operational-related department's manager and safety representative, along with safety and compliance departments. These meetings with each department will be useful to gather their possible hazards, associated risks and mitigation proposals.

Afterwards, a risk's assessment model which therefore encompasses each department related risks' must be performed in order to find measures to mitigate those risks and approve the operation or deny it if those risks cannot be alleviated, as the existing risk assessment matrix only evaluates airports' related risks. This matrix shall assemble the highest number of risks of each sector, involving the human factors contribution to the operation's risk. Each hazard that may turn into an incident or accident, if the proper mitigations were not applied, has its own risk which therefore shall be assessed. Simultaneously, the value for each risk will be analysed and adjusted through the ICAO's safety risk assessment matrix.

Once the risk assessment model is performed, the risk level shall be assessed for two of the major long-term operations performed by this company during the last two years. In those risk assessments the risk mitigation procedures shall also be eestablished in order to guarantee not only the risk mitigations for those risks, but also more accurate results.

With this, there will be enough data to understand if the actual method, where a separate risk assessment is performed for each hazard related risks through a template in Microsoft Word is more suitable than performing a general risk assessment encompassing all airport operational risks through IQSMS platform and further operational concerns into a general operational risk assessment matrix.

An opportunity to accomplish a benchmarking with other national operators was raised due to an essential good relation between their safety departments. With this, a wider perspective regarding each operational risk and respective mitigation strategies must be ensured by sharing the outcomes and analysis between organizations. As a result of this safety promotion, a better safety assurance will be accomplished among the national operations.

Subsequently, an evaluation of the most appropriate method of long-term operations risk management shall be performed in order to guarantee the best level of safety assurance, by comparing the current risk assessments with the new ones to analyse which is the most suitable way to evaluate the risks of an operation.

1.3 Methodology

The achievement of the proposed objective requires a well-defined sequence of actions to be succeeded. Figure 3 evidences the methodological phases and subsequent structure of the dissertation.

Initially, airline companies' strategies to manage the risks must be understood in order to establish the difference between which standards airline companies apply under the current legislation from ANAC, EASA, ICAO and IATA. Hence, an incisive research must be done, through reliable information sources, not only in pursuance of measuring and evaluating company's risks and their consequences to aviation safety, but also by studying airline companies' and legislation's risk management strategies to oppose with the relevant risks that could turn into hazards.

Then, regarding to the risk assessment model for long operations, each department's considered risks must be understood to perform the most effective matrix for the risk evaluation by gathering all possible risks. Mitigation strategies for those risks shall also be established together with Safety, Compliance and the risk-related departments in order to brainstorm and come up the most suitable approaches to oppose with operational risks.

The safety risk likelihood and severity assessment process can be used to derive a safety risk index through ICAO's safety risk assessment matrix which will be used to determine each risk's harshness.

The IQSMS platform, which is an integral part of EAA's Safety Management System, can therefore be used to introduce those risks and limitations, along with the acceptable mitigations in order to quantify the risk severity and probability in percentage.

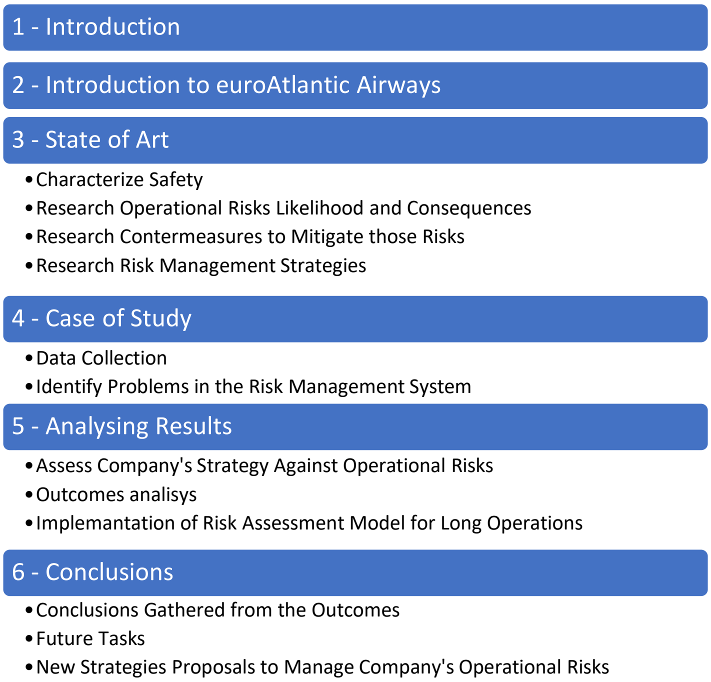

Figure 3 - Methodology Phases and Dissertation Structure (Own Elaboration).

1.4 Work limits

The main limitation of this dissertation is that risk probability and harshness cannot be numerically quantified. Instead, it shall be accessed and classified into ranges of likelihood and severity as will be explained afterwards.

IQSMS risk assessment model is limited to airport evaluation. However, the main objective of this dissertation is gathering all operational risks into a single support document for further operations' risk assessments. With this, several hazard categories that are not directly related to the operating airports are also extremely important to maintain operations' safety, such as employees' fatigue and route concerns, must be considered for this new model.

The final risk assessment matrix shall encompass each airports' related hazards as well as the en route and other operational safety related hazards in an operational hazard log.

1.5 Structure

With this, the dissertation will be divided into 6 chapters. Chapter 1 is the Introduction, with the Motivation, Object and Objectives, Methodology, and Dissertation Structure. Chapter 2 is a presentation of key aspects and features of EAA, where the research work is developed. Chapter 3 is the State of the Art concerning the main topics of the dissertation. In that Chapter the highest developed and modern Safety and Risk Management strategies will be approached, as well as the roots of Aviation Safety and the legislation inherent to each operational sector of an airline company. Chapter 4 is the presentation, explanation and development of the Case Study, where each risk and consequent mitigation procedures will be assessed. A Risk Assessment matrix encompassing all of those risks to analyse the exposure of an airline company to them during their long-term operations. Chapter 5 is the Results Analysis. Chapter 6 is the Conclusion, divided into Dissertation Synthesis, Concluding Remarks, and Prospects for Future Research.

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Chapter 2 - Introduction to euroAtlantic Airways

2.1 A Brief History

The development of this dissertation would not be feasible without an airline company as a case of study. EAA is a Portuguese International Airline specialized in several services such as Charter, ACMI, Dry Lease and Ad Hoc Flights worldwide. On August 25th, 1993, EAA's chairman and largest shareholder until 2019, Tomaz Metello, founded Air Zarco. The company's core business was operating as a Broker, between aircraft lessors and lessees, until 1997. In this same year, the company not only adopted the name of Air Madeira, but also acquired a Lockheed L-1011 Tristar and started operating with its own AOC. On May the 17th, 2000 the company adopted the current name, euroAtlantic Airways – Transportes Aéreos S.A. (EAA, 2019b). November the 15th, 2019 marks the date when EAA was acquired by I-Jet Aviation PT-SGPS, Lda. EAA's logo history can be seen in Figure 4.

Figure 4 - euroAtlantic Airways Logo History (EAA, 2020a).

euroAtlantic Airways fleet is currently composed by a Boeing 737-800NG, six Boeing 767-300ER and a Boeing 777-200ER. Two additional B787-800 Dreamliners are expected to phase in EAA's fleet by the end of 2021. Table 1 describes EAA's fleet information on aircraft, respective manufacturer serial numbers (MSN), powerplants and cabin configuration layouts.

Table 1 – euroAtlantic Airways Fleet Information (EAA, 2020b).

Aircraft	Registration	MSN	Powerplant	Cabin Configuration
B737-800	CS-TQU	30646	CFM56-7B	16C 144Y
B767-300ER	CS-TKS	30841	CF6-80C2B7F	16C 246Y
B767-300ER	CS-TKT	30853	CF6-80C2B7F	300Y
B767-300ER	CS-TKR	30854	CF6-80C2B7F	16C 246Y
B767-300ER	CS-TST	33047	PW4060-3	30Y
B767-300ER	CS-TSU	33048	PW4060-3	12C 239Y
B767-300ER	CS-TSV	33049	PW4060-3	34C 199Y
B777-200ER	CS-TFM	28513	RB211-Trent 884-17	24C 302Y

2.2 Operational Overview

EAA's operational base is Humberto Delgado Airport. Its current regular flights are operated from this airport. However, the non-regular flights are operated in the most diverse airports. Over the last years, our company has operated in five continents, and landed in seven hundred different airports around the globe (EAA, 2019b). Its routes cover the entire planet with an Air Transport License and FAOC (Foreign Air Operator Certificate) to operate in North, Central and South Americas, Caribbean, Africa, Middle East, Pacific, Australia and Oceania. With the call sign YU, EAA is an IATA member since 2010 as well as EASA (Air OPS19), FAA (FAR1298) and IOSA certified since 2009 (EAA, 2020c).

Besides most of EAA's revenue being originated by the aircraft chartering and operation, it also offers consulting services, due to expertise and knowledge involved within the airline industry proposing customized solutions to fit client's needs. The company is also approved to perform line maintenance in all its aircraft, as it holds an EASA Part 145 approval (ANAC, 2013).

2.3 EAA's Structure and Safety's Role within the Organization

euroAtlantic's dimension is reflected in the complex organizational structure it currently has, aiming to optimize the task between different departments. The organizational chart is shown in Figure 5.

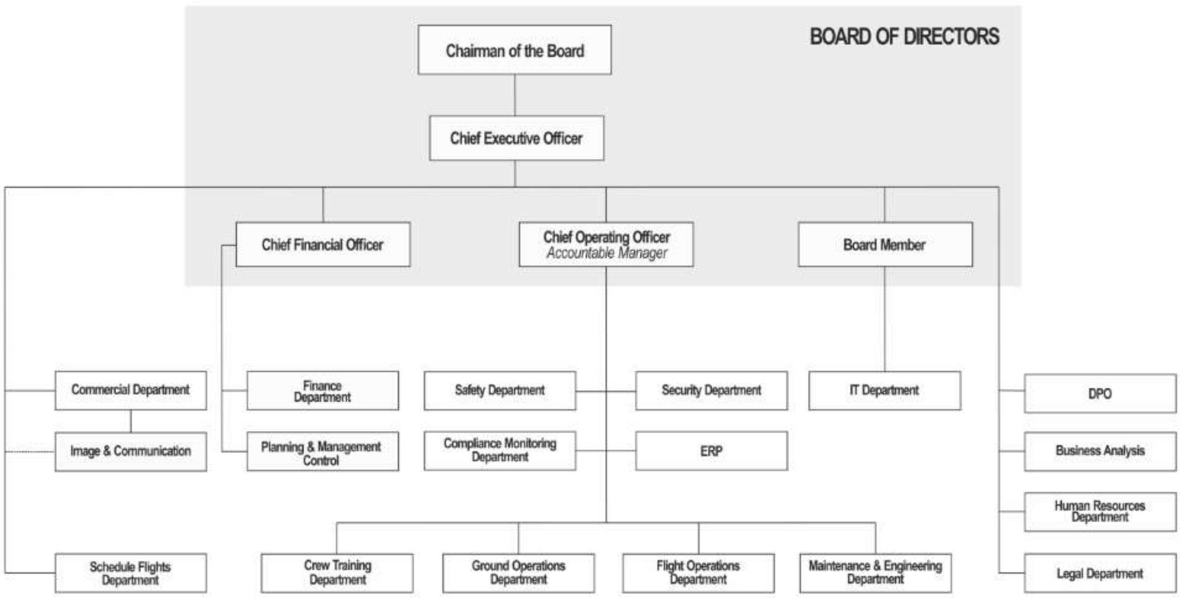

Figure 5 - euroAtlantic Airways General Organization Chart (EAA, 2020c).

Despite being represented as a single department, Safety is inherent to each operational department which makes it transversal to the entire organization. Figure 5 demonstrates that the Safety Department answers directly to the Chief Operating Officer (COO), who is also the Accountable Manager. As the position name implies, the Accountable Manager assumes a huge responsibility over the management of several different EAA departments in such way that “The accountable manager has the authority to ensure the allocation of resources necessary to manage safety risks” (EAA, 2020c).

With this, it can be noticed that safety implementation, promotion, assurance and monitoring in EAA is Safety’s department duty. It must ensure continuous conformity with all requirements and standards from regulatory entities, national authorities, as well as with its internal procedures. Regarding to EAA’s Safety standards they are represented in company’s Safety Management Manual (SMM). This Manual was developed in accordance with several key milestone safety improvement procedures which were responsible for safety progress and maturation within the airline industry. Some of those documents are Annex 19 of the Chicago Convention, guidance from ICAO Doc.9859, industry standards, European Regulations (EU) No 376/2014, (EU) No 996/2010, (EU) No 965/2012, Implementing Regulation (EU) 2015/2018, Portuguese DL318/99 and DL 218/2005 and applicable requirements from National Civil Aviation Authority (ANAC), (EAA, 2020c).

Figure 6 represents the safety department structure.

Figure 6 - euroAtlantic Airways Safety’s Department Chart (EAA, 2020c).

The Safety Manager is the person responsible for the oversight of the euroAtlantic’s safety performance. He is the focal point for the development, implementation and continuous administration and subsistence of the SMS on behalf of the Accountable Manager, while reports directly to him regarding all safety aspects (EAA, 2020c).

As aforementioned, it is conceived that Safety comprises all EAA's operational areas. With this, it was considered of higher importance to appoint a safety representative to each of them in order to create a desirable level of connection between the safety and the other departments. The main tasks of the department safety representatives are (EAA, 2020c):

- "when required, support the investigation procedures for all the occurrence reports related to their functional area, providing the safety department with all the necessary elements to the investigation process closure;
- promote the volunteer safety reporting among their department and team members, raise awareness to the importance of the volunteer safety reporting;
- cooperate with the Safety Department promotion activities;
- actively participate in the Safety Review Board and Safety Action Group;
- provide the Safety Department with all relevant information and recommendations to improve operational safety;
- relay urgent and routine safety-related information within their department;
- identify and analyse safety hazards within their department aiming at its' elimination or risk mitigation;
- collect and manage the data for safety performance indicators;
- collaborate in the edition of safety documentation".

2.3.1 Safety within Flight Operations Department (DOV)

euroAtlantic Airways establishes Safety as one of its core businesses in order to gain trust from their clients. Its commitment to develop, implement, maintain and continuously improve strategies and processes to ensure that all its aviation activities occur notwithstanding an appropriate allocation of resources, either financial or human, aiming to meet the highest level of safety performance and regulatory requirements, while delivering its services, is essential for organizational healthy. This responsibility belongs to each individual, from office workers, to ground operators or aircrews.

Safety's management and performance on airborne operations is crucial in order to deliver the services the safest way possible without jeopardizing company's revenue. With this, a well-defined structure within this department will play a great role on managing safety.

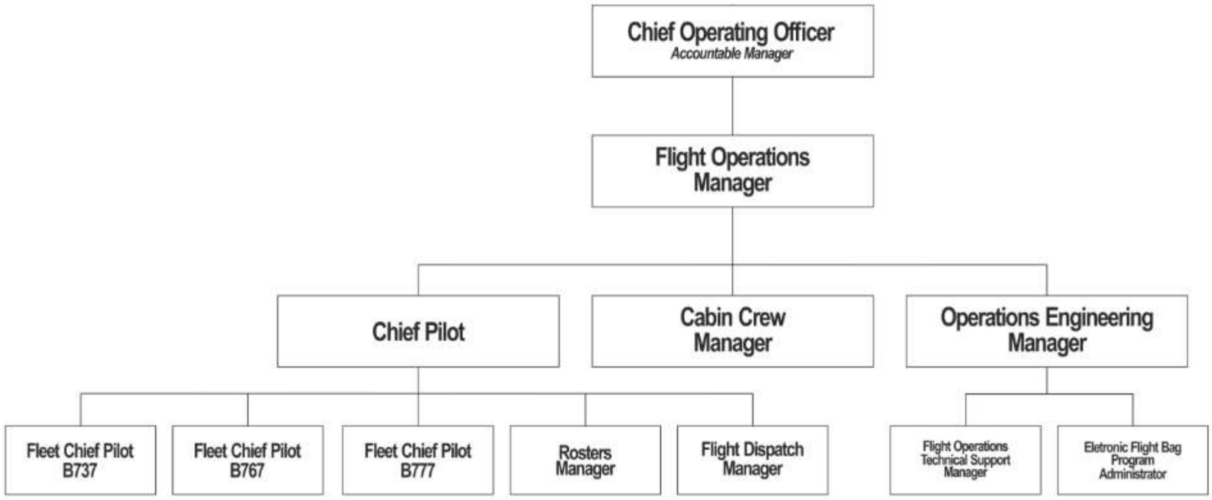

Figure 7 - euroAtlantic Airways DOV Chart (EAA, 2019b).

As it can be noticed in Figure 7, Safety department acts like a core area over Flight Operations Department (DOV), Ground Operations, Training and Continuous Airworthiness. The reason for this importance is due to the constant communication between safety and every sector of those departments, in order to actively enforce the management of safety as a primary responsibility of each manager and employee during their tasks, fostering safe practices, encouraging effective safety reporting and communication, and eestablishing and performing hazard identification and risk management processes (EAA, 2020c).

2.3.2 Safety within Maintenance and Engineering Direction (DME)

It's EAA responsibility to ensure that maintenance operations are conducted in accordance with the conditions and restrictions of the Air Operator Certificate (AOC) by managing safety risks in aircraft maintenance. The DME is responsible for certifying that all maintenance is performed in accordance with the manufacturer maintenance program. In the following Figure 8 Maintenance and Engineering Department structure can be noticed, along with its related Compliance Monitoring Department.

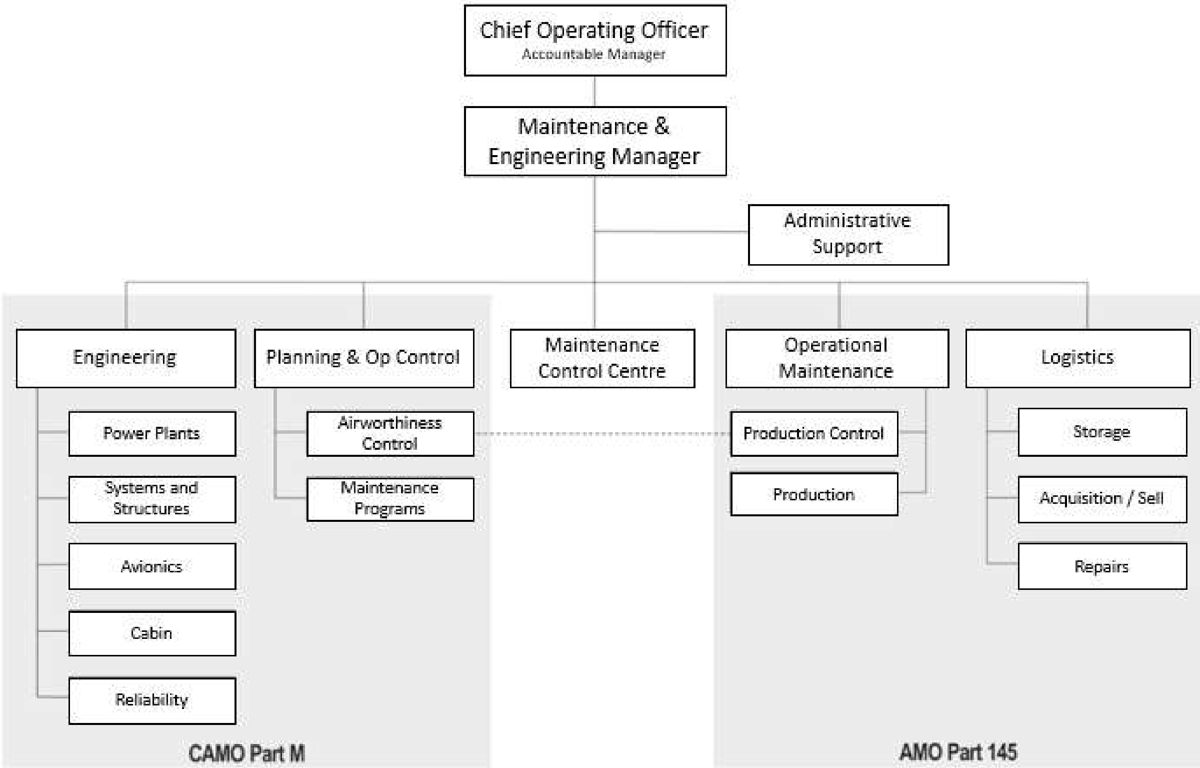

Figure 8 - euroAtlantic Airways DME Chart (EAA, 2019c).

Considering that this dissertation is focused on the operational sectors of EAA, DME's operational area is DME/MOP, EAA's Approved Maintenance Organization Part 145. Nevertheless, in order to ensure the implementation of a safety system and compliance with EASA's requirements, Part CAMO has already a new exposition under National Authority's approval. This new guide shall establish procedures to guarantee an efficient safety management system for all maintenance and engineering tasks.

2.3.2.1 Safety within EAA Part 145

In accordance with EuroAtlantic Safety and Quality's policy the Part 145 Maintenance organization establishes safety as a prime factor to be taken into account, undertaking to apply the principles of Human Factors, by encouraging employees to report maintenance errors, as well as occurrences and incidents. This policy refers that all personnel have a duty to comply with regulatory requirements and approved procedures, as well as standards of safety.

The EAA/DME's Part 145 Organization must actively contribute to maintaining the high levels of safety required by the aviation industry, in order to safeguard the conditions of safety of people and property, and to protect the environment.

The main objectives of the EAA/DME's Part 145 to keep high levels of safety within the Organization are (EAA, 2019c:37):

- “Develop management systems for continuous reassessment of DME's safety culture.
- Minimize the impact of DME activities on people and the environment.
- Apply aviation safety regulations systematically.
- Eestablish a system of strict control of possible breaches of safety procedures, by addressing all possible complaints and concerns.
- Benefit from our own experience and from others in the field of safety aviation.
- Develop a safety culture, so that it can be shared by all staff”

EAA’s ground operations, such as aircraft handling, catering and fuelling, are performed by external service providers, due to the large number of airports it operates. With this, an implementation of an effective Safety Management System arises from each service provider need to comply with international and national regulations. EAA Safety Department along with Quality and Compliance Department conduct audits in order to ensure those service providers comply with EAA internal procedures, as well as regulatory requirements.

The proposed assessment will only be accomplished as a result of the cooperation with the aforementioned airline company, more precising with its Safety department. Through the information provided along with the support and partnership with each operational sector previously mentioned, its relevance can be noticed. Taking into account the priorly referred values, the current risk management strategies of this organisation can be evaluated, which will be essential to perform the new risk assessment model.

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Chapter 3 – State of Art

3.1 Introduction

Safety was undoubtably essential for the commercial aviation growth over the last decades. An active safety culture was the goal to be achieved by the regulators and operators. Regulatory authorities have implemented innovative regulations pushing the development of technology and infrastructures. Those new requirements have not only improved staff's training, but also human factors, compliance and other safety concerned themes important for the eestablishment of an effective safety management system. Several measures and techniques for are deepen analysed in the following subchapters.

This Chapter is intended to review and synthetize relevant bibliography for this project from regulators, experts and operators. The definition of safety pertinent data to implement an adequate safety management system, along with its components that support its implementation is accomplished.

3.2 Safety

As previously described, UN's specialized agency for civil aviation is ICAO. Its aim is to standardize operational guidelines concerning a safe and organized growth of international civilian aviation. According to this entity, the concept of Safety is defined as:

- "The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management" (EAA, 2020c).

In a safety environment, it is acknowledged that the goal of being completely free of hazards and associated risks is impossible to be reached. Human-built systems and human activity cannot be assured to be entirely free from operational failures. Therefore, safety emerges intending to fulfil the gap between the continuous risk mitigation and the authorities demands expressed by norms and legislations.

Historically, safety can be subdivided into three different eras (Stolzer et al., 2010), which are represented and can be graphically analysed in Figure 9:

The technical era (1900 – 1960): Aviation arises as a mean of mass transport, in which identified safety defects were initially related to technical factors and technological failures.

Safety's main target was then the investigation and improvement of those technical factors. By the decade of 1950, World War II led to technological improvements gradually declining the accidents' frequency.

The human factors era (1970 – 1990): Due to considerable technological advances and simultaneous enhancements to safety regulations, the frequency of aviation's accidents was significantly reduced. As an acceptable safety level was reached, aviation became a safer form of transportation. Thus, safety's endeavours were extended to encompass human factor issues, such as the man/machine interface.

This evolution led to a safety awareness beyond what was achieved by the previous accident investigation procedures. Despite the investment of resources in human performance mitigation, it continued to be cited as a recurring factor of accidents. The application of human factors science tended to focus only on the individual, without fully considering the operational and organizational context. It was not until the early 1990s that it was first acknowledged that individuals operate in a complex environment, which includes multiple factors having the potential to affect behaviour and consequently performance.

The organizational era (1990 – Present day): Since the early 1990's safety began to be seen from an integral perspective, encompassing organizational factors in addition to technical and human factors. Subsequently, the notion of organizational accident was introduced, considering the impact of institutional culture and policies on the effectiveness of safety risk controls. Traditional methods of data analysis which were limited to the usage of data collected through accident and incident investigation have been supplemented with a new proactive approach to safety. This different approach consists on frequent data collection and analysis using not only reactive, but also proactive methodologies in order to monitor eestablished safety risks and detect emerging safety concerns.

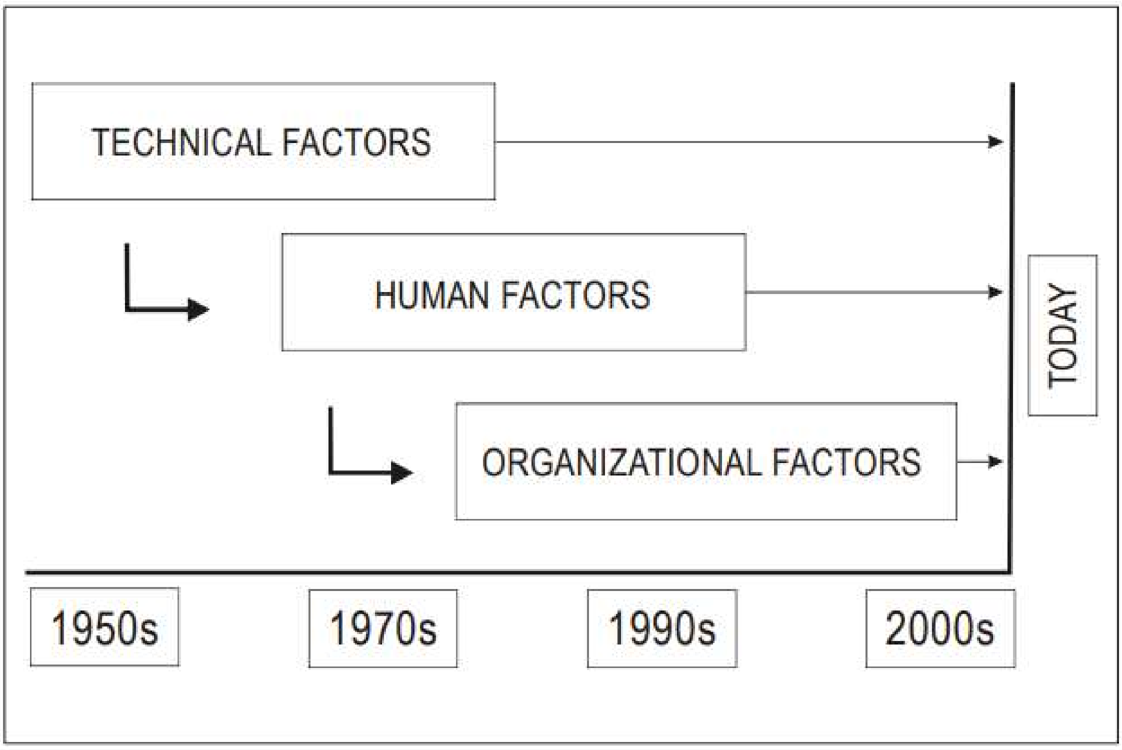

Figure 9 - Evolution of Safety's Notion (Stolzer et al., 2010).

Safety is a dynamic concept which is being evolving over the decades. Beginning with a reactive approach until late 1960s, that was changed to a proactive attitude until the present. However, a predictive mentality is the most desirable, represented in Figure 10, and could be reached by following the implementation of (Distefano & Leonardi, 2014), (Camm et al., 2009):

- An unconstrained and mandatory report system, both confidential;
- flight data (monitoring) analysis;
- Safety indicators;
- Audits;
- Forecasting;
- Updated databases;
- Manpower who could link all the parameters.

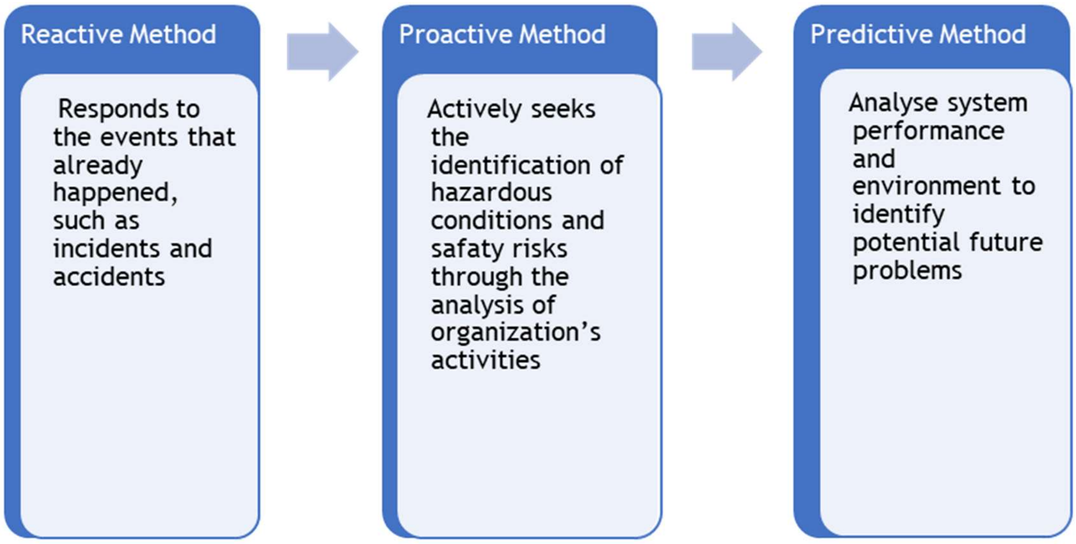

Figure 10 – Evolution of Safety's Methodologies (Adapted from: Alan J. Stolzer, Carl D. Halford, 2010).

3.3 Safety Culture

An effective safety culture is considered to be vital to the continuing sustainability and success of a proper safety management. It has been described as (CAE Oxford Aviation Academy, 2014):

- "The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management."

A strong safety culture relies on a high degree of trust and respect between personnel and management, actively pursues improvements, remains aware of hazards and appropriately uses tools and systems for constant monitoring, analysis and investigation. It must be present in each aviation organization. Other characteristics of a healthy safety culture include a shared commitment by personnel and management to personal safety responsibilities, confidence in the safety system, a documented set of rules and policies and a reporting culture. The last one is a key component for safety due to the mix of cultures within the aviation organizations and can negatively influence effective hazard reporting, shared root-cause analysis and acceptable risk mitigation. A continuous improvement in safety performance can be reached when safety becomes a common value among the entire organization, as well as the first concern in a professional context.

As has been stated in (CAE Oxford Aviation Academy, 2014) a safety culture possesses five elements:

- An informed culture;
- A reporting culture;
- A learning culture;
- A flexible culture; and, finally,
- A just culture.

An informed culture in an organization is acknowledged as a culture where those who manage and operate the system are aware of the human, organizational, technical and environmental factors (Reason, 2007). Management intends to foster a culture where people understand the hazards and risks inherent in their areas of operation (EAA, 2020c).

Meanwhile the reporting culture will be posteriorly analyzed, a learning culture is accomplished by the continuous teaching and practice of the mistakes committed during operation through lessons, workshops and certifications aiming to promote safety education in all company levels. For an organization, learning is seen as requirement as well as valued as a lifetime process. People are encouraged to develop and apply their own skills and knowledge to enhance organizational safety.

A flexible culture is the one who is responsible for increasing the susceptibility of change of both individuals and organizations, adapting effectively to changing demands (Air Safety Support International, 2020).

Lastly, a just culture implies the non-punishment of errors and unsafe acts if unintentional. This non-punitive culture encourages employees to have the confidence to report each safety concern.

3.4 Production vs. Protection

Safety management policy aims to identify hazards with the probability to negatively influence organizational safety. These processes also provide efficient mechanisms to implement procedures to extinguish those hazards or mitigate its associated risks. The intention of these processes is to assist the progress of achieving an acceptable safety's level while stabilizing the resources between production and protection (ICAO, 2018b).

In each organization whose commitment is delivery services, production and safety risks are linked. Safety Space is considered to be the concept which describes the balance between production and protection from a resource allocation perspective (ICAO, 2018b), being represented in Figure 11 and Figure 12.

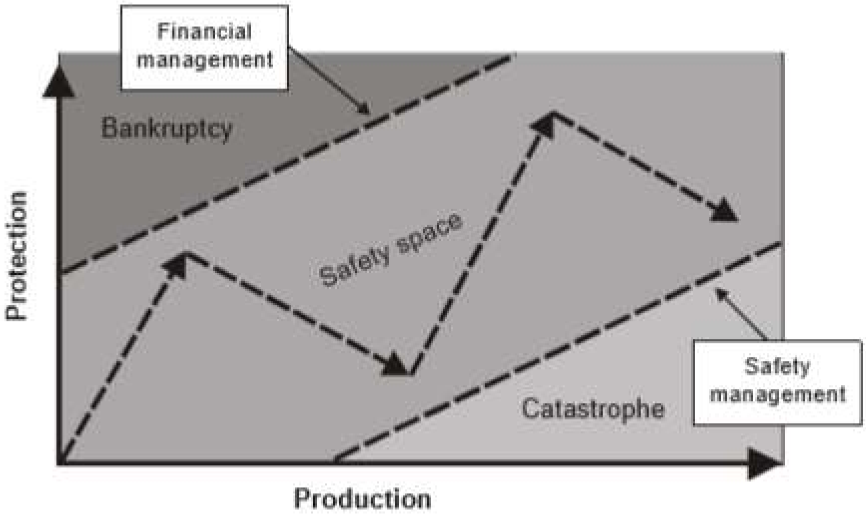

Figure 11 - The Safety Space (ICAO, 2006).

When there is an increment of production, an organization must redefine its existing safety procedures in order to avoid the simultaneous growth of the inherent operational risks (ICAO, 2006). An unbalanced resource allocation may eventually lead to:

- An impact on safety's performance, increasing the chance of hazards, when an organization privileges production, over its own protection and operations' safety. It is represented below Safety Management line in Figure 11, where a catastrophe can occur due to the prevalence of production;
- Unprofitability of the organization, when the allocation of resources is towards the protection side of the balance, thus leading to bankruptcy, as represented in Figure 11, above Financial Management line. Therefore, the safety space boundaries should be defined by the management of the organization and reviewed continually to ensure those accurately reflect the current situation.

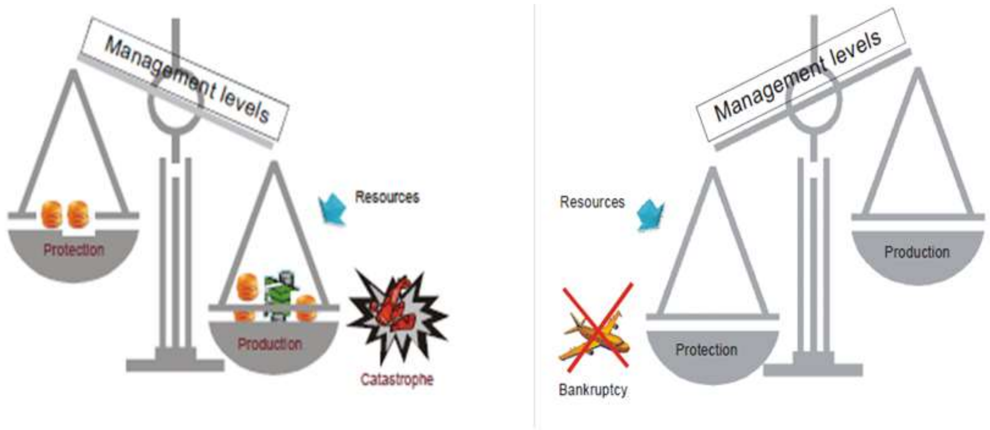

Figure 12 – Resources Allocation : Production vs. Protection (ICAO, 2018a).

Since aviation organizations have as a primary objective the delivery of services, the timely and efficient delivery of the services may occasionally come in conflict with operational safety considerations. For example, due to the need to meet a schedule, an airliner needs to land at a certain airport at a particular time, regardless of weather conditions, traffic volume, airport limitations and similar constraints which are absolutely related to the delivery of the service.

If the delivery service efficiency considerations were removed, in terms of meeting schedules, operational safety (adverse weather conditions, high traffic volume, airport limitations) would cease to be a factor. The operation would be conducted only when the constraints have disappeared. This is, however impractical, because it would destroy the viability of the aviation industry. Aviation operations must therefore be conducted under conditions that are dictated not so much by operational safety considerations but rather by service delivery considerations. (EUROCONTROL, 2015).

3.5 Organizational Accident

According to ICAO, human errors at an operational level act to breach the system's inherent safety defences, suggesting there is always a human contribution in the chain of events preceded by an accident.

When the systems that deal simultaneously with both human and technology fail, a tendency to assign the responsibility for the failure to the human being is immediate while there is no possibility to identify failure's origin. Human error is therefore considered as default if there were not found any mechanical failures. It is an inevitable choice that fits finely into an equation, where human error is the inverse of the amount of mechanical failure (Sidney

Dekker, 2004). However, this impulse can be deceitful, and conceal the true cause in most of the cases. Starting the investigation with the wrong step can lead to these circumstances.

Assuming that the absence of accidents and incidents does not assure the privation of errors. On the other side, the error awareness cannot be entirely related to the accidents on its own. Consequently, it is crucial to the organisation's safety the presence of a proper report mechanism and culture to collect and analyse human failures' data. Thus, it is possible to investigate de origin of the errors, which frequently encompasses a complex chain of events featuring organizational factors and system-human interaction fallibilities.

There are two types of accidents: Individual Accidents and Organizational Accidents. The main differences between these two types of accidents are represented in Table 2.

Table 2 – Individual vs. Organisational Accidents (Amparo et al., 2002).

Individual Accidents	**Organizational Accidents**
Common	Rare
Limited consequences	Generalized consequences
Limited causes	Diverse causes
Brief history	Long history
Lapses, errors or mistakes	Modern technology products
Multiple defences	None or a few defences

Organizational accidents' start for several reasons, compromising different hierarchical levels under the same company, and influencing its systems and subsystems (Reason, 2007). On the other side, individual accidents are considered as the accidents involving an individual or a group of people who are, not only the motive, but also the victims of the accident (Åhsberg, 1998).

Nevertheless, the main difference between organizational and individual accidents relies in the quality, quantity and variety of defences and barriers which protect people and organizational belongings from the local operational hazards. Meanwhile individual accidents take place when the hazards are close to people and defences are restricted or non-existent, organizational accidents occur in complex systems that have several defence barriers and preventive standards (Amparo et al., 2002).

3.6 James Reason's "Swiss-Cheese" Model

The human fallibility dilemma can be seen from two different perspectives: the person and the system approaches (Reason, 1997).

The first one focuses on personal unsafe actions, inaccuracy and procedural violations. These unreliable acts arise from negligence such as forgetfulness and discouragement, which implies carelessness. Preventive countermeasures therefore aim to reduce undesired human behaviours. These deterrent methods include the creation and inclusion of new procedures, training and corrective disciplinary changes (Reason, 1990a).

On the other side, the system approach rellies in a premise where the humans are prone to err. As a result, the failure is expected. Failure is considered a consequence rather than the motive, due to having their origins in systemic factors in place of the human nature obstinacy. Despite human behaviour cannot be changed, the countermeasures adopted were based on the assumption that the conditions under the human works can. The main goal of this approach is to define system defences. Thus, when an unfortunate event occurs, the main purpose is to analyse how and why the defences have failed, rather than to blame who made the mistake. It is considered a non-punitive approach (Reason, 1997).

On behalf of this second approach, in 1990 Professor James Reason developed the "Swiss-Cheese" Model, where defences, barriers and safeguards reside as essential in the system perspective (Reason, 1990a). Sophisticated and high-tech systems have several defensive stratums:

- Based on engineering – physical barriers, alerts, automatic shutdowns;
- Focused on the human being – operators, pilots, maintenance personnel;
- Relied on procedures and administrative management. Stratums' function is to shield possible victims and resources from different hazards. However, there are always weaknesses that can breach the multiple system defences (ICAO, 2006).

In an ideal context, all these barriers should remain intact. Despite persisting flawless, the layers have several holes suggesting a Swiss Cheese comparison. However, unlike the cheese, these holes are constantly opening, shutting and shifting their location. While the presence of holes in a "slice" is innocuous, the alignment of the breaches in many defensive layers enables an accident opportunity (Reason, 1990a). These breaches can be triggered by several empowering circumstances as equipment failures and operational mistakes (ICAO, 2018a). James Reason's Swiss Cheese Model is shown in Figure 13.

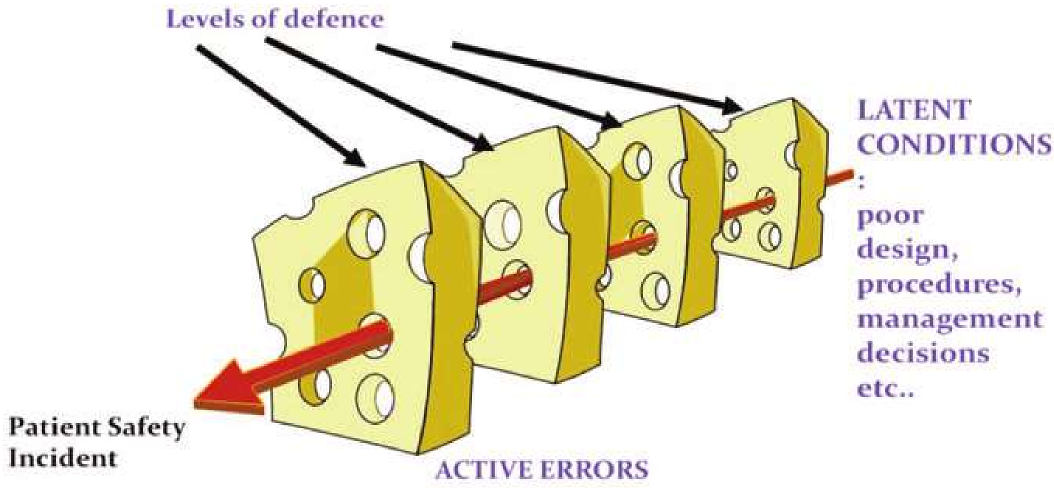

Figure 13 – James Reason's Swiss Cheese Model for Organisational Events (Reason, 1990b).

These failures, which are represented as cheese holes, arise from two main reasons: active failures and latent conditions (Reason, 1990a). The active failures are defined by people's negligent acts that are connected with the system. This type of failure has usually a brief impact on the defences. On the other hand, latent conditions are intrinsic anomalies on the system. They have two unfavourable effects:

- Are prone to increase on-job misbehaves, such as fatigue and inexperience;
- Can create permanent "holes" and fragilities on company's defences, as low reliability alarm triggers and first-stage project's deficiencies. These latent conditions are therefore inherent on the system as long as an incident expose them (Reason, 1990a).

In conclusion, active failures cannot be easily foreseen. However, latent conditions can be predicted and identified before an undesired episode occurs (Reason, 1997).

James Reason has identified another approach besides the "Swiss Cheese Model". In his book "Human Error", two types of human faults: variable and constant were identified.

Variable errors, representing target A in Figure 14, are random in nature, whereas the constant errors, shown in target B in Figure 14, follow some kind of consistent, systematic (yet erroneous) pattern.

The implication is that constant errors may be predicted and therefore controlled, while variable errors cannot be predicted and are much harder to deal with. If the nature of the task, the environment it is performed in, and the nature of the individual are known enough, there is a greater chance of predicting an error.

It is rare to have enough information that can permit accurate predictions. However, a pilot is more likely to make a mistake during night, after having been working for twelve hours, than during the morning with only two hours of duty period; or for an aircraft maintenance technician, reassembling tasks are more prone to incur in errors than dismantling tasks. Consequently, it is possible to refine these predictions with more accurate information, but there will always be random errors or elements which cannot be predicted.

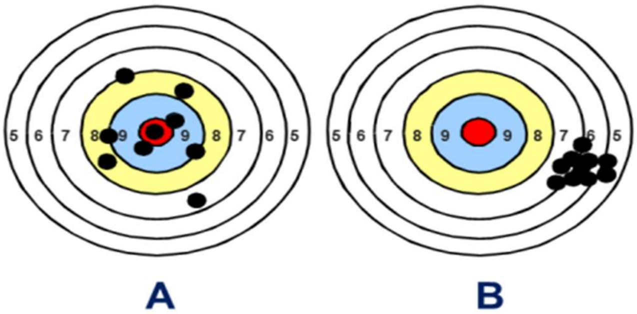

Figure 14 - Variable Errors vs. Constant Errors (Reason, 1990a).

3.7 SHELL Model

Being aviation generally considered a highly complex system, due to all intricate interactions between each system's element with hazardous odds, several models were created to provide guidance and support for safety assurance.

The SHELL Model is recognized for explaining the importance of human performance and interaction with the external elements, by considering human factors as an essential part of safety risk mitigation process.

Figure 15 illustrates the relationship between the human being (in the centre of the model) and the following four components:

- Software (S): Procedures, manuals;
- Hardware (H): Equipment, machines;
- Environment (E): System's working environment;
- Liveware (L): Pilots, maintenance personnel, cabin crew, etc.

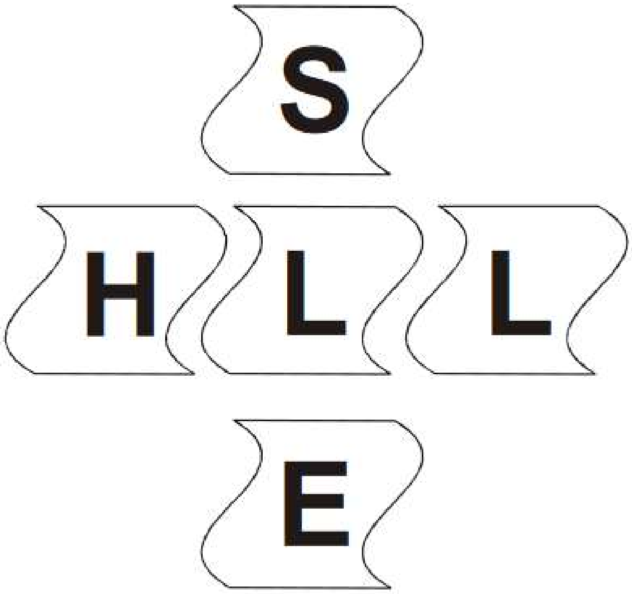

Figure 15 – The SHELL Model (ICAO, 2018a).

Higher importance, as previously stated, is given to the Liveware due to the simple fact of being the least regular component among the others. In the Figure 15, the shape of the designed boxes is irregular in order to represent the unperfect interface between the human being and the other elements of the system, even with each other.

This model's usefulness arises from the explanation of the interface between the various components of the system (ICAO, 2018a):

- L-H Interface: represents the relationship between humans and all the physical components, such as equipment, machines and facilities;
- L-S Interface: characterizes the relationship between humans and the supporting system, for example manuals, SOPs, machines' software, checklists and regulations;
- L-E Interface: represents the interface between the human being and its physical environment;
- L-L Interface: symbolizes all the human relationships among each other in the workplace, such as between pilots, cabin crew, air traffic controllers, maintenance personnel, etc. Due to the high importance of this interface, group dynamics, such as CRM have been adapted not only to flight crew, but also to air traffic services and maintenance operations to extend the management of operational errors among the entire aviation system.

According to SHELL model, each mismatch between the centre of the diagram and any other component can result in an occurrence led by human error.

3.8 Safety Management System

A safety management system is a systematic approach to manage safety. It shall clearly define lines of safety obligation and willingness to account for throughout a service provider organization, including a direct accountability for safety at a senior management level (EASA, 2020)

A company's SMS must have an organized, proactive and integrated methods to manage safety related issues. These procedures require strong organizational structures, accountabilities, policies and procedures and shall correspond to the nature and complexity of the enterprise, taking into account the hazards and associated risks of those activities (ICAO, 2018a)

A SMS is designed and implemented not only aiming to identify safety hazards during operations, but also do ensure remedial action is implemented to control, or if possible, prevent those safety risks, provide for on-going monitoring and assessment of safety performance and to keep making continual improvement to the level of safety during operations. All of those safety prevention objectives' must be defined by every airline company and included into an approved manual, in order to comply with several regulations, such as Annex 19 of the Chicago Convention, guidance from ICAO Doc.9859, industry standards, European Regulations EU No 376/2014; EU 996/2010; EU 1018/2015; EU No 965/2012, and in case of a Portuguese airline, Portuguese DL 318/99 and DL 218/05 and applicable requirements of Portuguese Civil Aviation Authority (ANAC, 2015).

Within each State, the safety performance of the SMS will be agreed between the State oversight authority and individual aviation organizations. Each agreed safety performance should be commensurate to the i) complexity of individual aviation organization specific operational context, and ii) availability of aviation organization resources to address them.

With this, an effective SMS shall allow each organization the easiness to accomplish the following two essential targets (Neubauer et al., 2015):

- Continuous improvement of safety performance by establishing root causes, preventive corrections and corrective actions after each hazard occurrence;
- Have a possibility to anticipate and manage the predictive risks before the system fails.

The avoidance of hazards in aviation is unbearable, which means that a 100% safe activity is impossible to obtain. Due to this unreachable status, the SMS role is to implement effective processes which will allow the mitigation and minimization of the risks. This will guide to a continuous improvement of an organization operational safety (Ludwig et al., 2007).

System's safety is the application of management and engineering philosophies, criteria and techniques to achieve an acceptable level of safety throughout all phases of a system.

Achieving this definition of system safety is the primary objective of SMS. A well-structured SMS provides a systematic, explicit and comprehensive process for managing risks. This process must include objectives and its definitions, planning and a continuous performance evaluation, aiming to guarantee that the targets and goals are being met.

This orientation of an effective SMS must carry out several key safety aspects, such as the ones stated below (Ludwig et al., 2007):

Management commitment to safety: As the entire staff can be significantly influenced by management attitudes and actions, it is therefore indispensable that these leaders commit to the success of an SMS implementation and a safety culture throughout all company's levels (EASA, 2014).

Proactive identification of hazards: Early identification and hazard reporting can save a significant amount of time and resources which can be translated into company's profit or loss.

Corrective actions taken to manage risks: The SMS must be in place to counteract known risks, by eliminating or mitigating the root cause(s), which will prevent a reoccurrence of an existing detected non-safety-compliant conditions or situations. A proper determination of the root cause is crucial for defining effective corrective actions to prevent the same mistakes (ASQS, 2020a).

Evaluation of safety actions: A continuous evaluation of the impact of risk management actions is crucial to determine if further counteractive activities are required.

An active SMS has several benefits apart of its ultimate goal: increased safety which will be translated into the lower number of accidents and injuries (Ludwig et al., 2007). Some of those benefits which are responsible for increasing the safety system level include:

- Reduction of direct and indirect costs of incidents;
- Augment productivity and employee happiness, by promoting communication between management and all organization layers, which will improve self-determination;

- Improve company's safety record, which can attract new investment and business opportunities;
- More efficient maintenance planning and scheduling, allowing effective resource utilization, increasing the likelihood that maintenance is performed on time without compromise the operation;
- Avoid incident investigation resources and costs, which could not only cause operational disruptions, but also cause a significant loss of profit and reputation to the company.

A SMS must allocate responsibilities to all company stages aiming to have a safe operation. With this, the number of employees involved in safety concerns is much higher, lowering the odds of uncommon occurrences happen without being noticed or reported. This will lead to less hazardous episodes. These increasement of defensive layers of an effective SMS represented is shown in Figure 16 where each slice represents an organization level (Ludwig et al., 2007).

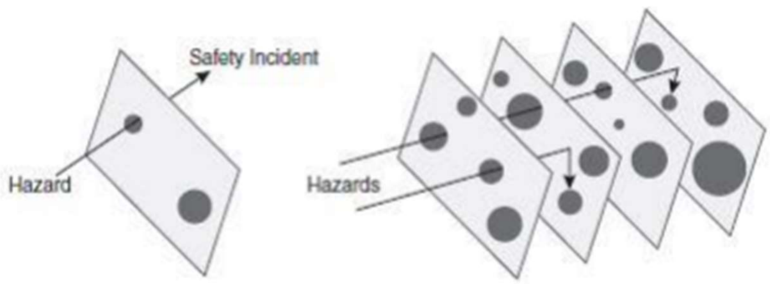

Figure 16 – SMS Layers (Ludwig et al., 2007:3).

Each slice has its wholes, which is an analogy to each organisation's layer latent failures. The risks can pass unnoticed through each layer for two reasons:

- The layer is not aware to deal with it;
- Human error.

An effective safety management measure to go along with this mitigation is to unify all the layers. With this, the likelihood of a risk trespass all the layers without being noticed and, consequently being evaluated and mitigated, is highly reduced.

SMS recognises that human and organisational errors cannot be entirely eradicated. Herewith the aim is mainly to minimize the chances of occurrence by developing an organizational culture focused on safety.

Each airline organization shall have its Safety Management procedures comprised in an exposition. In relation to EAA, there is a Safety Management Manual which is an internal reference document, submitted and approved by the ANAC, whose scope is to describe how safety is managed internally. SMM is considered the key instrument for communicating company's safety approach to all its personnel, to customers and all other parties to demonstrate the willingness and capability of the operator.

3.8.1 Safety Management System: Functional Components

A systematic SMS approach comprises four functional components which are key points for a healthy safety culture inside each organization. Those four elements are the following:

- Safety Policy;
- Safety Promotion;
- Safety Assurance;
- Safety Risk Management.

3.8.1.1 Safety Policy

Every aviation organisation has its safety policy, which is characterized as the means eestablished to maintain and, if practicable, improve safety levels in each activity. On a reverse side it aims to minimize organisation's contribution to the risk of an aircraft accident, by eestablishing and operating hazard identification and risk management processes (including a hazard report system) in order to remove or mitigate the safety risks and the consequence of hazards resulting from organization's operations or activities to a point as low as reasonably practicable.

Besides being endorsed by the Accountable Manager (EASA, 2020), the safety policy reflects the organisational commitment regarding safety and its proactive and systematic management. The commitment eestablished by the Senior Management to continually improve safety performance aims to define methods, processes and organisational structure needed to meet the required safety goals. Every safety policy must include the commitment to (EAA, 2020c):

- Improve towards the highest safety standards through SMS, by creating clear safety objectives and commitment to manage those objectives;

- Comply with all the current legislation, meeting all applicable standards, by developing fully documented policies and processes considering the best practices;
- Enforce safety as a primary responsibility of all the managers and employees; and finally;
- Support the management of safety through the provision of all appropriate resources, resulting in an organizational culture that fosters safe practices, encourages safety reporting and communication.

An efficient safety policy among a company facilitates cross-organizational communication and cooperation, which can improve company's business opportunities improving client's investment, which will increase its profit.

3.8.1.2 Safety Promotion

This key point is an essential process to promote a culture of safety, not only on the senior management layer, but also to all personnel. Each employer shall be aware in their day-to-day activities, they are key players in promoting safety, therefore contributing to an effective SMS.

Training and constant communication regarding safety concerns are essential processes to emphasise a reliable safety promotion which will increase a safety culture within all levels of the workforce.

3.8.1.3 Safety Assurance

Safety Assurance consists in an evaluation of the implemented processes and activities undertaken in order to determine whether the SMS is operating in accordance with the expectations and requirements, and the continued effectiveness of implemented risk control strategies. Safety department shall constantly monitor those internal processes, as well as the operating environment to detect changes or deviations which may introduce emerging safety risks or degradation of the existing mitigation procedures.

There are several approaches to evaluate those processes and activities, such as monitoring safety performance, safety audits, management of change.

Eestablishing safety performance for the SMS leaves unaffected the obligations of service providers and other related parties, and it does not relief the services providers and other related parties from compliance with Standard and Recommended Practices (SARPs) and/or national regulations, as applicable. The notion of safety performance is an essential ingredient of the effective operation of an SMS. It serves for developing a performance-based regulatory environment, in order to monitor the actual performance of an SMS.

The safety performance monitoring of services provided shall be expressed in practical terms through two measurements:

- Safety performance indicators;
- Safety performance targets.

Those two measures delivered through various tools and means are considered the safety requirements.

A safety performance indicator (SPI) is considered a data-based parameter used for monitoring and assessing safety performance. The assessment of safety performance could include benchmarking, reviewing or risk assessment to aid the identification of possible safety actions and their effectiveness (European Commission, 2013).

In relation to safety performance targets (SPT) are the planned or intended objective for safety performance indicators over a given period. Targets should be achievable, realistic and time-bounded, and aim at effectively steering sustainable performance.

Regarding safety audits, those are proactive management activities that provide means for identifying and validating potential hazards before causing any impact on safety. Its aim is to identify operational weaknesses, as well as areas of risk and devise rectification strategies (EAA, 2020c).

Management of change has also an important role for safety assurance. The purpose is to evaluate and manage all safety risks concerned with changes in the organisation. Implementation of processes is vital to identify internal or external changes that could have an adverse effect on safety. It uses the existing identified hazards, risk assessments and mitigation processes as advantages for managing the changes (ICAO, 2018a).

These methods enhance the guarantee of several essential safety-related issues accomplishment, such as recognition of new hazards, reporting awareness, ensure that product and service providers comply with SMS requirements. They also provide insight analysis regarding opportunities for improving safety and minimizing inherent risks. Creating an efficient safety assurance will cause a self-sustained service improvement due to continuous evaluation and monitoring.

3.8.1.4 Safety Risk Management (SRM)

This key functional component is the most important one for the ambit of this work. Its relation with the other components will also be analyzed. Obtain an infallible SMS is an impracticable task, thus risk identification and management of operational risks are crucial to assure operational safety (Caldwell et al., 2009).

First of all, it is extremely important to understand the differences between hazard and risk concepts in order to understand the notion of risk management (ICAO, 2018a). In accordance with ICAO and EASA, hazard has the following definition:

- **Hazard –** "Condition, object or activity with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function." (ICAO, 2018a), (EASA, 2020).

Taking into consideration the same two regulators, the definition of risk is:

- **Risk –** "The assessment, expressed in terms of predicted probability and severity, of the consequence(s) of a hazard taking as reference the worst foreseeable situation." (EASA, 2020; ICAO, 2018a).

With this, risk can be seen as a conjugation of hazard with two other factors: severity and probability (Canale & Distefano, 2014).

Safety risk management encompasses the assessment and mitigation of safety risks. The objective of safety risk management is to assess the risks related with identified hazards and develop and implement effective and appropriate mitigations. Safety risk management is therefore a key component of the safety management process at both the State and product/service provider level.

Safety risks are conceptually assessed as acceptable, tolerable or intolerable. Risks assessed as initially falling in the intolerable region are unacceptable under any circumstances. The probability and/or severity of the consequences of the hazards are of such a magnitude, and the damaging potential of the hazard poses such a threat to safety, that immediate mitigation action is required (EAA, 2020c).

The risks assessed in the tolerable region are acceptable provided that appropriate mitigation strategies are implemented by the organization. A safety risk initially assessed as intolerable may be mitigated and subsequently moved into the tolerable region provided that such risks remain controlled by appropriate mitigation strategies. In both cases, a supplementary cost-benefit analysis may be performed if deemed appropriate.

Safety risks assessed as initially falling in the acceptable region are acceptable as they currently stand and require no action to bring or keep the probability and/or severity of the consequences of hazards under organizational control.

In conclusion, SRM determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risks.

The entire SRM process is outlined in the following Figure 17.

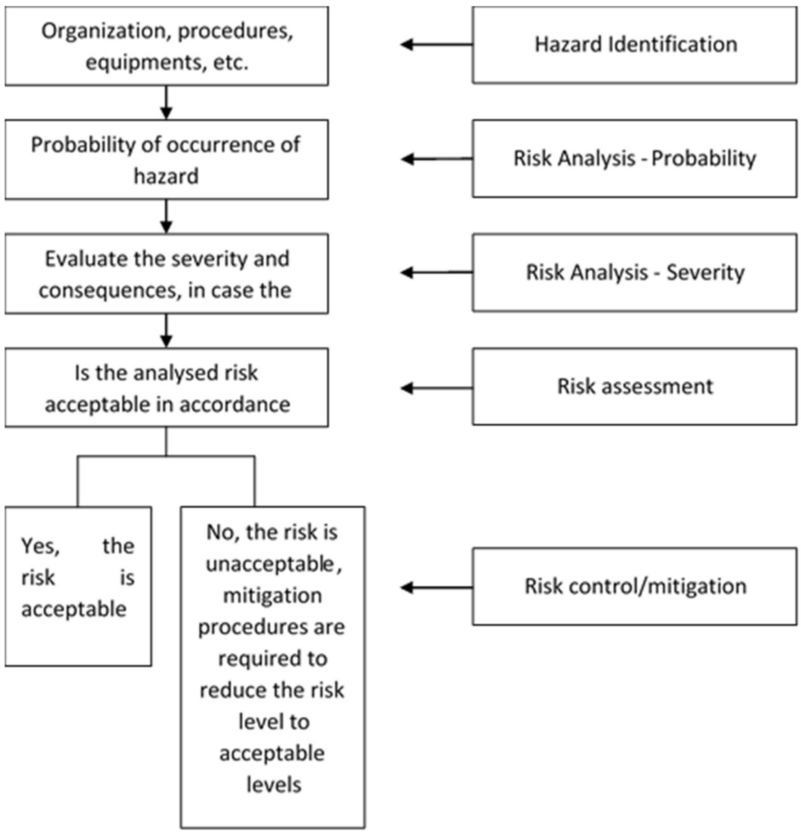

Figure 17 – Formal SRM Process (Adapted from: FAA, 2017a).

For those reasons stated above, SRM is considered the most important functional component for the purpose of this work. Nevertheless, for an efficient and systematic SMS, an interaction with the other functional components is mandatory (Neubauer et al., 2015).

3.8.1.5 Interface between SRM and Other Functional Components

As already stated, SRM will not be effective without the safety policy, safety assurance, and safety promotion components supporting SRM outputs. The relationships among the components of an SMS resemble a wheel, with SRM as the hub, as shown in Figure 18.

Figure 18 – The SRM Wheel (Neubauer et al., 2015).

As previously stated, the main purpose of an effective SMS is establishing safety objectives and goals. The definition of those goals belongs to the organization safety policy. The evaluation of mitigation actions' efficiency during a SRM process, once data and measures are available and can be tracked, is safety assurance's responsibility. Thus, the safety policy sets up metrics by which the success of SRM is determined.

In case of unsatisfactory metrics, SRM process actions may trigger a review of safety policy, by modifying organization's objectives and goals. Those new mitigation procedures defined during the SRM process will undergo a senior management approval process. New procedures and allocation of resources will result by this novel mitigation actions, which will help prove organization's support for SMS and their safety policies, as well as administration's commitment to improve company's safety. The commitments of resources for improvement, coupled with feedback from organization's management, are part of safety promotion inside the corporation (Neubauer et al., 2015).

Additionally, when performing the SRM and SA processes, some risk mitigation actions adopted will be part of the safety promotion component. For example, when a new SOP is developed, the SRM process is used to ensure the safe implementation of new procedures. Recommended mitigation actions may include developing a training program for operators or displaying posters to improve safety awareness. These actions, while performed because of effective SRM, are also safety promotion initiatives that enhance risk mitigation actions, which causes the SMS wheel to continue its movement around the SRM hub.

The SRM and safety assurance are considered the operational components of the SMS, being directly connected with each other. Figure 19 shows the connection between those two key components, where the data created by the SRM feeds safety assurance process and vice-versa (FAA, 2017b).

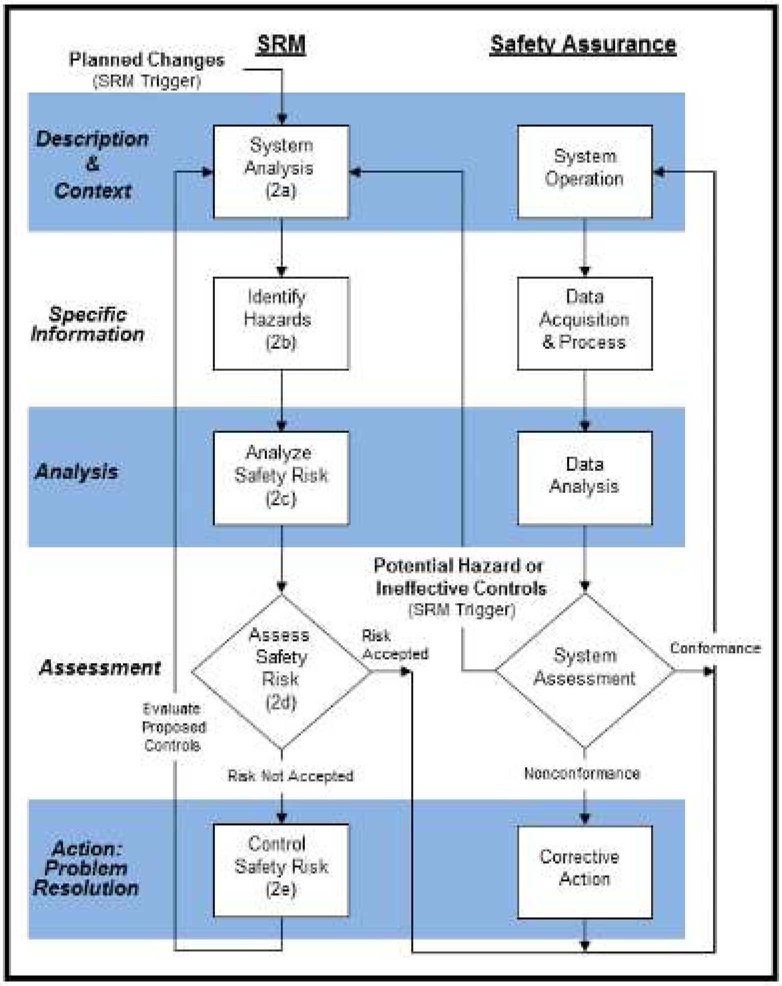

Figure 19 – Connection between SRM and Safety Assurance (Neubauer et al., 2015).

With this, its easily noticed that the SRM process aims to identify the hazards and evaluate those risks. The mitigation actions to control those hazards are therefore developed and implemented. Its safety assurance's duty to guarantee that those actions are being applied and meet organization goals (Stolzer et al., 2010).

3.9 Risk Management Methodologies

There are several distinct methodologies to assess and manage the risks. The first one to be approached is the Operational Risk Assessment in Aviation Organizations, developed by

Aviation Risk Management Solutions (ARMS). This methodology is composed by three main elements:

- Hazard identification;
- Evaluation of the hazards;
- Risk reduction.

Besides having three elements, it also has two different stages. The first one, named Event Risk Classification (ERC), consists in event evaluation and respective classification in urgency and risk level. On the other hand, the second stage comprises detailed analysis of the safety breaches aiming to list them in a database with possible mitigation actions. It is named Safety Issues Risk Assessment (SIRA), (ASQS, 2020a).

Taking in consideration the first stage – ERC, it is based on two crucial questions:

- Which would be the most probable consequences in case of an event turned to an accident?
- What would be the effectiveness of the remaining barriers between this event and the most probable accident outcome?

First question’s goal is to identify the result of the worst accident, once any incident occurs. Into another words, the objective of the first question is to find which accident is being prevented by trying to avoid the respective incident reports.

In relation to the second one, it aims to consider the remaining defensive barriers to estimate the probability of further escalation into the most credible accident outcome (from first question). The barrier, which stopped the escalation, will be counted in (because it was still in place) along with any others that are believed to still remain. The already failed barriers will be identified.

Figure 20 demonstrates, in a practical way, the proposed ERC application in a 4x4 matrix (ASQS, 2020a).

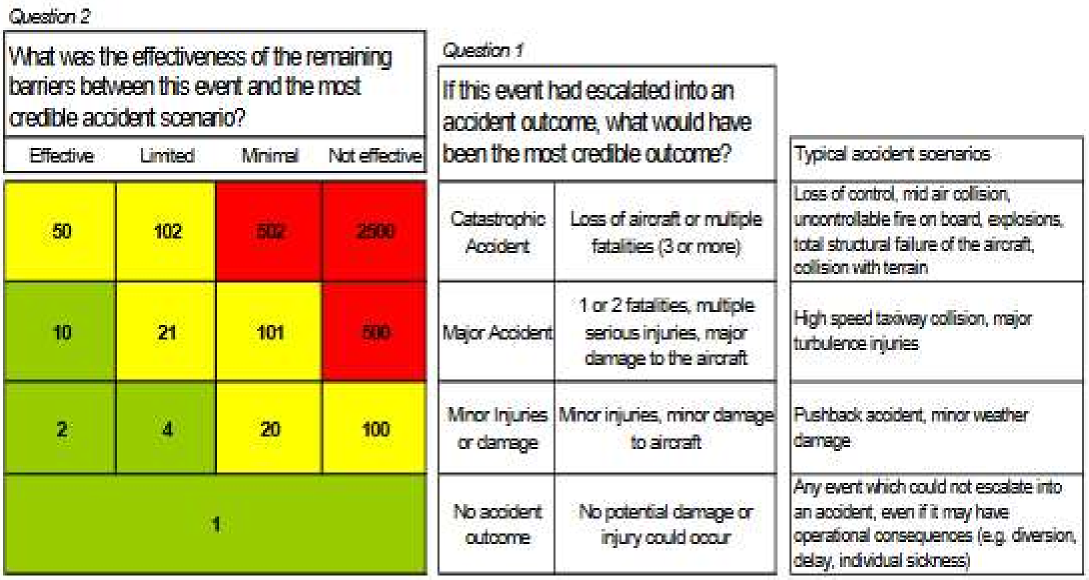

Figure 20 – ERC 4x4 Matrix Application (ARMS, 2010:19).

To interpret the previous Figure, the first question shall be asked: “If this event had escalated into an accident, what would have been the most credible accident outcome?”. First objective is to try to identify the accident consequence. If it is considered that there no accident outcomes, then the ERC value is 1, taking into consideration the listed “typical accident scenarios” to help. The most improbable, but credible scenario must also be considered and, consequently its result evaluated.

The second question: “What was the effectiveness of the remaining barriers between this event and the most credible accident outcome?” shall also be answered in order to understand the preceding Figure. This question intends to access the remaining margin considering the number and robustness of the outstanding barriers, because the ones that have failed are ignored, between the evaluated event and the accident scenario from question 1. Only the barrier that prevented the accident and the subsequent ones must be considered. The aim of the second question is to understand which column frame is applicable to the considered event.

Through the evaluation of the event by the ERC matrix, the corrective action must be generated taking in accordance the obtained result, as shown in Figure 21 (ARMS, 2010:21).

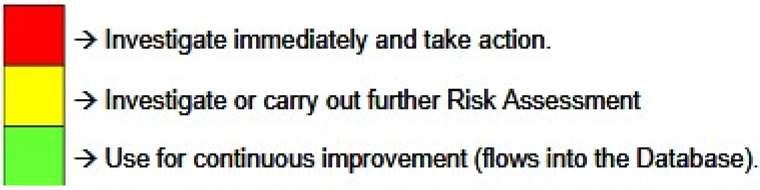

Figure 21 – ERC Results (ARMS, 2010:21).

The second stage of this methodology is, as already defined before, designated by SIRA. During this stage, the safety breaches shall be analyzed in detail, taking into consideration the risk level. A database with possible corrective actions shall be continuously updated aiming to assure that these breaches are identified.

The second risk management approach to be studied is the Risk Management (RM). It is based on the philosophy that it is irresponsible and wasteful to wait for an accident to happen, then figuring out how to prevent it from happening again. A risk is managed whenever the way something is done to make our chances of success as great as possible is modified, while making the chances of failure, injury or loss as small as possible. It's a commonsense approach to balancing the risks against the benefits to be gained in a situation and then choosing the most effective course of action. Risk management is the systematic application of management and engineering principles, criteria and tools to optimize all aspects of safety within the constraints of operational effectiveness, time, and cost throughout all mission phases. To apply the systematic risk management process, the composite of hardware, procedures, and people that accomplish the mission or produce mishaps, must be viewed as a system. Risk management must be a fully integrated part of planning and executing any operation, routinely applied by management, not a way of reacting when some unforeseen problem occurs (Canale & Distefano, 2014).

This methodology has six stages, not only described below, but also shown in Figure 22 (Distefano & Leonardi, 2014):

- Hazard identification;
- Risk assessment;
- Analyzation of liable risk's mitigation procedures;
- Implement decisions to control the event generated by the hazard;
- Implement decisions to control the risk consequences;
- Supervision and review of the implemented decisions.

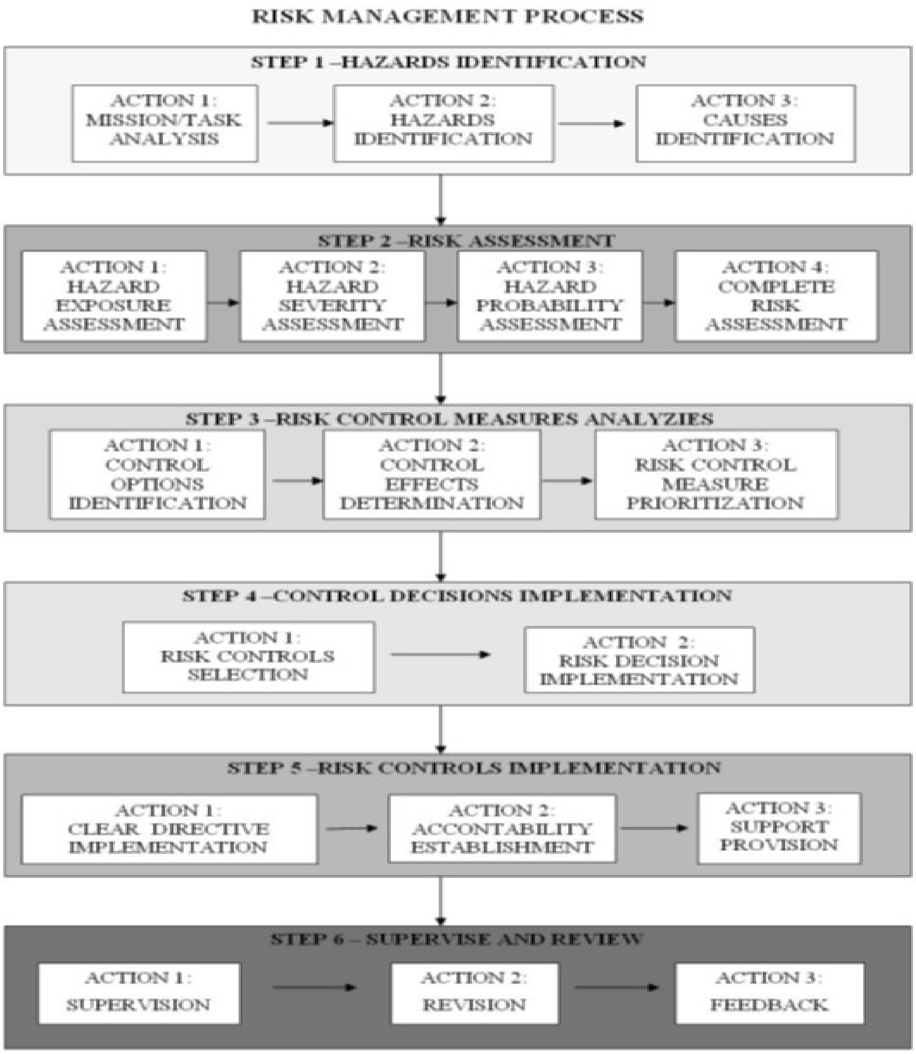

Figure 22 – Risk Management Approach (Canale & Distefano, 2014).

Another risk management methodology available for organizations is the BOW-TIE. This approach owes its name due to its scheme being similar to a bow-tie. It consists in a simple way to describe and analyze the risk paths, in a schematic way, from its causes until its consequences.

This scheme can be splitted in two different parts:

- **Prevention Phase –** Where the prevention controls are evaluated to face the potential causes before any undesirable event occurs;
- **Recovery Phase –** The recovery methods are assessed in this phase, to prevent potential outcomes, after an undesirable event occurs.

The main objective of this scheme is to focus on the barriers between the causes and events, and therefore between events and consequences, showing a clear differentiation between proactive and reactive risk management. In a brief view, the Bow Tie aims to analyze the causes that may stir an event up, and consequently the consequences that may occur from an unwanted event (CGE Risk Management Solutions, 2017). In Figure 23 the Bow-Tie scheme can be analyzed.

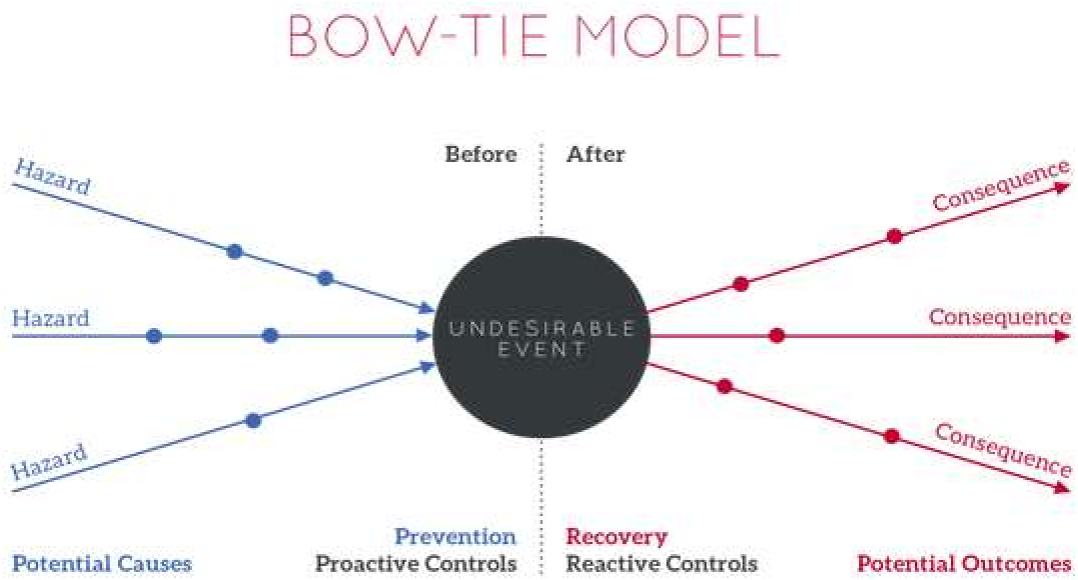

Figure 23 – Bow-Tie Diagram (ASQS, 2020a).

To pursue this methodology scheme, the following steps must be followed (CGE Risk Management Solutions, 2017):

- Identify the hazard to be analysed, considered the undesirable event (centre point in Figure 23);
- A list of all potential causes shall be created, taking into consideration the hazard sources;
- Identify the mechanism responsible for the event;
- Draw lines between each hazard and event, creating BOW-TIE's left side;
- The barriers which could have avoided the event shall be drawn as circles in each hazard line;
- On the right-hand of the scheme, different consequences shall be associated to the event. Afterwards lines must be drawn from the undesirable event until the consequences;
- The barriers that will control and mitigate the event are also represented as circles on consequences' lines;

- The final result of the BOW-TIE is a simple diagram (Figure 23), where the hazard and consequence paths are represented in order to avoid or mitigate the undesirable events.
- The risk management software used by EAA (IQSMS from ASQS) applies this bow-tie methodology.
-

3.10 Risk Assessment and Analysis

As already stated before, ICAO defines risk as "The assessment, expressed in terms of predicted probability and severity, of the consequence(s) of a hazard taking as reference the worst foreseeable situation". Taking in accordance the same organization, the Tables 3 and 4, shown below, represent its risk classification on probability and severity (ICAO, 2018a).

Table 3 – ICAO Safety Risk Probability (Adapted from: ICAO, 2018b).

Risk Probability	**Definition**	**Value**
Frequent	Likely to occur many times (has already occurred in the company (freq. >3 x year), and has frequently occurred in aviation's history)	5
Occasional	Likely to occur sometimes (has already occurred in the company (freq. <3 x year), and has infrequently occurred in aviation's history)	4
Remote	Unlikely to occur, but possible (has already occurred in the company at least once, and has regularly occurred in aviation's history)	3
Improbable	Very unlikely to occur (not known to have occurred in the company, but has already occurred in aviation's history)	2
Extremely Improbable	Almost inconceivable that the event will occur (it has never occurred in aviation's industry)	1

Table 4 – ICAO Safety Risk Severity (Adapted from: ICAO, 2018b).

Risk Severity	**Definition**	**Value**
Catastrophic	Equipment destroyed; Multiple deaths.	E
Hazardous	A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks; Serious injuries; Major equipment damage.	D
Major	A significant reduction in safety margins, in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency;	C

	Serious incident; Injury to persons.	
Minor	Nuisance; Operation limitations; Use of emergency procedures; Minor incident.	B
Negligible	Little consequences.	A

Joining both tables, the result is the Safety Risk Matrix (Figure 24). In this table there are three possible outcomes: i) Acceptable, represented in green; ii) Tolerable after mitigative actions, characterized by yellow; iii) Unacceptable, shown in red. In order to understand risks tolerability, arises safety risk tolerability matrix shown in Figure 25.

SAFETY RISK ASSESSMENT MATRIX					
RISK PROBABILITY	**RISK SEVERITY**				
	NEGLIGIBLE (A)	MINOR (B)	MAJOR (C)	HAZARDOUS (D)	CATASTROPHIC (E)
FREQUENT (5)	5 A	5 B	5 C	5 D	5 E
OCCASIONAL (4)	4 A	4 B	4 C	4 D	4 E
REMOTE (3)	3 A	3 B	3 C	3 D	3 E
IMPROBABLE (2)	2 A	2 B	2 C	2 D	2 E
EXTREMELY IMPROBABLE (1)	1 A	1 B	1 C	1 D	1 E

Figure 24 – Safety Risk Assessment Matrix (EAA, 2020c).

SAFETY RISK TOLERABILITY MATRIX		
SUGGESTED CRITERIA	**ASSESSMENT RISK INDEX**	**SUGGESTED CRITERIA**
Intolerable region	3E; 4D; 4E; 5C; 5D; 5E	Intolerable under the existing circumstances
Tolerable region	1E; 2C; 2D; 2E; 3B; 3C; 3D; 4A; 4B; 4C; 5A; 5B	Acceptable based on risk mitigation. It may require management decision
Acceptable region	1A; 1B; 1C; 1D; 2A; 2B; 3A	Acceptable

Figure 25 - Safety Risk Tolerability Matrix (EAA, 2020c)

The previous Risk Matrix is a crucial element, because it defines what is acceptable and what is not. The knowledge of what a hazard can cause and its likelihood is vital in order to calculate the elements that allow the risk assessment and consequent analysis. With this, a database with previous events is essential to define the future hazard outcomes.

Taking in consideration the results and risk classification obtained by the Risk Matrix, decisions and mitigative actions shall be implemented. The Figure 26 describes the procedures for each possible outcome.

Risk Index	Tolerability	Action required
3E; 4D; 4E; 5C; 5D; 5E	**Intolerable**	Take immediate action to mitigate the risk or stop any activity until sufficient control measures have been implemented to reduce the risk as low as reasonably practicable (ALARP). If this is not possible, the activity may only resume after the Accountable Manager approval
1E; 2C; 2D; 2E; 3B; 3C; 3D; 4A; 4B; 4C; 5A; 5B	**Tolerable**	Can be tolerated based on the safety risk mitigation. The activity may resume after the Nominated Person approval.
1A; 1B; 1C; 1D; 2A; 2B; 3A	**Acceptable**	Acceptable (Risk mitigation or review is optional). Distributed to managers of departments involved.

Figure 26 – ICAO Tolerability Matrix (ICAO, 2018a).

The risk assessments, and consequent analysis performed by EAA are in accordance with the methodology introduced above. The risk matrix adopted by EAA is the same provided in EASA's guidelines, and is eestablished in its SMM(EAA, 2020c).

3.11 IQSMS

IQSMS is an integrated, web-based Safety, Quality and Risk Management solution for the aviation sector. This platform was created by Advanced Safety and Quality Solutions (ASQS) and offers a wide set of tools for the Safety and Compliance departments different activities.

Once applied to the aviation segment, this software must comply with several parameters stipulated by EASA (2016) and ICAO (2018), and contains the nine following modules (ASQS, 2020a):

- Quality Management Module;
- Reporting Module;
- Risk Management Module;
- Airport and Flight Risk Module;
- Flight Data Monitoring (FDM) Risk Module;
- Ground Operations Module;
- Survey Module;
- Emergency and Response Plan Module;
- Fatigue Risk Management Module;

Besides this software encompasses those nine modules, each organization can opt on which modules will be used/acquired. In relation to EAA, only four modules are used: Quality management module, Reporting module, Risk management module and Airport and flight risk module.

In EAA, the analysis of long-term operations based on outstations is performed in "Airport and Flight Risk Module", more precisely in the "Airport evaluation" chapter (Figure 27).

Figure 27 – Airport and Flight Risk Module in IQSMS (ASQS, 2020b).

Afterwards, a chart is introduced, encompassing all airports and EAA aircraft, separated by fleets (B737-800, B767-300ER and B777-200ER). In the following chart different colours and letters can be observed, which represent the levels of operational risks and airport classification, respectively (Figure 28).

Airport	B738	B763	B772ER
HSNL		B	
HSNN		A	
HSSG			
HSSJ		B	B
HSSM		A	
HSSS			
KEWR		B	
KJFK		B	

Figure 28 - IQSMS Airport Chart (ASQS, 2020b)

The analysis begins by choosing the airport which we intend to study, as well as the aircraft type that will conduct the operation. In the case of a risk assessment of a long-term operation, we shall start by performing the risk assessment of the base where the aircraft does the night-stops (in case is always the same airport), which will be where the human resources allocated to each operation are based as well. Afterwards, a risk assessment of the operating conditions of all the other airports where the aircraft(s) is/are going to operate, must also be performed.

The risk assessment is divided into two phases: the first part includes a checklist concerning the airport conditions; the second part is composed by a checklist related with the aircraft type. These checklists can be seen in the Appendix 1.

The checklist filling is performed based on the identified risks and conditions for each operation and airport. The IQSMS software generates the risk classification as in Figure 29.

Figure 29 – Risk Classification IQSMS (ASQS, 2020b).

After filling both checklists, the software analysis the input information, by adding each risk value, calculating the operation's risk level. The result introduced in the risk assessment can vary in three different risk zones, each of them corresponds to a level of risk (Figure 30). These three levels are separated into colours and percentage of risk. As it can be seen in Figure 30, the low risk level is represented by green colour and its risk value is from 0 to 15%. In relation to the medium risk level, it is characterized by yellow colour and the risk value range varies between 15 and 60%. Last, but not least, represented by red colour, is the high-risk level. Its range values are within 60 and 100%. The thresholds can be defined in the Administrator Functions, however conservative values must be applied, in order to guarantee considerable safety margins.

Figure 30 – Risk Assessment Result in IQSMS (ASQS, 2020b).

Taking into consideration the risk assessment result from Figure 30 whose result was 100%, since it exceeds the defined threshold of the medium risk, the operation is prohibited. However, it can be afterwards approved after the mitigative procedures were applied and the risk level reduces to the maximum of 60%. In case the risk is set in the medium risk area, the mitigative actions for each risk shall be stipulated and written in the risk assessment, otherwise the risk assessment is not concluded in the IQSMS, and an approval from the Flight Operations Manager must be issued, in order to approve the operation to that airport. Finally, for the low-risk range, there is no need for approval, neither mitigative procedures.

Figure 31 – IQSMS Mitigative Measures and Operation Approval (ASQS, 2020b).

The final result of each operation is introduced as shown in Figure 31, however, with a new value, after the risks are mitigated.

For the purpose of this work, long-term operations, the risk assessment matrix was updated, in order to encompass other safety risks, rather than airport conditions for each aircraft type. Meetings with the safety representatives of each department involved in the operations were done, aiming to include other risks that they can predict. With this, OCC, DOV, Roasters, DOT and DME/MOP were consulted to list all of its concerns and encompass them in the risk assessment.

3.12 Conclusion

In the final stage of this chapter, it can be concluded that the requirements to eestablish a SMS have been improved over the years with new measures and techniques to conduct all type of operations safely.

Several safety related data was not only analysed but also defined in the previous subchapters, encompassing the definition of safety and its culture, the comprehension of the requisite of management's importance of protection over the production, risk management methodologies, accident prevention measures, safety functional components and different risk management techniques. EASA's proposed risk management matrix, which is also adopted by EAA, was described for its tolerability and likelihood ranges. The content of these matrixes will be essential, over the next Chapters, for the risk classification of each identified hazard.

Additionally, the integrated safety management system used by EAA, IQSMS, was properly introduced in order to explain its

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Chapter 4 – Case of Study

4.1 Introduction

Aircraft Operations is a multicomplex environment with interrelated factors that affect safety. Those factors are human, technical, organisational and environmental. The hazards that may influence operation's safety must be deeply scrutinized during this chapter to ensure an efficient analysis to EAA's current procedures for risk management.

With this, in the following Chapter, in an initial phase, a detailed examination throughout several technical data must be carried out. Regulation and aerodrome analysis information shall be transmitted. The methods for obtention of the identified hazards of each operational sector must be defined, as well as the encompassment of those in a single Operational Risk Assessment matrix, the proposed strategy. Its implementation and test with previous long-term operations must be defined in order to ensure an efficient coverage of different operations.

4.2 Aerodrome Analysis

Before proceeding with the design of a new risk management model for long-term operations, there are several technical aspects that must be analysed regarding operative airports, routes and aircraft which are the main interactions with the human being, and therefore more prone to occur unsafe acts.

In relation to airports, the primary source of information to retrieve data was the Aeronautical Information Publication (AIP) from the respective airport's country. This document is issued by the state itself or by an institution dully authorized for the purpose. It is divided into three parts (ICAO, 2013):

- GEN (General);
- ENR (Enroute);
- AD (Aerodromes).

In this document we are able to find the standards for the study of the aerodromes. This information will provide not only guidance to identify new potential hazards for the new risk assessment model, but also support to determine if the identified hazards can occur in those aerodromes. As forementioned in Chapter 3, the operated airports were evaluated through the new risk assessment matrix.

In accordance with ICAO, an aerodrome is "A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and movement of aircraft" (ICAO, 2018b).

A certified aerodrome shall comply with the requisites stated in the following documents (ICAO, 2018b):

- ICAO ANNEX 14 – Aerodromes;
- ICAO Doc 9774 – Manual on Certification of Aerodromes;
- ICAO Doc 9157 – Aerodrome Design Manual;
- ICAO Doc 9476 – Manual of Surface Movement Guidance and Control System;
- ICAO Doc 9137 – Airport Service Manual:
  - Part 1 – Rescue and Fire Fighting;
  - Part 2 – Pavement Surface Conditions;
  - Part 3 – Wildlife Control and Reduction;
  - Part 4 – Fog Dispersal;
  - Part 5 – Removal of Disabled Aircraft;
  - Part 6 – Control of Obstacles;
  - Part 7 – Airport Emergency Planning;
  - Part 8 – Airport Operational Service;
  - Part 9 – Airport Maintenance Services.

4.2.1 Aerodrome and Aircraft Categorization

Airports are categorised from Category A to C. This classification is based on the need (or not) of specific flight crew training, or crew briefings before the operation (EAA, 2019b) due to the difficulties on access routes or airport conditions itself.

With this, Category A corresponds to the airports with no restrictions, while Category B and C are progressively more demanding. Below are stated the requirements that a certain airport must comply to be classified as A, B or C:

Category A aerodromes satisfy the following requirements:

- An approved instrument approach procedure;
- At least one runway with procedure for take-off and/or landing;
- Published circling minima not higher than 1000ft above aerodrome level;

- Night operations capability.

Category B aerodromes do not satisfy the Category A requirements or require extra considerations such as:

- Non-standard approach aids and/or approach patterns;
- Unusual local weather conditions;
- Unusual characteristics or performance limitations;
- Any other relevant considerations including obstructions, physical layout, lighting, etc.

Category C aerodromes require additional considerations to the ones considered Category B:

- Crew training for the specific airport before the operation;
- Instrument Flight Rules (IFR) not available requiring Visual Flight Rules (VFR) which therefore implies navigation data different than the usual, and the need of specific airport training.

Aiming to support the operators on the decision if a defined aircraft can, or not, operate in a certain airport, ICAO has defined a standard code reference for aerodromes composed by two components (ICAO, 2018b):

- Code numbers based on the reference field length, which is the minimum length to take-off with Maximum Take-off Weight (MTOW). Code number reference table can be seen in Table 5.

Table 5 – ICAO's Aerodrome Reference Chart – Code Numbers (ICAO, 2018b).

Code Number	**Reference Field Length (RFL)**
1	RFL<800m
2	800m<RFL<1200m
3	1200m<RFL<1800m
4	RFL>1800m

- Code letters based on aircraft's wingspan. Table 6 shows code letter reference.

Table 6 – ICAO's Aerodrome Reference Chart – Code Letters (ICAO, 2018b).

Code Letter	**Wingspan**
A	<15m
B	≥ 15m ∧ < 24m
C	≥ 24m ∧ <36m
D	≥ 36m ∧ <52m

E	≥ 52m ∧ <65m
F	≥65m ∧ < 80m

As previous stated aircraft are also classified into letter codes. Those codes are based on aircraft's performance, more precising the aircraft approach speed factor. ICAO has established categories according to a specific speed interval. The criteria considered to assign a certain category to the aircraft is the Indicated Airspeed at the Runway Threshold (VAT) while the aircraft is in normal landing configuration with Maximum Landing Weight (MLW) certified. Table 7 shows aircraft category's speed approach.

Table 7 – ICAO's Aircraft Speed Approach Reference Chart (ICAO, 2018b).

Aircraft Category	V_{AT}
A	<161km/h (91kt)
B	≥161 km/h (91kt) ∧ <224 km/h (121 kt)
C	≥224 km/h (91kt) ∧ <261 km/h (141 kt)
D	≥261 km/h (141kt) ∧ < 307 km/h (166 kt)
E	≥307 km/h (166kt) ∧ < 391 km/h (211 kt)

4.2.2 Instrument Approach Systems

The Instrument Approach Procedures (IAP) allow a safe approach to any aircraft operating in IFR conditions, from the initial point of the approach procedure until a closer point to the runway where visual references can be acquired to perform the touchdown. There are two main instrument approach groups: Precision Approach (PA), and Non-Precision Approach (NPA).

NPA's are instrument approaches which only utilise lateral guidance, with vertical guidance not available for these instruments. This type of approach is frequent with certain navigation systems such as VHF Omnidirectional Radio Range (VOR), Non-Directional Beacon and the Localizer (LOC).

PA utilise both lateral and vertical guidance. These types of approaches are considered more precise than NPA approaches. The most common PA system is the Instrument Landing System (ILS), however there are others, such as Global Navigation Satellite System (GNSS).

Since ILS is the most frequently used among the PA's this will be a parameter analysed in the new risk management model. This system is divided into three different categories, being that the last one (CAT III) is subdivided into three subcategories. The system classification is defined in accordance with the Decision Altitude/Height (DA / DH) and the Runway Visual Range (RVR) or the visibility, as can be seen in Table 8.

Table 8 – ILS Approach Categories (EASA, 2019).

Category	DH	RVR	Visibility of at least
CAT I	≥60m (200ft)	≥550m	800m
CAT II	<60m (200ft) ∧ ≥30m (100ft)	≥300m	N/A
CAT IIIA	<30m (100ft)	≥200m	N/A
CAT IIIB	<30m (100ft) or no DH	<200m ∧ ≥75m	N/A
CAT IIIC	No DH limitations	No RVR limitations	N/A

4.2.3 Rescue and Fire Fighting

Rescue and Fire Fighting Services (RFFS) are all amenities provided in an aerodrome specifically dedicated to safety support for aircraft operation. Beyond firefighting, these services also provide support to incidents (leakages cleaning for example), evacuations and possible passenger and crew rescue.

ICAO clearly defines RFFS parameters to be complied in Annex 14, Volume 1 – Aerodrome Design and Operations, and provides Doc 9137 – Airport Service Manual, Part 1 – Rescue and Fire Fighting as guidance to implement the forementioned annex.

The RFFS services are also categorized into 10 levels, according to maximum aircraft's fuselage length and width. With this, the RFFS level available in a certain aerodrome limits the maximum dimensions of the operating aircraft. Table 9 illustrates the RFFS levels (ICAO, 2015).

Table 9 – RFFS Categories (ICAO, 2015).

RFFS Category	Aircraft Length	Aircraft Fuselage Width
1	<9m	2m
2	≥9m ∧ <12m	2m
3	≥12m ∧ 18m	3m
4	≥18m ∧ 24m	4m
5	≥24m ∧ 28m	4m
6	≥28m ∧ 39m	5m
7	≥39m ∧ 49m	5m
8	≥49m ∧ 61m	7m
9	≥61m ∧ 76m	7m
10	≥76m ∧ 90m	8m

4.2.4 ACN – PCN

Aircraft Classification Number (ACN) – Pavement Classification Number (PCN) is a established ICAO standard to evaluate aircraft operational limitations in a certain aerodrome, considering its weight and type of existing pavement.

ACN is a single number that expresses the effect of an aircraft with a given weight configuration on a pavement classified subgrade category (ICAO, 2018b). This value varies upon aircraft mass, runway physical characteristics (rigid or flexible) and resistance (A, B, C, D) differences.

PCN is a five-part subdivided code regarding any section of aerodrome's pavement (runway, taxiway, stand) and classifies its mechanical resistance in relation to excessive wear. Each code's part is divided by a slash "/" (ICAO, 2018b):

- **Numeric Value:** Represents pavement's cargo capacity;
- **First letter:** Represents pavement's flexibility:
  - R – Rigid;
  - F – Flexible.
- **Second letter:** Expresses the strength of the subgrade that is underneath the considered pavement section:
  - **A –** High Strength**;**
  - **B –** Medium Strength;
  - **C –** Low Strength;
  - **D –** Ultra Low Strength.
- **Third letter:** Establishes the maximum tyre pressure than a considered pavement can support:
  - **W -** No pressure limits;
  - **X –** 1,75 MPa;
  - **Y –** 1,25 MPa;
  - **Z –** 0,5MPa.
- **Fourth Letter:** Describes the method through which the first value was obtained:
  - **T –** Technical Evaluation;
  - **U –** Physical Testing Regime.

Considering the information provided, if the ACN is inferior or equal to PCN the aircraft can operate with no weight limitations (besides its structural limitations). By the other side, is ACN is higher than PCN the Maximum Ramp Weight (MRW) shall be calculated, in accordance with the following procedure:

- Retrieve PCN data from the concerned airport;
- Retrieve ACN from the organization's approved navigation database charts;
- In case ACN>PCN the MRW shall be found:
  - Establish the value ACN=PCN;
  - Interpolate the values from the navigation database charts to obtain the MRW;
  - A safety margin of 5% and 10% shall be given to rigid and flexible pavements respectively.

In Table 10 EAA's actual fleet is characterizes in aerodrome reference code, RFFS category and approach speed category.

Table 10 – EAA Fleets' Characteristics (EAA, 2019b)

Aircraft	Aerodrome Ref Code	RFFS Cat	Approach Speed Cat
B737-800NG	4C	7	C
B767-300ER	4D	8	D
B777-200ER	4C	9	C

4.3 Aircraft Operator Analysis

European Commission Regulation, through EASA, defines standards to regulate Air Operators. Its regulation is known as EASA Air Ops. Aiming to facilitate operators to understand the requirements, EASA Air Ops is sub-divided into eight different annexes:

- Annex I – Definitions;
- Annex II – Part-ARO (Authority requirements for air operators);
- Annex III – Part-ORO (Organisation requirements for air operators);
- Annex IV – Part-CAT (Commercial air transport operations);
- Annex V – Part-SPA (Operations requiring specific approvals);
- Annex VI – Part-NCC (Non-commercial operations with complex-motor-powered aircraft);
- Annex VII – Part-NCO (Non-commercial operations with other than complex-motor-powered aircraft);
- Annex VIII – Part-SPO (Specialized operations).

Each subpart is then encompassed by other subparts, as shown in Figure 32.

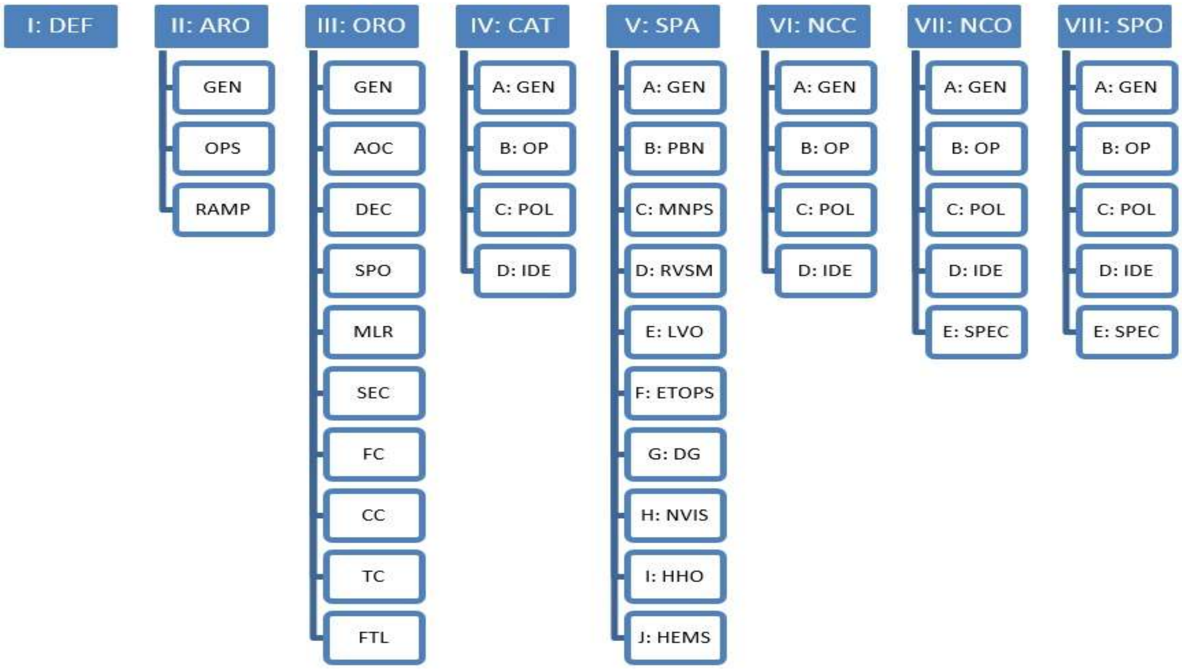

Figure 32 – EASA Air Ops Subparts (Skybrary, 2018).

While Annex I only include definitions, and Annex II establishes the requirements to be followed by the competent authority regarding civil aviation air operations, Annex III defines standards to be followed by any air operator conducting Commercial air transport operations (ORO.GEN.005). Several subparts of this annex were crucial for hazard identification and its risks' prevention, such as ORO.AOC (Air Operator Certification), ORO.SPO (Commercial Specialised Operations), ORO.MLR (Manuals, Logs and Records) to guarantee its traceability and update during the operations, ORO.FC (Flight Crew), ORO.CC (Cabin Crew), as well as ORO.FTL (Flight and Duty Time Limitations and rest requirements) to identify crew fatigue's related hazards. Annex IV subdivisions CAT.OP (Operating Procedures), CAT.POL (Aircraft Performance and Operating Limitations) and CAT.IDE (Instruments, Data, Equipment) were also considered for this dissertation. Regarding Part SPA, SPA.PBN (Performance Based Navigation), SPA.RVSM (Reduced Vertical Separation Minima), SPA.LVO (Low Visibility Operations), SPA.ETOPS (Extended Range Operations with Two-Engine Aeroplanes), SPA.DG (Dangerous Goods) and SPA.EFB (Electronic Flight Bag) were also studied during this dissertation in order to verify regulation's compliance in risk mitigation strategies. Annex VI to VIII were not considered for this purpose as EAA does not perform any type of those operations.

For aircraft maintenance during operations the general regulations analysed for this study were the ones important for line station capabilities. Those requirements are retrieved from EASA Part 145 and Part M regulations.

EASA Part 145 is the European standard for the approval of organisations that perform maintenance on aircraft and aircraft components. These guidance describe the requirements in terms of facilities, personnel including certifying staff and support staff, equipment, tools, material, acceptance of components, maintenance data, production planning, certification, occurrence reporting, as well as safety and quality policies, maintenance procedures and quality system, to become an EASA Part 145 approved maintenance organisation (AMO), (EASA, 2015).

On the other hand, Part M is the regulation for Continuing Airworthiness. For the purpose of this study only several applicable subparts were considered, such as Subpart F (Maintenance Organisation), Subpart G (Continuing Airworthiness Management Organisation) and Subpart H (Certificate Release to Service).

As previously described, the focus will be on the requirements necessary to be an approved AMO, more precising the qualifications to raise a line maintenance station in the considered airports. All Means of Compliance (AMC) of regulations to have an EASA approved line station were analysed not only through EASA Part M and Part 145 regulations, but also through EAA DCM internal audit checklists and results. The objectives of using these data are not only to identify any possible missing hazard, but also to collect mitigation strategies and guarantee its compliance.

4.4 EAA Risk Assessment Model

As previously proven, safety risk management has improved throughout the history of aviation with a pace proportional to industry's demand. Innovative risk assessment models and measures are therefore continuously surging over the years. EAA is a clear demonstration of this constant improvement as new risk mitigation strategies arise to ease the identified hazards. Its risk assessments are performed based on ICAO's Safety Risk Matrix classifying each risk on severity and probability, both divided in five levels that will compose a final matrix from the arithmetical multiplication of factors (EAA, 2020d). A general title is given to the risk assessment taking into consideration the comprised hazards listed in this risk assessment. With this, as shown in Figure 33, the identified hazards are introduced into topics. Each hazard subject is specified into components. Then the hazardous consequences are listed for each item.

After encompassing all relevant information into those three columns there is enough data to evaluate, classify and quantify each risk's tolerability, level of consequence and safety risk index.

Hazard Topic	Specific components of the hazards	Hazard-related consequences	Safety risk index
			Safety risk index: Safety risk tolerability:
			Safety risk index: Safety risk tolerability:
			Safety risk index: Safety risk tolerability:
			Safety risk index: Safety risk tolerability:
			Safety risk index: Safety risk tolerability:

Figure 33 – EAA Risk Assessment Form (EAA, 2020d).

Once risk assessment index is achieved from concluding risk's severity and probability, its tolerability shall be identified as acceptable, tolerable or intolerable, in accordance with Figure 25 and 26. Each tolerability level involves the accomplishment of required actions.

Considering the previous assessment and its indexes, risk mitigation measures shall be addressed. Taking into account those measures the safety risk index can decrease if acceptable mitigations were assured, which can imply a reviewed risk tolerability.

The forementioned procedure is EAA's actual risk assessment model. An individual risk assessment is performed for each set of hazards, or for a single one, in a case-by-case basis. As none model is proved to be infallible, EAA's Safety department is always looking forward to identify new risk mitigation approaches, enabling the development of this study focusing on eestablishing a new risk assessment model for long-term operations where all operational hazards are listed and classified in accordance with ICAO's Safety Risk Matrix.

Afterwards, each hazard that could occur during the operation shall be selected. If the hazard is related to the airport, it must be included in the Airport Risk Assessment in IQSMS Airport Risk Module. Otherwise, it must be only included in the Operational Hazard Log along with the identified risks from each operated airport. Thus, mitigation strategies must be adopted to decrease operational inherent risks' probability and severity to ensure a proper Operational Risk Assessment matrix.

4.5 Operational Risk Assessment

The fundamental of this study is the improvement of EAA's risk assessment techniques and mitigation strategies in order to ensure a safe environment during its operations. Accordingly, each operational sector shall, not only be involved in hazard identification and development of mitigative methods, but also endorse these techniques in order to ensure a widely safe culture among each operator. Herewith, meetings with each operational sector were performed aiming to establish each division's specific hazards and consequences, which will be crucial to classify each hazard into probability, severability and tolerability. After, mitigation measures were also identified in order to tolerate each hazardous risk.

All IQSMS public and closed reports, 296 in total, were analysed during the meetings with each operational sector, as well as its related risks in the Hazard List[1] Further analyses were performed to other department-related regulations, safety indicators, such as SPI's and other reports applicable to each department, to guarantee no missing identified hazards were left behind.

4.5.1 Flight Operations Risks' and Mitigation Procedures

Flight operations department (DOV) comprises several subdivisions such as Rosters, Flight Dispatch and Crew Training along with cabin crew manager and Chief Pilots from each fleet. Meetings were performed with the first two departments listed, in order to gather the forementioned data.

During these meetings several competent authority's regulations and required reports from the last two years, such as trimestral Crew Training, Fatigue and FDM reports, as well as each division's related SPI's were analysed to identify additional hazards.

Each DOV-related hazard must be categorized into aerodrome related hazard, and consequently be introduced in IQSMS's airport risk management matrix, or into general operational hazard which will therefore be included in the Operational Hazard Log

The identified hazards are categorized and listed along with its risk classification established during the meetings, risk mitigation strategies, department responsibilities over mitigation measures, and risk classification after mitigation approaches applied in Appendix 2.

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[1] EAA Hazard list is a company's record of the identified hazards. This list is in continuous revision once new hazards are identified.

4.5.2 Maintenance Risks' and Mitigation Procedures

Considering that this study comprises operational risk management, EAA Part 145 will be the major concern over DME. In order to perform EAA's aircraft maintenance in each airport, the operator shall either decide if subcontracts other EASA certified Part 145 or if EAA Part 145 performs all required preventive, predictive and corrective maintenance, not only in operations' base, but also in each destination where EAA operates.

DME/MOP is the department that involves EAA Part 145, besides having several Part M functions, such as subcontract other Part 145 organizations to perform line maintenance to EAA aircraft. By this means, DME/MOP was the focal point to agglomerate every operational maintenance hazard and related mitigation strategies.

As previously mentioned, meetings with head of DME/MOP and its safety representative were done. During these meetings several published documents were analysed, including not only previous reliability and repetitive snag reports, but also department's SPIs and DCM audit checklists and finding reports from EAA Part 145 current operational bases, line maintenance work packages and daily service check audits.

Hazard identification, risk assessment and mitigation measures were outcomes of these meetings along with the classification of each hazard into, as previously described, general operational hazards or airport related hazards.

Each maintenance-related hazard and respective category, risk classification into probability and severity, mitigation measures and risk classification after those mitigation strategies were applied is listed in Appendix 3.

4.5.3 Ground Operations Risks' and Mitigation Procedures

As almost entirely of EAA's ground handling is provided by external providers the safety related issues are audited by DCM. Besides, as previously mentioned, there is no Safety Management requirements Nevertheless, meetings with the head of DOT and its safety representatives together with DCM auditors were performed to identify and gather all hazards, its risks and mitigation strategies.

In order to guarantee that no data was forgotten, previous SPIs and DCM, internal and service providers audits checklists were studied and discussed during the meetings.

All ground handling related hazards and its risk classification along with proper mitigation strategies are also listed in Appendix 4.

4.6 Risk Assessment Model for Long-Term Operations

As the main objective of this dissertation is to assess and analyse each operational sector inherent hazards, and respective risk classification and applicable mitigation strategies, which therefore implies the evaluation of organization's methodologies to mitigate the considered risks, a new risk assessment model is proposed.

This novel risk assessment model aims to encompass organization's operational hazards into a single Operational Risk Assessment pattern to be performed before the beginning of each future operation. The considered model must include all categories of hazards related to airports, routes, aircraft maintenance, employees' conditions in all destinations, human factors, type of operation. Subsequently, each hazard related risks and its classification shall be addressed as well as its mitigation procedures to alleviate those risks. Once its information is collected, it must be gathered into the operational hazard log represented in Appendix 5.

Aiming to perform this new matrix, as already mentioned, the considered hazards must be segregated into airport-related hazards, which will therefore be included in the new IQSMS matrix for airports, or into general operational hazards.

For the airport-related hazards, in accordance with EAA procedures, those must be introduced in IQSMS platform along with its risk classification. Considering that quantify a risk can be ambiguous, its risk classification is based on ICAO's Safety Risk Model, precisely ICAO's Tolerability Matrix. With this, risk classification will be retrieved from the operational hazard log risk assessment tolerability level: Acceptable, Tolerable or Intolerable.

As forementioned in Figure 26, IQSMS risk classification levels are slightly different from the ICAO's Safety Risk Model. With this, the following adaptations shown in Table 11 were performed in order to standardize the risk classification levels.

Table 11 – IQSMS Risk Classification adapted from ICAO Safety Risk Model (Own Elaboration).

Risk Classification IQSMS	Risk Classification ICAO
No Risk	Acceptable
Low Risk	Acceptable
Medium Risk	Tolerable
High Risk	Intolerable
No Flight	Intolerable

Once all hazards are introduced along with each risk classification, the new IQSMS Airport Risk Assessment Matrix is ready to be uploaded and used in new risk assessments. Afterwards, each selected risk in each operated airport must be collected and included in the results of the new Risk Assessment Model along with its risk assessment as well as its mitigation strategies and responsibilities.

On the other hand, the general operational hazards that were selected from the operational hazard log must also be included in the assessment encompassing the final Operation Risk Assessment along with the airport hazards identified in the concerned operation.

The following flowchart in Figure 34 represents the previously described path to obtain the long-term operation risk assessment.

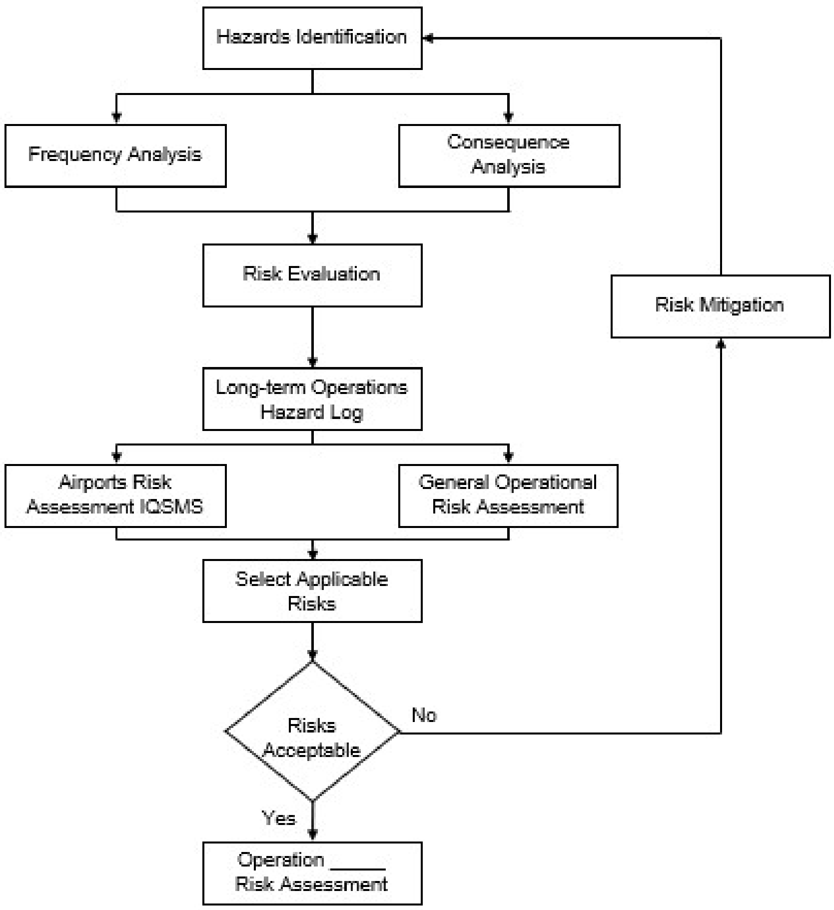

Figure 34 -- Risk Assessment Model Flowchart (Own Elaboration).

As previously stated, although hazard's separation, those must be encompassed in the final operational hazard log with respective risk assessment and mitigation strategies for the concerned operation. The final log must also state the operating airports, aircraft(s) involved in the considered action and the duties of the departments responsible to ensure the mitigation strategies are not only applied, but also to guarantee those are adequate to reduce risk's severity and likelihood to an acceptable level.

4.7 Implementation of the new Risk Assessment Model into Previous Long-Term Operations

For the purpose of test and implement the new Risk Assessment Model, three of the most demanding operations in the last two years were chosen. With this, those operations were selected considering the following premises:

- Number of aircraft involved at the same time;
- Most operated hours (FH[2]) per day per aircraft ($\frac{FH}{Day}$);
- Most operated cycles (FC[3]) per day per aircraft ($\frac{FC}{Day}$).

Consequently, the nominated operations are shown in Table 12.

Table 12 – Selected operations to test the Risk Assessment Model (Own Elaboration).

Client	Base	Start Date	Finish Date	Duration (days)	Aircraft Involved	Total FH	$\frac{FH}{Day}$	Total FC	$\frac{FC}{Day}$
Client A	KEF/BIKF	01/05/2019	28/09/2019	150	CS-TKS	1652,01	11,01333	465	3,1
	KEF/BIKF	14/04/2019	30/09/2019	169	CS-TKR	1887,49	11,16858	512	3,029586
	KEF/BIKF	16/06/2019	15/09/2019	91	CS-TSV	720,33	7,915714	214	2,351648
Client B	LOS/DNMM	07/11/2019	21/03/2020	135	CS-TQU	815,59	6,041407	949	7,02963
Client C	FCO/LIRF	11/08/2019	20/09/2019	40	CS-TKT	584,74	14,6185	73	1,825

As noticeable in Table 12, the operation on behalf of Client A with established hub in Reykjavík–Keflavík Airport (IATA Code: KEF; ICAO Code: BIKF), Iceland, was not only the one that registered more aircraft involved at the same time (CS-TKS, CS-TKR and CS-TSV), but also with the highest number of flown hours, 4259,82 FH. Considering the previous statistics, along with seasonal weather phenomena frequently faced in Nordic regions the success of this operation indeed requires well-structured risk management policies.

Secondly, the average of most operated hours per day per aircraft had occurred on support of Client C, however established in Leonardo da Vinci-Fiumicino Airport (IATA Code: FCO; ICAO

[2] FH- Number of hours flown.
[3] FC – Number of operated cycles.

Code: LIRF), Rome, Italy. During those 40 days of operation, a total of 584,74 FH was performed, averaging approximately 14,62 FH per day.

Finally, the average of most cycles performed per day during a long-term operation was registered in Nigeria, where EAA operated a total of 949 FC with Client B's code during 135 consecutive days resulting on an average of approximately, 7,03 FC per day. Such a huge flight demand requires an efficient and prolific team not only to avoid delays but also to maintain a safe operation due to the difficulty to meet such a challenging timetable.

An efficient safety culture is essential to be established within all organisation's departments, and consequently among all employees to prevent potential hazards that could jeopardize operation's safety due to the challenging calendars, different cultures, seasonal weather conditions, shifts etc., notwithstanding the need to meet client's demands and ensure a safe and profitable operation.

4.8 Conclusion

In this Chapter relevant technical data related to aerodrome infrastructures was understood in order to perform accurate airport risk analysis. Technical regulation of each department was then scrutinized with the same purpose. The meetings performed with each department's manager and safety representatives were described along with the methods to gather the identified hazards related to each operational area. The aggregation of those hazards, and mitigation techniques into a single matrix to perform the Operational Risk Assessment was also defined.

A Long-term Operations Hazard Log was then created with the considered data. It is represented in Appendix 5. The premises to decide which operations should be chosen were accurately defined to guarantee a wider perspective of the operational risks that will be identified.

Further information regarding operated airports during each operation along with its identified hazards is described in Chapter 5.

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Chapter 5 – Results Analysis

5.1 Introduction

The analysis of the proposed matrix is extremely important for its comprehension and effectivity for EAA's benefit. For this purpose, three different demanding operations were then used to test the risk management strategy.

During this Chapter the results of each selected operation risk assessment must accomplished. To meet this requirement, several technical information related to each operated airport and general operational conditions must be scrutinized.

Afterwards, the identified hazards shall be analysed and risk mitigation procedures shall also be established along with the responsibilities to mitigate those risks. Once there is enough intel to perform the risk assessment of each operation, the results should be obtained in IQSMS, as well as the Long-term Operation Hazard Logs must be performed to ensure the encompassment of each operations' hazards into a single log.

5.2 Client A Operation

As stated in Table 12, EAA's operation on behalf of Client A was performed with three aircraft from its B767-300ER fleet: CS-TKR (MSN 30854), CS-TKS (MSN 30841) and CS-TSV (MSN 33049). Its base was located in KEF/BIKF and flights were performed to the following destinations: Amsterdam Schiphol Airport (AMS/EHAM), Netherlands; Charles de Gaulle International Airport (CDG/LFPG), France; Copenhagen Kastrup Airport (CPH/EKCH), Denmark; Oslo Gardermoen Airport (OSL/ENGM), Norway; Toronto Lester B Pearson International Airport (YYZ/CYYZ), Canada; and Boston Logan International Airport (BOS/KBOS), United States of America. The following Table 13 describes several airport relevant parameters that were considered for the risk assessment.

Table 13 – Operated Airports OBO Client A Categorization (Own Elaboration).

Aerodrome	IATA Code	ICAO Code	Airport Cat.	RFFS	Runway	Lenght (m)	Pavement Surface	PCN	Maintenance Provider
Reykjavík–Keflavík International Airport	KEF	BIKF	B	9	02/20	3065	Asphalt	73 F/A/W/T	Provider A
					11/29	3054	Asphalt	80 F/A/W/T	
Amsterdam Schiphol Airport	AMS	EHAM	B	10	04/22	2014	Asphalt	79/F/C/W/T	Provider B
					06/24	3500	Asphalt	90/F/C/W/T	
					09/27	3453	Asphalt	90/F/C/W/T	
					18C/36C	3300	Asphalt	90/F/C/W/T	

					18L/36R	3400	Asphalt	90/F/C/W/T	
					18R/36L	3800	Asphalt	90/F/C/W/T	
Charles de Gaulle International Airport	CDG	LFPG	B	9	08R/26L	2700	Concrete	68/R/C/W/T	Provider B
					08L/26R	4215	Asphalt	100/R/B/W/T	
					09R/27L	4200	Asphalt	100/R/B/W/T	
					09L/27R	2700	Asphalt	77/F/C/W/T	
Copenhagen Kastrup Airport	CPH	EKCH	A	9	04L/22R	3600	Asphalt	80/F/C/X/U	Provider C
					04R/22L	3300	Asphalt	80/F/C/X/U	
					12/30	3070	PEM	80/F/C/X/U	
Oslo Gardermoen Airport	OSL	ENGM	B	9	01L/19R	3600	Asphalt	75/F/A/W/T	EuroAtlantic Airways (PT.145.027)
					01R/19L	2950	Asphalt	75/F/A/W/T	
Toronto Lester B Pearson International Airport	YYZ	CYYZ	A	9	05/23	3389	PEM	79/R/B/W/T	Provider D
					15L/33R	3368	Asphalt	79/R/B/W/T	
					15R/33L	2770	Asphalt	79/R/B/W/T	
					6L/24R	2956	Asphalt	79/R/B/W/T	
					6R/24L	2743	Asphalt	79/R/B/W/T	
Boston Logan International Airport	BOS	KBOS	B	10	04L/22R	2397	Asphalt	90/F/C/W/T	Provider E
					04R/22L	3050	Asphalt	90/F/C/W/T	
					15R/33L	3073	Asphalt	90/F/C/W/T	

The outcomes from the airport risk assessments performed for the operated airports are its hazards, risk classification and mitigation strategies that must be included in the final result of the Client A's operation risk assessment together with the selected general operational hazards. Due to hazard's list size, is shown in Appendix 6.

In operations base, KEF/BIKF, where a large westerly magnetic variation, five hazards were identified. This airport is considered by EAA as a Category B airport. As per regulatory requirements, stated in Chapter 4, crews must follow EAA SOP's guidance in EAA Operations Manual Part C for the considered airport risk mitigations. The remaining four hazards were related to seasonal weather phenomena: frequent snow storm, severe ice, wind shear and fog. Snow storms and severe ice were only selected due to be very frequent during autumn and winter seasons. Considering the operation calendar, those two hazards frequency are extremely improbable. Nevertheless, mitigations strategies were identified and listed in Table 14. Regarding wind shear, it can occur during all year with speeds over 50kt in winter and over 35kt during summer. As a consequence, crosswinds must be highly prevented. With this, crews must follow ATC instructions and its Enhanced Ground Proximity Warning System (EGPWS) outputs. Between the months of June to November fog is also frequently reported in airport's vicinity. During this period several flights, depending on departure airport, require prior approval to land in KEF before departing. Nevertheless, all EAA aircraft are certified to perform up to ILS Category IIIB landing.

Amsterdam Schiphol Airport (AMS/EHAM) had several recognized hazards. Circling procedures may be required due to high traffic demand, leading to low altitude and airspeed manoeuvres. Considering that circling flight is tested in simulator conditions, crew briefing before departure will increase its awareness for circling procedures notwithstanding aircraft performance under those conditions. Bird strike events in this aerodrome are often reported and have already occurred to EAA in the past. In case of bird concentration seen in airport's vicinity crews will be informed by ATS and appropriate actions must be given. Netherland's largest airport is considered a category B airport due to the low altitude circling requirements. With this, crew briefing before departure is required and shall be addressed in accordance with EAA standard operating procedures for the considered airport. Snow storms are prone to occur during winter and autumn seasons, which was not the operated period of these flights.

Charles de Gaulle Airport (CDG/LFPG) is considered a Category B airport due to its four parallel runways which require frequent runway incursions. In order to prevent any damage to property crews shall follow EAA Route and Aerodrome Instructions and Information, where all the procedures for taxing and vacating a TWY or RWY in CDG are detailed. Additionally, in summer season severe turbulence can be expected with easterly wind gradient. Special attention must be taken while approaching, landing and taking-off under these weather conditions due to parallel RWY's. Visual Separation must be maintained. Crews must also avoid to deviate from route's centreline during these moments.

Copenhagen Kastrup Airport (CPH/EKCH), is considered the main airport of Denmark. It has gathered two hazards related to weather conditions: snow storm and wind shear. Although the extremely improbable likelihood of occurring the first hazard during this operation's period, wind shear is a commonly recorded weather phenomenon. To prevent these types of occurrences, as previously mentioned, all EAA aircraft are equipped with EGPWS alerting the crew for wind shear in advance.

Oslo Gardermoen Airport (OSL/ENGM) is considered a Category B airport for all EAA aircraft due to European regulatory considerations for circle to land procedures being greater than 1000 ft AAL. As previously stated, crew briefing before departure is required in order to guarantee crews awareness for aircraft performance under required circling procedures. Severe ice and snow storms are frequently faced during winter and autumn seasons. A handling service hazard due to unexperienced staff in operated aircraft type was reported during the operation, and therefore included in the outcomes of this assessment. An IO must be part of the crew as stated in EAA's Booklet for Cargo Flight and in EAA Cargo Operations Manual.

Toronto Lester B Pearson International Airport (YYZ/CYYZ) is a Category A airport which foresees a smooth operation. Nevertheless, during winter seasons snow storms are frequently reported as one of the adverse weather conditions. Crews must follow ATC instructions along with its weather radar outputs. In these occasions, de-icing and anti-icing must be requested.

Boston Logan International Airport (BOS/KBOS) is considered a Category B airport due to its parallel 04L/22R and 04R/22L runways being intersected by the longest runway: 15R/33L. Besides, runways 15L/33R and 09/27 crossing another two of the main runways each. Those kinds of infrastructures will then require runway incursions and vacations occasionally. EAA SOP's provide clear procedures for these situations. This airport is surrounded by water which will imply a saline atmosphere in airport's vicinities. Considering that this airport only served as a rotation airport instead of operation's base, several parking and preservation procedures will not be required. However, in case of saline accretion on aircraft's windshield crews must coordinate instructions with ATC. ATC itself has also a high workload demand which will increase talks' speed with non-standard and abbreviated inputs. Crews shall avoid occupy radio transmission, however clarify is necessary.

The risk results retrieved from IQSMS Airport Risk Assessments for the forementioned airports can be consulted in Table 14.

Table 14 - Operated Airports OBO Client A IQSMS Risk Assessment Classification for B767-300ER ((Own Elaboration).

Airport	**IQSMS Risk Classification (%)**	**Level of Risk**
KEF/BIKF	15	Medium
AMS/EHAM	15	Medium
CDG/LFPG	60	Severe
CPH/EKCH	15	Medium
OSL/ENGM	15	Medium
YYZ/CYYZ	15	Medium
BOS/KBOS	60	Severe

As can be noticed in the obtained results, IQSMS risk classification for airports declared two operated airports with a severe level of risk. Those two aerodromes were CDG and BOS. After those risks were mitigated, a tolerable level of safety was achieved, as can be seen in the results of Client A Operation Risk Assessment. The remaining aerodromes were also classified with medium level of risk, and once mitigation strategies were applied the risk level reduces to acceptable levels.

The risk assessment for Client A's operation can only be finished after evaluating the general operational hazards for this operation. With this, the following Table 15 shows the selected general operational hazards.

Table 15 – General Operational Hazards identified for Client A's operation (Own Elaboration).

Classification	Category	Hazard Identification	Possible Consequences	Risk Assessment	Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation
General Operational Hazard	Employees Needs	VISAs required to enter in considered country	If VISAs are required and crews do not hold it temporarily landing permits may be needid which require all employees to fly every 72 hours	4C Tolerable	VISAs must be issued before operation's beginning	DOV/Rosters	3C Tolerable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty from 4 to 6 hours	Crew not acclimatised to the time zone until 72 hours of time elapsed which can lead to crews' fatigue during its duty	4B Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3A Acceptable

As noticeable in Table 15, crew VISAs are required for entering and operating in USA. In this operation's case, Crew VISA will be required to operate to BOS/KBOS airport. Those required VISAs must be issued before the beginning of the operation. Regarding the second hazard, which is related to crew flight time limitations, the time difference between reference time (KEF – UTC time) and local time where the crew will start the next duty, in the case of flights to BOS/KBOS and YYZ/CYYZ (UTC -4h during operation's period), was 4 hours. Crew will therefore not be acclimatised to the time zone within 72 hours of elapsed time. If the operator decides to augment the number of flight crew members, the required resting period diminishes.

Appendix 7 shows the final result of Client A's Operation Risk Assessment along with each identified risk, mitigation strategies encompassing its hazard log.

5.3 Client B Operation

As forementioned in Chapter 4, the operation whose more cycles were performed occurred on behalf of Client B, an airline company based in Lagos Murtala Muhammed International Airport (LOS/DNMM). The aircraft involved was EAA's B737-800 CS-TQU (MSN: 30646) performing domestic flights to and from Nnamdi Azikiwe Abuja International (ABV/DNAA), Port Harcourt International Airport (PHC/DNPO), Mallam Aminu Kano International Airport (KAN/DNKN), Yola Airport (YOL/DNYO) and Sam Mbakwe International Cargo Airport (QOW/DNIM). Table 16 describes further information regarding Nigerian operated airports.

Table 16 – Operated Airports OBO Client B Categorization (Own Elaboration)

Aerodrome	IATA Code	ICAO Code	Airport Cat.	RFFS	Runway	Lenght (m)	Pavement Surface	PCN/LCN	Maintenance Provider
Lagos Murtala Muhammed International Airport	LOS	DNMM	B	9	18R/36L	3900	Asphalt	89/F/B/W/T	EuroAtlantic Airways (PT.145.027)
					18L/36R	2745	Asphalt	91/F/B/W/T	
Nnamdi Azikiwe Abuja International Airport	ABV	DNAA	B	9	04/22	3610	PEM	98/F/B/X/T	
Port Harcourt International Airport	PHC	DNPO	A	8	21/03	3000	PEM	92/F/B/W/T	
Mallam Aminu Kano International Airport	KAN	DNKN	B	9	06/24	3300	Asphalt	90	
Yola Airport	YOL	DNYO	B	6	17/35	3000	PEM	50	
Sam Mbakwe International Cargo Airport	QOW	DNIM	B	6	17/35	2700	PEM	55	

Client B's operational hub (LOS/DNMM) and headquarters are located in Ikeja, Lagos. This airport is currently under expansion, as a new international terminal is being built. Still, it possesses five terminals besides two runways, 18R/36L for international and night arrivals and departures, and 18L/38R for domestic flights. Regarding its terminals, there are two domestic terminals (DT1 and DT2 which is also known as MMA2), an international terminal, a general aviation terminal and a cargo and pilgrim terminal. It is one of the busiest airports in the African continent. EAA was based in this aerodrome during the operation. The aircraft night stop was always done in its base to perform all preventive, and planned maintenance.

LOS is classified as a Category B airport which requires a crew briefing before departure due to ATC issues due to inbound clearances which must be obtained before crossing Lagos UTA boundary. Current weather conditions must also be debated in order to aware flight crew along with general aerodrome deficits. Regarding its risks, three are related to approach aids and patterns, two to seasonal weather phenomena, employees' necessities has also two identified hazards while concerning aircraft hazards, handling services, RWY and TWY general considerations gathered two and three identified hazards.

Deficiencies in RWY and airport lights are likely to occur causing misunderstandings during the approach. Crews must consult NOTAM's as this type of information is always spread in the considered publications. LOS is a joint civilian a military aerodrome. As military navigation and communication systems are different, its traffic information will be unavailable to all operators. Crews must be aware of traffic information and follow ATC instructions to have clearances.

Weather phenomena are also very likely to occur in Lagos. Although instability rain may occur during any month of the year the rainy season is from May to July, while a secondary maximum occurs in October. Besides, in West Africa during dry season, which occurs between November and March, the Harmattan occurs. It is characterised by dusty winds from Sahara Desert decreasing visibility. In accordance with Operations Manual Part C, during this season, whenever the forecast visibility is low, consider an additional one hour holding fuel. Once the Harmattan reaches the coast which normally occurs between December and January, thick dust haze is in the atmosphere. Low cloud is frequent in the early morning with fog almost occurring in a daily basis during these months. Each EAA aircraft is approved to perform up to Cat. IIIB landings that only require at least 75 meters of RVR, mitigating fog's risks. Regarding dust and sand storms, accumulation of impurities will reduce lifespan and damage aircraft's components. To avoid these risks, maintenance personnel must cover all air data probes as well as engines' inlet cowls during night stops.

Employees needs identified hazards were VISA requirement to enter in the considered country and operate in all Nigerian airports, as well as no permanent airport badge issuance for maintenance personnel. For the first hazard, DOV/Roasters and DME/MOP must ensure VISA issuance before the beginning of an operation and smooth renewals if needed. Concerning access badges, since airport access to maintenance personnel is granted on a daily basis and must be renewed every 12 hours, there is a high risk of aircraft rotation delays and increased downtimes in case of any impediment for badge issuance.

Handling services are also a field of activities prone to be hazardous. Incorrect cargo loading often occurs providing wrong weight data to the crew. An IO must always be on board to guarantee correct cargo loading. In case of any doubt, EAA's booklet for cargo flight recommendations provides all required information. Marshalling is also wrongly performed and sometimes no marshal arrives to the apron to park the aircraft. Crews must be aware for these situations and reduce taxiing speed while maintenance personnel and ground staff shall support crew while towing.

As previously stated, this airport is currently under construction which can impact the operations and increase FOD's in RWY's and TWY's. In case of unreliable access routing, communication, FOD' and dust control, etc. EAA must report to the competent authority. Power cuts also occur regularly, limiting ATC communications and aerodrome lightning. Do not rely on its lightning neither on ATC lack of communication. Exercise caution during taxi due to uncontrolled vehicular and pedestrian movements Bird strike is also a hazard susceptible to occur. If large concentration of birds in airport's vicinity is seen ATC must inform all operators and provide appropriate actions.

The second most operated airport in this operation was Nnamdi Azikiwe International Airport (ABV/DNAA) in Abuja. It is also classified as a category B airport due to the significant terrain and weather conditions during certain seasons. This aerodrome is surrounded by mountains in north and southwest of the areas. This geography can cause windshear, updrafts and downdrafts, turbulence and mountain waves. EGPWS is installed in all EAA aircraft and these occurrences are practiced in simulators. Nevertheless, approach limitations must be discussed in the crew briefing. ABV is a both a civilian and a military aerodrome and military traffic may be unavailable. Crew must be aware of traffic information and follow ATC instructions. Weather conditions can be hazardous during winter when Harmattan winds bring dust storms resulting in poor visibility and during summer because line squalls may occur. Incorrect cargo loading is also prone to happen due to the high demand of work. Cargo loading must always be supervised in order to guarantee correct cargo weight loading in accordance with flight crew requirements. Finally, animal and bird hazards can occur damaging aircraft equipment and airframe structure. If any wildlife that may damage property is seen in airport's vicinity, ATC shall inform operators and provide instructions.

Port Harcourt International Airport (PHC/DNPO) is the third largest and busiest aerodrome in Nigeria behind LOS and ABV. However, PHC is considered a Category A airport by EAA. Nevertheless, adverse weather phenomena are frequently reported due to heavy rains and sand storms due to the Harmattan. Furthermore, bird strike hazards and incorrect cargo loading are also considered hazards. Additionally, lack of EASA certified organisations is noticeable in PHC. In case of preventive maintenance required before continuing operation the aircraft will be AOG until a certified organization performs the defect rectification. To mitigate this risk, EAA Part 145 certifying staff must always be on board as flying spanner.

Even operating with a certified technician on board, if any component needs to be replaced, a longstanding AOG may occur due to the difficulty in getting EASA approved parts in PHC. EAA must ensure a smooth cooperation with client's logistic departments to guarantee required part on site as soon as possible.

Mallam Aminu Kano Airport (KAN/DNKN) is the main airport in northern Nigeria serving Kano State. This is also classified as a category B aerodrome due to several hazards. Deficiencies in RWY and TWY lights are common causing visual misunderstandings during approach and taxi. Adverse weather conditions can be usually felt. Line squalls moving from east to west during the spring. Those are characterised by long lines of dark clouds, rapid rise in wind speed, heavy rain and wind shear. Crews must follow SOP's guidance for operating under these conditions and pay special attention to EGPWS and weather radar system to understand the upcoming weather. These themes must be discussed in crew briefing before operate to and from KAN. Bird strikes can also occur due to the huge wildlife richness of Nigeria. ATC must inform all operators of birds' presence and give proper instructions. Regarding aircraft maintenance considerations, several hazards were risen. No base maintenance facilities to perform major maintenance can be found in this aerodrome. As this aerodrome was only used to perform short rotations, base maintenance facilities will not be required. Nevertheless, DME/MOP must ensure capability to perform major line maintenance tasks in case of any defect rectification required to release the aircraft to service. As in KAN there are also no EASA certified Part 145 organizations, EAA must ensure enough man power allocated to the considered operation to have a flying spanner on board while operating to KAN. As there are no certified maintenance organisations, certified tools will not also be available. To avoid any delay or AOG due to lack of tools, the aircraft must operate with a fly-away-kit on board with spare parts and tools for defect rectification. As a result of lack of international flights to KAN, there is a huge difficulty to get EASA certified components on time without implying AOG status for over a day. With this, EAA shall ensure quickest plans to get certified parts on site in KAN.

Yola International Airport (YOL/DNYO) provides support to Yola city, the capital of Adamawa State. This aerodrome is located under a Class E airspace. IFR and VFR operations are allowed. IFR flights are separated from other IFR flights. ATC service is provided, but traffic information is unreliable. All EAA aircraft are equipped with traffic and collision avoidance systems (TCAS). Crew shall rely on its outputs as well as the reported attitudes of other aircraft.

YOL is classified as a Category B aerodrome due to deficiencies in runway lightning, adverse weather conditions and lack of ground operation services. As previously described, YOL airport usually has deficits in its lightning system thus, no night flights are allowed. It is a combined civil and military airport. Military aircraft traffic information will be unavailable so crew must be aware of ATC instructions and guidance.

Adverse weather conditions are related to Harmattan dust storms decreasing visibility and heavy rains and thunderstorms causing loss of aircraft's control. Crews must follow weather radar outputs to understand the weather ahead, and SOP's guidance for low visibility operations.

The absence of handling services in YOL can also become a hazard. No potable water servicing is available so cabin crew must ensure full water servicing before departing to YOL otherwise potable water tanks can become empty. Additionally, no air starter is available in this aerodrome. Air starter units are used in case of no APU available to provide a large volume of compressed air to start rotating engine's compressor spools before igniting the engines. Normally APU is available, however due to operational requirements the aircraft can be released to service with no APU to continue operating. With this, and with no air starter equipment the aircraft cannot operate. To mitigate this risks EAA maintenance coordinator shall priorly guarantee air starter availability in the considered aerodrome, APU snag rectification or, in case of an unscheduled defect that cannot be solved in time inform the client of this incapacity. Bird strikes can also remotely occur and mitigation strategies have already been described. YOL rescue and firefighting capabilities are classified as Level 6 and CS-TQU, B737-800 requires at least a Level 7 capability. To mitigate this hazard's risks, flight crew must not only request ATC for RFFS assistance during ground operations, but also park in remote areas and not embark passengers while refuelling.

YOL gathers several maintenance related hazards that can result in flight delays or longstanding AOG's. No base maintenance facilities can be found in YOL, so EAA must ensure along with the client full support to perform any heavy line maintenance task to put the airplane back in service. Additionally, there are no EASA certified Part 145 organisations implying lack of ground handling equipment, tools and spare components to rectify any defect.

An EAA certifying technician must be on board as flying spanner to release the aircraft in YOL. Regarding lack of tools and spare parts, a fly-away-kit must always be on board to avoid any delay.

Lastly is Sam Mbakwe International Cargo Airport (QOW/DNIM) located in Owerri city, the capital of Imo State, in southeast of Nigeria. This aerodrome is a Category B airport implying a crew briefing to discussed main unusual characteristics of the considered aerodrome and flight. Adverse weather conditions are likely to occur all over the year. During rainy seasons between March and May and October and November heavy rains and thunderstorms are usual, so crews must be aware of weather radar outputs to decide flights route. Harmattan also happens in Owerri region which is recognized by low visibility operations under dust and sand storms. Crew's shall discuss this concern during the briefing to guarantee SOP's knowledge for operating in low visibility environments. As all other Nigerian aerodrome's, in QOW there also a risk bird strike hazard. Along with YOL airport, RFFS level is 6. As B737-800 requires level 7, crew must request RFFS assistance during rotation, park in remote areas and embark only after refuelling has finished.

Regarding QOW's maintenance related hazards, there are no base maintenance facilities, certified EASA Part 145 organisations, nor certified tools and components. As these risks are also inherent to YOL airport, its mitigation strategies were previously referred.

Airport risk classification in accordance with IQSMS are the following listed in Table 17.

Table 17 – Operated Airports OBO Client B IQSMS Risk Assessment Classification for B737-800 (Own Elaboration).

Airport	IQSMS Risk Classification (%)	Level of Risk
LOS/DNMM	60	Severe
ABV/DNAA	60	Severe
PHC/DNPO	60	Severe
KAN/DNKN	60	Severe
YOL/DNYO	60	Severe
QOW/DNIM	60	Severe

All airports have the same level of risk: severe. This occurs due to some intolerable risks such as bird strike hazards which were inherent to all aerodromes. Those risks, once mitigated reach tolerable and acceptable levels of safety. However, IQSMS does not allow to classify the risks after mitigate which implies the severe level and the same classification to all aerodromes.

Client B's operation risk assessment is not completed until identifying the general operational hazards. Those risks are shown in Table 18.

Table 18 – General Operational Hazards of Client B's operation (Own Elaboration).

Classification	Category	Hazard Identification	Possible Consequences	Risk Assessment	Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation
General Operational Hazard	Employees Needs	Employees duty periods do not comply with regulatory requirements for resting days between shifts	Employees stress and tiredness will increase affecting their effectiveness on duty	3E Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods that comply with regulations	DME/MOP DOV/Roasters DOT	1B Tolerable
General Operational Hazard	Flight Time Limitations	Multpiple Sectors Operated	Increased fatigue levels and reduced FDP	4A Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1B Acceptable

As per the information provided in Table 18, two hazards were identified. Regarding employees' duty periods that did not comply with regulatory requirements, in the beginning of the operation schedule demand has increased requiring a higher number of maintenance personnel to be flying spanners, to perform transit assistances during the day in LOS as well as all predictive and preventive maintenance during night stoppages. Due to the high flight demand, as previously stated a mean of approximately 7 FC were performed per day during the entire operation. This schedule requires multiple sectors operation by the crews. This will increase fatigue levels and reduce FDP. With this, operator could operate with an augmented flight crew. However, EAA has decided to decrease operated sectors to four per crew maintaining all allocated crews with enough resting period to guarantee reduced fatigue and stress levels.

Appendix 8 shows all identified airport and general operational hazards for Client B's operation in its hazard log, along with appropriate risk mitigation strategies, responsibilities and risk classification after mitigations were applied.

5.4 Client C Operation

This final operation whose risk was assessed was performed OBO Client C with CS-TKT (MSN: 30853) a B767-300ER. Although Client C's hub is located in Oslo Gardermoen Airport (OSL/ENGM), this operation's base was placed in Rome Fiumicino Leonardo da Vinci Airport (FCO/LIRF). During the 40 days of operation, flights to Charles de Gaulle International Airport (CDG/LFPG), Boston Logan International Airport (BOS/KBOS), Newark Liberty International Airport (EWR/KEWR), Copenhagen Kastrup Airport (CPH/EKCH) and John F Kennedy International Airport (JFK/KJFK) were performed. Table 19 describes operated airports' additional information which will be useful for the risk assessments.

Table 19 – Operated Airports OBO Client C Categorization (Own Elaboration)

Aerodrome	IATA Code	ICAO Code	Airport Cat.	RFFS	Runway	Lenght (m)	Pavement Surface	PCN	Maintenance Provider
Charles de Gaulle International Airport	CDG	LFPG	B	9	08R/26L	2700	Concrete	68/R/C/W/T	Provider B
					08L/26R	4215	Asphalt	100/R/B/W/T	
					09R/27L	4200	Asphalt	100/R/B/W/T	
					09L/27R	2700	Asphalt	77/F/C/W/T	
Boston Logan International Airport	BOS	KBOS	B	10	04L/22R	2397	Asphalt	90/F/C/W/T	Provider E
					04R/22L	3050	Asphalt	90/F/C/W/T	
					15R/33L	3073	Asphalt	90/F/C/W/T	
Rome Fiumicino Leonardo da Vinci Airport	FCO	LIRF	A	10	07/25	3309	Concrete	140/R/D/W/T	EuroAtlantic Airways (PT.145.027) and Provider F
					16L/34R	3900	Concrete	140/R/D/W/T	
					16C/34C	3600	Concrete	120/R/C/W/T	
					16R/34L	3900	Concrete	118/R/C/W/T	
Newark Liberty International Airport	EWR	KEWR	B	10	04L/22R	3352	Asphalt	96/R/B/X/T	Provider G
					04R/22L	3048	Asphalt	96/R/B/W/T	
					11/29	2073	PEM	96/R/B/W/T	
Copenhagen Kastrup Airport	CPH	EKCH	A	9	04L/22R	3600	Asphalt	80/F/C/X/U	Provider C
					04R/22L	3300	Asphalt	80/F/C/X/U	
					12/30	3070	PEM	80/F/C/X/U	
John F Kennedy International Airport	JFK	KJFK	B	10	13L/31R	3048	Asphalt	90/F/B/W/T	Provider G
					13R/31L	4423	Asphalt	98/R/B/W/T	
					04R/22L	2560	Asphalt	90/F/B/W/T	
					04L/22R	3681	Asphalt	90/F/B/W/T	

The results of this operation's risk assessment included the outcomes of each operated airport risk assessment along with general operational hazards that may occur during the referred operation. Thus, all hazards, risk classification and mitigation strategies that encompass Client C's operation risk assessment can be seen in Appendix 9.

Rome Fiumicino Leonardo da Vinci Airport (FCO/LIRF) was the operational base of this operation. This aerodrome possesses all the conditions for this fleet to operate with no limitations. Therefore, it is considered a Category A airport. To support this categorisation no tolerable nor intolerable risks concerned to FCO were selected.

Newark Liberty International Airport (EWR/KEWR) is located about 24km southwest of Manhattan, New York City. As per EAA Operations Manual Part C, it is classified as a Category B aerodrome which requires crew briefing before flight. The main reason for this classification is the high traffic volume which implies an increased ATC workload. Non-standard phraseology and a busy environment will be found. Crews shall not occupy the radio transmission, however shall request ATC to speak in accordance with ICAO standards to clarify instructions. Regarding Newark's seasonal weather, during winter heavy snowfalls occur. In summer morning sea fog and low clouds are frequently reported continuing into afternoon. Besides low visibility, EAA aircraft are certified to land with a RVR up to 75m. Yet, crew must request approval before approaching the considered aerodrome. Flocks of birds are rarely seen in airports vicinity nevertheless the risk was considered. ATC must communicate to all crews the presence of birds and tale appropriate actions.

John F Kennedy International Airport (JFK/KJFK) is a major international airport granting all necessary conditions to EAA aircraft operation. It is classified as Category B airport due to the high traffic demand implying limited communications with ATC. A crew briefing must occur before each flight to and from this aerodrome where strategies to mitigate ATC fast, non-standard and abbreviated wording must be established. Speak slowly while request ATC to clarify any instruction is acknowledged that will make ATC operator speak clearly. During autumn and winter seasons moderate to heavy snow and rain occur due to a deep low pressure along the East Coast of USA and Canada, named Nor'easter. To mitigate this climate harsh de-icing and anti-icing shall be requested prior departure, ATC instructions must be followed and crew use SOP's guidance for operating in adverse conditions in case of any confusion. Nevertheless, all EAA aircraft are equipped with weather radar system which shows the weather conditions ahead.

Since the remaining operated airports were also flown in Client A's operation, its risks and mitigation strategies were already discussed in its sub-Chapter.

The risk assessment results in IQSMS from operated airports OBO Client C are shown in Table 20.

Table 20 – Operated Airports OBO Client C IQSMS Risk Assessment Classification for B767-300ER (Own Elaboration).

Airport	IQSMS Risk Classification (%)	Level of Risk
FCO/LIRF	15	Medium
EWR/KEWR	60	Severe
CDG/LFPG	60	Severe
JFK/KJFK	15	Medium
CPH/EKCH	15	Medium
BOS/KBOS	60	Severe

Regarding Client C's general operational hazards, flight time limitations was the hazard category more emphasised because of the long flights performed between the European and the American continents. With a time-difference between reference time and local time where the crew member starts the next duty from 6 to 9 hours, crews would not be acclimatised to the time zone until 96 hours of elapsed time. Operator can extend its flight crews in order to reduce the required acclimatisation period, or guarantee at least 96 hours before next duty.

As a consequence of the flight schedule demand, several crew flight duty periods were almost exceeded which could cause a delay or flight cancelation in case of a previous delay due to operational or maintenance reasons. Ensure a stand-by crew fit for duty at least in the operative base, and operate with augmented flight crews.

The considered general operational hazards are shown in Table 21.

Table 21 – General Operational Hazards of Client C's operation (Own Elaboration).

<table>
<tr><th>Classification</th><th>Category</th><th>Hazard Identification</th><th>Possible Consequences</th><th>Risk Assessment</th><th>Mitigation measures</th><th>Department Responsible for Risk Mitigation</th><th>Risk Assessment After Mitigation</th></tr>
<tr><td rowspan="2">General Operational Hazard</td><td rowspan="2">Flight Time Limitations</td><td rowspan="2">Time difference between reference time and local time where the crew member starts the next duty from 6 to 9 hours</td><td rowspan="2">Crew not acclimatised to the time zone until 96 hours of time elapsed which can lead to crews' fatigue during its duty</td><td rowspan="2">3C
Tolerable</td><td>Operate with Augmented Flight Crew</td><td>DOV/Rosters</td><td>3B
Tolerable</td></tr>
<tr><td>Ensure a resting period of at least 96 hours before next duty</td><td>DOV/Rosters</td><td>1A
Acceptable</td></tr>
</table>

General Operational Hazard	Flight Time Limitations	Crew's FDP almost exceeded	Flight cancelation or delay	2D Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1B Acceptable
					Ensure a stand-by crew fit for duty in the considered home-base	DOV/Rosters	1A Acceptable

5.5 Conclusion

Complete Clients A, B and C operations risk assessments are represented, in Appendix 7, Appendix 8 and Appendix 9, respectively. These risk assessments encompass airport related hazards and general operational hazards. The identified hazards, possible consequences, risk assessment into severity and tolerability, risk mitigation strategies, department responsibilities and risk classification after mitigation procedures were applied for each operation are also stated in the forementioned appendixes.

During this Chapter the results of operation's risk assessment were obtained, thanks to several important information regarding operated airports and general operational conditions gathered to perform the risk assessments. The evaluations to the operated airports were then performed in IQSMS airport evaluation module to test the model. Conclusions were reached, being described in Chapter 6. In a final stage of this chapter, IQSMS results and Operational Hazard Logs were generated for each of the assessed operations, encompassing all identified hazards that must be mitigated, along with its respective mitigation strategies to prevent or lower those risks.

Folha em Branco

Chapter 6 – Conclusion

6.1 Dissertation Synthesis

During the development of this dissertation several steps have been overtaken to accomplish the study results. After EAA proposal for organisation's risk assessment evaluation and improvement, the dissertation project has emerged. A deep study of company's structure, certifications and types of operations was achieved due to a couple of years working in DME/MOP department. Several technical representative and maintenance coordination roles were performed, including in a couple of the studied operations. This involvement on site in the day-to-day activities during the operations made me understand about the object of this dissertation, the operational sector of an airline company, and drove my motivation to meet the proposed goal. Each operational area of the company was analysed over its operational hazards and inherent risk management strategies to reduce the associated risks and prevent undesirable events to occur.

Nevertheless, an incisive state of art manuals, reports and studies were analysed aiming to get a wide comprehension of the examined subjects. Regulations applicable to each operational sector along with its requirements were also reviewed to guarantee the previously stated goal. Additionally, IQSMS was properly introduced in order to explain its importance during the project.

The methods for gathering the identified hazards were then described. Meetings with each operational sector's manager and safety representative were performed where all studied bibliography related to each area was discussed as well as their own identified hazards and mitigation techniques. Complete information gathered to implement the long-term operations hazard log arise from the forementioned references together with the outcomes of the meetings realised with all operational areas.

Once those hazards were separated into airport related hazards or general operational concerns the Operational Risk Assessment was ready to be performed after the airport hazards were introduced in IQSMS. With this, each operated airport related hazards for each operation can be analysed through IQSMS while the general operational concerns must also be included in the outcomes of the Operational Risk Assessment.

To test and guarantee the effectiveness of the proposed risk management model, the Operational Risk Assessment was performed to three of the most demanding operations of the years 2019 and 2020. For this purpose, premises to define the analysed operations were established based on different types of demanding operations.

The proposed objective was then accomplished, where each operational sector was scrutinized regarding its operational hazards and risk mitigation strategies to avoid, or reduce the impact of each hazard. Regarding EAA's strategy for hazard identification and consequent risk assessment, the current way to analyse each hazard through a single risk assessment is accurate. This is considered a good procedure to introduce each hazard into the risk management system. Afterwards, procedures must be established to ensure the considered risk assessment is not forgotten. The identified hazard and suggested mitigation strategies must be uploaded to EAA's Hazard List as well as for Operational Risk Assessment Matrix in case of an operational hazard.

Besides the achievement of the proposed objectives, there was a result that was not expected, which was the incoherency of the percentual results obtained in the IQSMS Airport Evaluation Module for the operated airports. These inconsistent results support regulatory guidelines to evaluate and classify the hazards and related risks into severity and likelihood, preventing ambiguous outcomes. Considering the incapacity of IQSMS Aerodrome Evaluation and Flight Risk Modules to comply with those standards, EAA should use a cost control mindset on this theme and review the celebrated agreement with IQSMS platform to remove those to modules, or exchange those into more valuable ones. After the evaluation of the proposed risk assessment strategy, the new model for long-term operations is ready to be used by EAA in case of finding it advantageous, by retrieving the outcomes from the Long-term Operational Hazard Log. New risk assessments for any potential operation can be performed through this model, and the potential hazards could be primarily identified before the contract signature. Certain hazards could be mitigated in advance before the beginning of the operation.

6.2 Concluding Remarks

A wide variety of conclusions can be retrieved from this study, however the most important one is what EAA Safety Department was trying to understand: if performing a separate risk assessment for each hazard is more appropriate than include all related hazards into the same risk assessment. With this, reached conclusions determine that each new hazard must be introduced in EAA Risk Management through the current risk assessment model, described in EAA-SAF-042. Once that hazard is classified and its risks mitigation strategies found, if it is considered an operational hazard, it must be included in the long-term operational hazard log as well as in airport risk assessment

IQSMS matrix in case of airport-related hazard. Otherwise, in case of a non-operational risk, it shall be included in EAA hazard list. These measures not only guarantee continuous tracking and awareness of all identified hazard, but also knowledge of the mitigation strategies.

IQSMS module for Airport Risk Assessment becomes unnecessary due to several reasons. Firstly, its risk assessment classifications are considered unclear as it does not allow the user to classify each risk after mitigation strategies were applied. With this, final risk classification is automatically downgraded by one level. Another proof of its ambiguousness is that, even with no selected medium nor high risk values, the final airport risk classification is 15%. This case occurs in FCO/LIRF IQSMS Airport Risk Assessment, for example.

Its superfluous usefulness arises due to the forementioned reasons along with the fact that EAA only uses IQSMS Airport Risk Assessment module as an interface to perform the risk assessments. All data required for risk assessment is provided by EAA, so an internal procedure defining a new homemade interface to perform airport risk assessment could be worthy in a cost reduction mindset.

An important conclusion of this study is also that classifying risks into numeric values is not a correct approach, because of being ambiguous among different risk assessment performers. Besides, each mitigation measure applied will reduce the risk into a new classification. However, what will be the numeric considerations for each risk mitigation? Very uncertainties and questions arise that make this approach dubious. A result in percentual values can be incoherent to evaluate hazards harshness and probability. Instead, each risk must be assessed through EASA's Safety Risk Assessment Matrix.

An additional important conclusion extracted from this work, is that there are several items in foreign long-term operations' preparation and management which could be improved. Regarding operations' planning, operational departments working closely, with a task force represented by a member of each one, would guarantee ensure a better cooperation and view in advance of the required needs. An efficient cost analysis check should be carried out by them, in case of operations carried out under EAA provisions. For operations management, the same task force represented by on-site and headquartered members, should carry out a continuous tracking of all operational items to ensure a safer and smoother operation. At the end, a debriefing from the operation should be required with the inputs of each participant, in anonymity if necessary, to prevent the occurrence of the same hazards and mistakes in future operations.

6.3 Prospects for Future Research

Taking into accordance the results of this research project, it is highly recommended that EAA considers the achievement of the following suggestions:

- In case of willingness to keep performing flight risk assessments in IQSMS platform, an improvement and implementation of a new checklist for flight risk assessment would be valuable, including FDM data from analysed events for each route;
- Those new risks must also be introduced in long-term operations hazard log to be used for new operations' risk assessments;
- Create an organisational functional procedure to define standards for long-term operations risk assessment;
- Operation's debriefing with all involved elements should be required in order to understand what can be improved in the future, as well as to find which hazards are likely to occur under those conditions;
- Require risk assessment analysis by each allocated employee in relation to their concerned role and hazards that are prone to occur;
- Use operations risk assessment outcomes for crew training and operational management improvement;
- Continuous improvement of long-term operations hazard log to guarantee a higher RA efficiency;
- Define procedures between Safety and Compliance Monitoring departments aiming to guarantee not only mitigation strategies appliance, but also the effectiveness of those mitigations.

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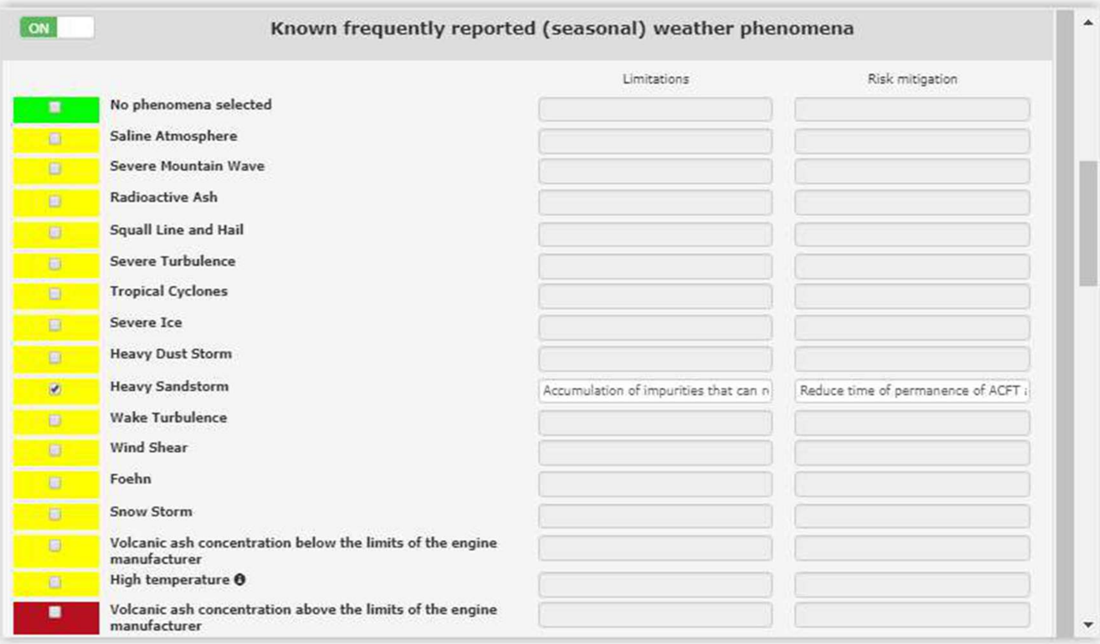
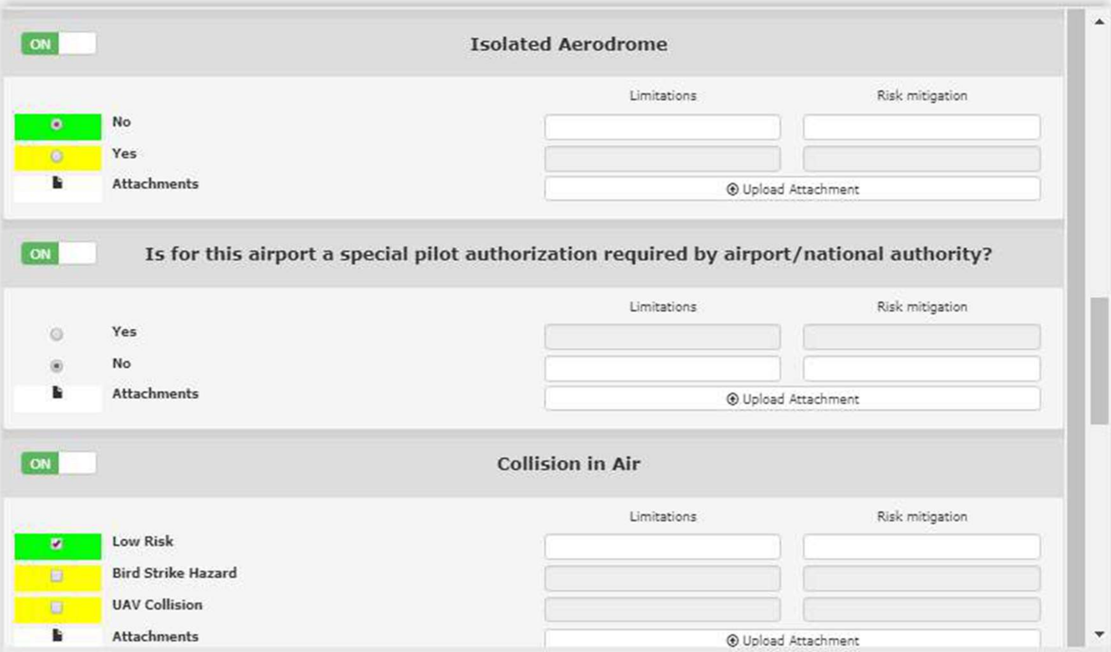
Folha em Branco

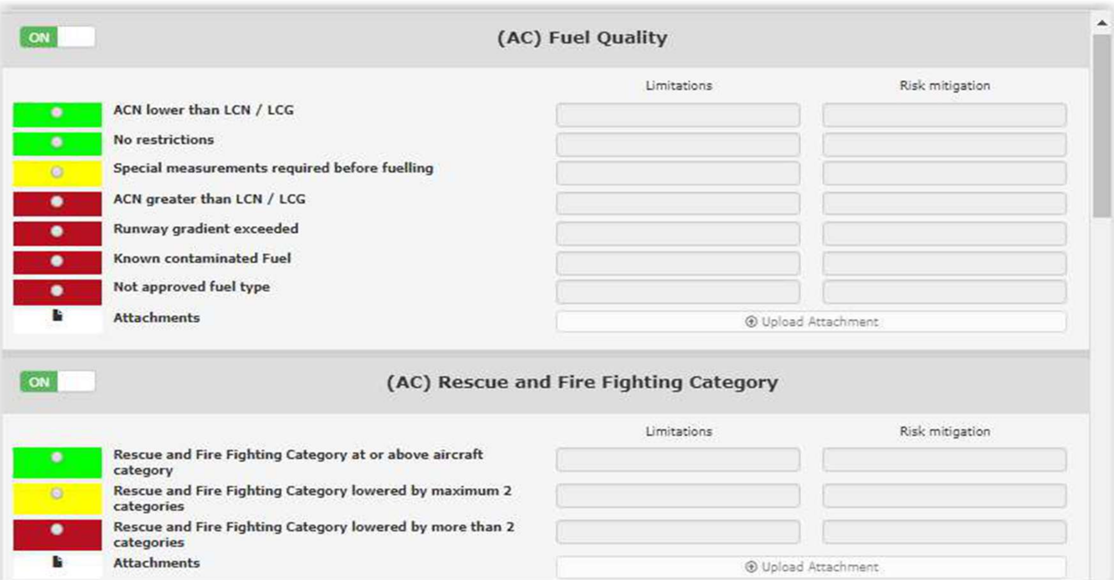
Appendixes

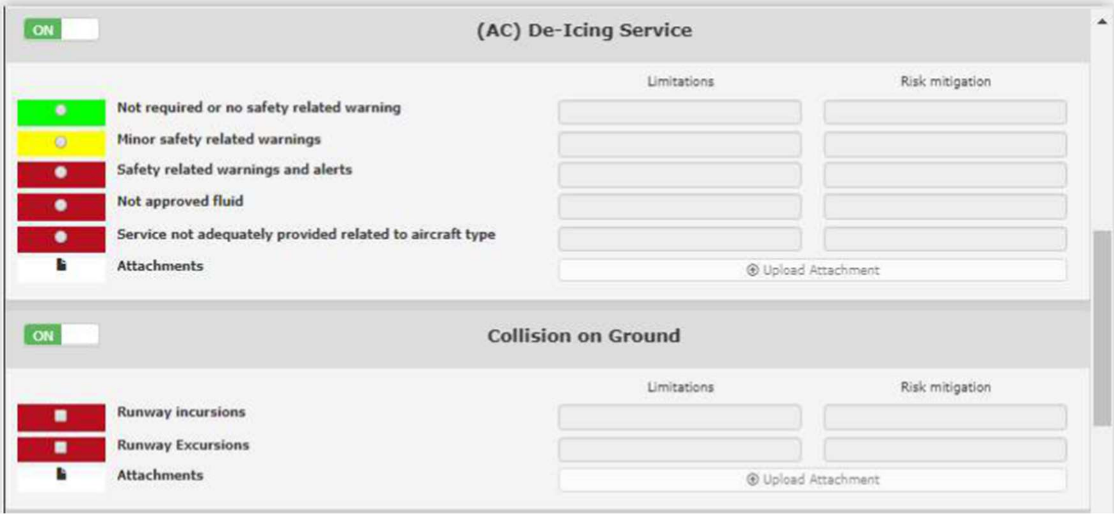
Appendix 1 – IQSMS Airport Evaluation Matrix

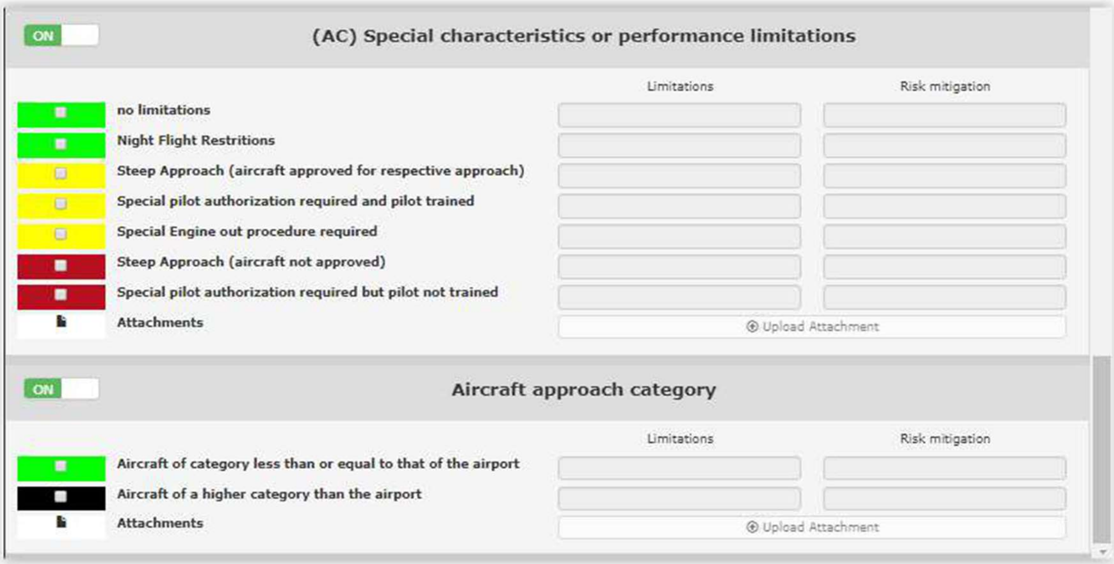



ON
Ground OPS
Limitations
Risk mitigation
Cargo Handling
Attachments
Upload Attachment
ON
Airspace Classification
Limitations
Risk mitigation
IFR and VFR traffic radar separation
Joint use with Military
Glider Activity
Uncontrolled VFR traffic
Attachments
Upload Attachment


ON
Isolated Aerodrome
Limitations
Risk mitigation
No
Yes
Attachments
Upload Attachment
ON
Is for this airport a special pilot authorization required by airport/national authority?
Limitations
Risk mitigation
Yes
No
Attachments
Upload Attachment
ON
Collision in Air
Limitations
Risk mitigation
Low Risk
Bird Strike Hazard
UAV Collision
Attachments
Upload Attachment


ON
(AC) Fuel Quality
Limitations
Risk mitigation
ACN lower than LCN / LCG
No restrictions
Special measurements required before fuelling
ACN greater than LCN / LCG
Runway gradient exceeded
Known contaminated Fuel
Not approved fuel type
Attachments
Upload Attachment
ON
(AC) Rescue and Fire Fighting Category
Limitations
Risk mitigation
Rescue and Fire Fighting Category at or above aircraft category
Rescue and Fire Fighting Category lowered by maximum 2 categories
Rescue and Fire Fighting Category lowered by more than 2 categories
Attachments
Upload Attachment


ON
(AC) De-Icing Service
Limitations
Risk mitigation
Not required or no safety related warning
Minor safety related warnings
Safety related warnings and alerts
Not approved fluid
Service not adequately provided related to aircraft type
Attachments
Upload Attachment
ON
Collision on Ground
Limitations
Risk mitigation
Runway incursions
Runway Excursions
Attachments
Upload Attachment


ON
(AC) Special characteristics or performance limitations
Limitations
Risk mitigation
no limitations
Night Flight Restritions
Steep Approach (aircraft approved for respective approach)
Special pilot authorization required and pilot trained
Special Engine out procedure required
Steep Approach (aircraft not approved)
Special pilot authorization required but pilot not trained
Attachments
Upload Attachment
ON
Aircraft approach category
Limitations
Risk mitigation
Aircraft of category less than or equal to that of the airport
Aircraft of a higher category than the airport
Attachments
Upload Attachment

Appendix 2 – Flight Operations Hazards and Mitigation Procedures

Classification	Category	Hazard Identification	Possible Consequences	Risk Classification		Mitigation Measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation	
Airport Related Hazard	Terrain and Obstacles in Approach	No relevant obstacles	None	1A	Acceptable	Not required	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Terrain and Obstacles in Approach	Surrounded by mountains	Can cause winshear, turbulence, updrafts, downdrafts and mountain waves	2D	Tolerable	EGPWS installed in all EAA's fleet	DOV/Crew Training	1D	Acceptable
Airport Related Hazard	Terrain and Obstacles in Approach	High Airport Elevation (more than 5000ft)	Unpredictable weather conditions, reduced air density detriorating aircraft's performance, probable need of special training for operating crew	3C	Tolerable	EGPWS installed in all EAA's fleet	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	Terrain and Obstacles in Approach	High Airport Elevation (more than 10000ft)	Unpredictable weather conditions, reduced air density detriorating aircraft's performance, probable need of special training for operating crew	4C	Tolerable	EGPWS installed in all EAA's fleet	DOV/Crew Training	3C	Tolerable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class A airspace	Only IFR flights allowed and ATC services provided	1A	Acceptable	Not required	DOV/Crew Training	1A	Acceptable

Airport Related Hazard	Airspace classification	Aerodrome located in a Class B airspace	IFR and VFR flights allowed and ATC services provided	1B	Acceptable	Follow ATC instructions to identify VFR operators	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class C airspace	IFR and VFR flights allowed and ATC services provided separately for IFR and VFR flights	2A	Acceptable	Follow ATC instructions for any VFR flight intersecting IFR routes	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class D airspace	IFR and VFR flights allowed and ATC services provided however IFR flights are separated from other IFR flights and from VFR flights. The same occurs with VFR flights.	2B	Acceptable	Follow ATC instructions for any VFR or IFR flight intersecting IFR routes	DOV/Crew Training	1B	Acceptable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class E airspace	IFR and VFR flights permitted, IFR flights are provided with ATC service and separated from other IFR flights. Unreliable traffic information.	3C	Tolerable	Give special attention to traffic collision avoidance systems and reported attitudes from other aircraft	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class F airspace	Only ATC separation as far as practical for IFR flights. Traffic information may be provided by relaying in other flights	3D	Tolerable	Give special attention to traffic collision avoidance systems and reported attitudes from other aircraft	DOV/Crew Training	2D	Tolerable

Airport Related Hazard	Airspace classification	Aerodrome located in a Class G airspace	Uncontrolled airspace. ATC has no authority in considered airspace	5C	Intolerable	Give special attention to traffic collision avoidance systems and reported attitudes from other aircraft	DOV/Crew Training	4C	Tolerable
Airport Related Hazard	Approach Aids and Patterns	CAT I/II/III Approach	No potential consequences	1A	Acceptable	Not required	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	VMC approach only	Damage to property due to no instrument approach and landing systems available	2B	Acceptable	Crew briefing before departure required	DOV/Crew Training	1B	Acceptable
						Additional navigation charts must be available			
Airport Related Hazard	Approach Aids and Patterns	Non Precisision Approach required	Damage to property due to no vertical guidance instrument approach and landing systems available	2A	Acceptable	Crew briefing before departure required	DOV/Crew Training	1A	Acceptable
						Additional navigation charts must be available			
Airport Related Hazard	Approach Aids and Patterns	SDF approach required	Damage to property due to no vertical guidance instrument approach and landing systems available	2A	Acceptable	Crew briefing before departure required	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Precision Approach	None	1A	Acceptable	Not required	DOV/Crew Training	1A	Acceptable

Airport Related Hazard	Approach Aids and Patterns	Circling	Maneuvers at low altitude, low airspeed and adverse weather conditions, which can result in loss of aircraft's control	2C	Tolerable	Crew briefing before departure to make sure flight crew is fully aware of aircraft performance to determine the exact circling maneuver considering the weather, unique airport design and aircraft position, altitude and airspeed	DOV/Crew Training	1B	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Incapacity to update iPad's EFB	Updated charts may not be available	3C	Tolerable	Ensure all equipment to update EFB is available in all aircraft/operations	DOT	2C	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Charts Available	None	1A	Acceptable	Not required	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Deficiences in RWY Lights	Can cause visual misunderstandings during the approach	2D	Tolerable	These deficiences are always spreaded through NOTAM's which shall be analyzed before perform any flight to/from the related airport	DOV/Flight Dispatch	1D	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Deficiences in RWY Approach Instruments	Can cause inadvert aircraft atittude change due to wrong inputs provided by the approach instruments	4D	Intolerable	Follow ATC Instructions	DOV/Flight Dispatch	2C	Tolerable

						These deficiencies are always spreaded through NOTAM's which shall be analyzed before perform any flight to/from the related airport			
Airport Related Hazard	Approach Aids and Patterns	ATC fast and abbreviated talks	Non-standard phraseology	3C	Tolerable	Request ATC to clarify instructions in accordance with ICAO standards	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	Approach Aids and Patterns	ATC with High Workload	Complex arrivals and busy ATC environment	3D	Tolerable	Avoid to occupy the radio transmission, however request clearance clarification if required	DOV/Crew Training	1D	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Runway gradient exceeded	Unstable approach	3E	Intolerable	Follow ATC instructions	DOV/Crew Training	2E	Tolerable
						Follow EAA SOP's guidance		2E	Tolerable
Airport Related Hazard	Approach Aids and Patterns	Unusual Approach Required	May require crew awareness and preventive training	3C	Tolerable	Different types of approaches are often trained in simulator	DOV/Crew Training	2B	Acceptable
						Follow EAA SOP's guidance for operating in airports unusual approach procedures		2B	Acceptable

Airport Related Hazard	Approach Aids and Patterns	Airport Category A	Approved instrument approach procedure, at least one runway with no performance limited procedure for take-off and/or landing, published circling minima not higher than 1000ft and night operations capability	1A	Acceptable	Not required	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Airport Category B	Non Standard Approach aids and / or approach patterns, or unusual local weather conditions, characteristics or performance limitations, or any other relevant considerations including obstructions, physical layout, lighting etc.	3B	Tolerable	Crew briefing before departure required	DOV/Crew Training	2B	Acceptable
						Follow EAA SOP's guidance for operating in CAT. B airports		2B	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Airport Category C	Requires additional considerations to a Category B aerodrome and is considered to pose certain problems for the approach and / or landing and / or take-off. Further training shall be required to flight crew.	4B	Tolerable	Specific training for the concerned airport shall be given and approved by chief pilot	DOV/Crew Training	3B	Tolerable

Airport Related Hazard	Airport Category vs. Aircraft Approach Category	Aircraft of category less than or equal to that of the airport	None	1A	Acceptable	Not required	DOV/Flight Dispatch	1A	Acceptable
Airport Related Hazard	Airport Category vs. Aircraft Approach Category	Aircraft of a higher category than the airport	Aircraft cannot operate in this airport	5E	Intolerable	Flight cannot be performed	DOV/Flight Dispatch	5E	Intolerable
Airport Related Hazard	Approach Aids and Patterns	Night Flight Restritions	Restrictions in airport operating hours due to limit levels of noise	2C	Tolerable	Flight dispatch must ensure airport curfew hours before perform the flight plan	DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Joint Civilian/Military AD	Military traffic information unavailable	3C	Tolerable	Be aware of traffic information and follow ATC instructions	DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	No phenomena selected	None	1A	Acceptable	Not required	DOV/Flight Dispatch	1A	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Fog in airports vicinity	Loss of sufficient RVR to perform the landing	3D	Tolerable	Previous approval shall be granted before aircraft's departure	DOV/Flight Dispatch	1D	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Squall Line and Hail	Loss of aircraft's control	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	1D	Acceptable

Airport Related Hazard	Seasonal Weather Phenomena	Severe Turbulence	Loss of aircraft's control	2E	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	1E	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Tropical Cyclones	Loss of aircraft's control	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2E	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Severe Ice	Loss of aircraft's control	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2E	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Heavy Dust/Sand Storm	Accumulation of impurities that can reduce lifespan or damage to aircraft's components	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training DME/MOP	2D	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Wake Turbulence	Loss of aircraft's control	2D	Tolerable	Follow ATC instructions	DOV/Crew Training	1D	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Wind Shear	Loss of aircraft's control	2D	Tolerable	Follow ATC instructions	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Foehn	Loss of aircraft's control	2D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2C	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Snow Storm	Loss of aircraft's control	2D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2C	Tolerable
						Request de-icing and anti-icing		2C	Tolerable
						Follow ATC instructions		2C	Tolerable

Airport Related Hazard	Seasonal Weather Phenomena	Volcanic ash concentration below the limits of the engine manufacturer	Loss of aircraft's control	3C	Tolerable	Only perform the considered flight in case volcanic ash concentration does not impact engines and air data instruments operation	DOV/Flight Dispatch	2D	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Volcanic ash concentration above the limits of the engine manufacturer	Loss of aircraft's control and damage to property	5E	Intolerable	Flight cannot be performed	DOV/Flight Dispatch	5E	Intolerable
Airport Related Hazard	Seasonal Weather Phenomena	Saline Atmosphere	Loss of visibility due to salt accretion on aircraft's windshield	2C	Tolerable	Follow ATC instructions	DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	High temperature	Deterioration of aircraft's performance	3C	Tolerable	Review the flight plan, MTOW and W&B calculations required	DOV/Crew Training and DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	Isolated Aerodrome	No	None	1A	Acceptable	Not required	DOV/Flight Dispatch	1A	Acceptable
Airport Related Hazard	Isolated Aerodrome	Yes	Flight requires prior approval by the competent authority	3C	Tolerable	Perform fuel tankering, and/or different further mitigation procedures established by the competent authority	DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	Handling Services	Transportation of passengers who require native speaking languages	Difficulty in transmit safety and evacuation procedures	4D	Intolerable	Hire native speaking approved flight attendants and administer them EAA's training	DOV/Crew Training and HR	1A	Acceptable

Airport Related Hazard	Handling Services	Inappropriate handling and carriage of dangerous goods	Uncontained fire, leakage of corrosive materials	3E	Intolerable	Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1E	Tolerable
Airport Related Hazard	Handling Services	Unrestrained/misloaded cargo	Weight Shift	2E	Tolerable	An IO must be part of the crew	DOT and DOV	1E	Tolerable
						Follow EAA's Booklet for Cargo Flight recommendations		1E	Tolerable
Airport Related Hazard	Handling Services	Handling provider unexperienced in aircraft type	Damage to cargo goods, and property	2E	Tolerable	An IO must be part of the crew	DOT and DOV	1E	Tolerable
						Follow EAA's Booklet for Cargo Flight recommendations		1E	Tolerable
Airport Related Hazard	Handling Services	Old/innapropriate handling equipment	Departure delays and/or unaccomplishment of certain services	2D	Tolerable	During contract negotiation ensure further ground time along with the client	DOT and DOV	1B	Acceptable
						Follow EAA's Booklet for Cargo Flight recommendations		1B	Acceptable
Airport Related Hazard	Handling Services	Incorrect cargo loading	Pilots will calcute aircraft's performance and weight and balance based on wrong data	3E	Intolerable	An IO must be part of the crew	DOT and DOV	1D	Acceptable
						Follow EAA's Booklet for Cargo Flight recommendations		1D	Acceptable
Airport Related Hazard	Handling Services	No air starter available in case of APU inoperative	With no APU neither Air Starter the aircraft engines cannot be started	3E	Intolerable	In case of APU Inop, maintenance coordinator shall priorly guarantee Air Starter availability in arrival/departure airport	DME/MOP and DOV	2E	Tolerable

Airport Related Hazard	Handling Services	No potable water servicing available	No potable water available during next flight	2C	Tolerable	Crew must ensure full water servicing before depart to the concerned airport	DOV/Crew Training DOT	1C	Acceptable
Airport Related Hazard	Handling Services	No waste tank servicing available	Lavatories cannot be operated during the flight in case of full waste tank(s)	3D	Tolerable	Crew must ensure full waste servicing before depart to the concerned airport	DOV/Crew Training DOT	2C	Tolerable
Airport Related Hazard	Handling Services	No/inappropriate catering provider available	No catering available	3D	Tolerable	Organize with the client (or directly with the service provider in case of a full charter) to load catering for two flights in case the arrival airport does not have any appropriate catering provider	DOT	1D	Acceptable
Airport Related Hazard	Handling Services	Untrained aircraft marshaller	Wrong aircraft clearance can be inducted by marshall	4D	Intolerable	Crews must reduce taxiing speed and maintenance may support aircraft pushback	DOV/Crew training DME/MOP	2D	Tolerable
Airport Related Hazard	Crisis and contingency management	Delay in responding to emergencies	Delays in medical assistance response	4E	Intolerable	In case of medical assistance required inform ATC as soon as possible	DOV/Crew Training	3C	Tolerable
General Operational Hazard	Cargo Transportation Cabin	**YES**	Further Weight considerations shall be addressed	4B	Tolerable	If this operation requires cargo transportation in main cabin, please consider MoC 002/2020 for further risk mitigation strategies	DOV, DOT and DME	3B	Tolerable
General Operational Hazard	Cargo Transportation Cabin	**NO**	None	1A	Acceptable	Not required	DOV	1A	Acceptable

Airport Related Hazard	Employees Needs	No transport from/to airport	Employees security may be jeopardized.	2E	Tolerable	Ensure adequate transport conditions at the time of contract negotiation	DOV/Roasters	1A	Acceptable
Airport Related Hazard	Employees Needs	VISAs required to enter in considered country	If VISAs are required and crews do not hold it temporarily landing permits may be needid which require all employees to fly every 72 hours	4C	Tolerable	VISAs must be issued before operation's beginning	DOV/Roasters	3C	Tolerable
Airport Related Hazard	Employees Needs	No hotel with minimum prerequisites for crews	Staying in a Hotel that does not comply with the security or with resting conditions may lead to higher levels of fatigue and stress among the crew	3E	Intolerable	Ensure adequate hotel conditions at the time of contract negotiation	DOV/Roasters	1E	Tolerable
Airport Related Hazard	Employees Needs	Hotel more than 15km from the Airport	Additional fatigue to personnel due to the travel distance	2D	Tolerable	Request a closer Hotel during contract negotiations with the client	DOV/Roasters	1A	Acceptable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Wrong density/weight indication by the supplier	Can lead to wrong weight calculus	2E	Tolerable	Fuel calculations must always be performed in aircraft technical logbook and cross-checked along with fuel supplier information and aircraft's fuel quantity indicating system	DME/MOP and DOV	1E	Tolerable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Known contaminated Fuel	Aircraft AOG	3E	Intolerable	Perform fuel tankering if required	DOV/Flight Dispatch	1E	Tolerable

Airport Related Hazard	Fuel Quality and Refuelling Procedures	Not approved fuel type	Aircraft AOG	3E	Intolerable	Perform fuel tankering if required	DOV/Flight Dispatch	1E	Tolerable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Incorrect Loading of Fuel	This hazard can only occur in B737, as B767 and B777 fleets are equiped with fuel load selector. Can lead to delays due to the removal of the exceeding fuel and/or cargo	3E	Intolerable	Ensure the reffueling is performed by the maintenance personnel or by the flight crew	DOT and DOV/Flight Dispatch	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Airport development, construction and maintenance activities	Construction may cause impact on operations and FODs as more likely to be seen	3C	Tolerable	Ensure considered airport has reliable access routing, communication, FOD and dust control, construction signage etc.	DOV/Flight Dispatch	2B	Acceptable
Airport Related Hazard	Runway/Taxiway General Considerations	Power cuts reported in aerodrome's infrastructures	Momentaneous Loss of contact with ATC and RWY/TWY lightning	4D	Intolerable	Do not rely only on ATC instructions neither on aerodrome's lightning	DOV/Crew Training	3D	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Short field length	Cannot be inferior than the required lenght in accordance with aircraft's AFM	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	2E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Narrow field width	Cannot be inferior than the required width in accordance with aircraft's AFM	3E	Intolerable	Follow EAA SOP's guidance.	DOV/Crew Training	1E	Tolerable

Airport Related Hazard	Runway/Taxiway General Considerations	Runway incursions	Damage to property	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Runway Excursions	Damage to property	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Animal Hazard	Damage to property	3E	Intolerable	Follow ATC instructions	DOV/Crew Training and DOV/Flight Dispatch	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Bird Strike Hazard	Damage to property	4D	Intolerable	If large concentration of birds is seen on or near the aerodrome, pilots will be informed by ATS. The crew in coordination with the ATC shall take appropriate actions.	DOV/Crew Training and DOV/Flight Dispatch	2D	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	UAV Collision	Damage to property	4D	Intolerable	Follow ATC instructions	DOV/Crew Training and DOV/Flight Dispatch	2D	Tolerable
Airport Related Hazard	Rescue and Fire Fighting Category	Rescue and Fire Fighting Category at or above aircraft category	No limitations	1A	Acceptable	Not required	DOV/Flight Dispatch	1A	Acceptable
Airport Related Hazard	Rescue and Fire Fighting Category	Rescue and Fire Fighting Category lowered by maximum 2 categories	Could cause delays due to the inhability to refuel during the embark	2D	Tolerable	Request ATC for RFFS assistance during ground operations. While refueling do not embark passengers.	DOV/Flight Dispatch	1B	Acceptable

Airport Related Hazard	Rescue and Fire Fighting Category	Rescue and Fire Fighting Category lowered by more than 2 categories	Could cause delays due to the inhability to refuel during the embark	3D	Tolerable	Request ATC for RFFS assistance during ground operations. While refueling do not embark passengers.	DOV/Flight Dispatch	2B	Acceptable
Airport Related Hazard	Airport Pavement	ACN lower than PCN	No weight limitations (besides its structural ones)	1A	Acceptable	Not required	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Airport Pavement	ACN greater than PCN	Weight limitations	2D	Tolerable	Follow SOP's guidance to calculate the new MRW	DOV/Crew Training	1A	Acceptable
Airport Related Hazard	Airport Pavement	Existance of FODs	Could cause aircraft systems technical failures as well as extra wear in aircraft wheels	3D	Tolerable	Airport and National Authority must be notified and further measures must be considered	DME/MOP, DOV and SAF	2D	Tolerable
Airport Related Hazard	De-icing and anti-icing	Not required or no safety related warning	No consequences	1A	Acceptable	Not required	DOV	1A	Acceptable
Airport Related Hazard	De-icing and anti-icing	Lack of equipment for aircraft type	Aircraft AOG	3E	Intolerable	Ensure with the client during contract negotiations that a solution	DCO	1E	Tolerable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty up to 2 hours	No consequences	1A	Acceptable	Not required	DOV/Rosters	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty inferior than 4 hours	Crew not acclimatised to the time zone until 48 hours of time elapsed, which can lead to crews' fatigue during its duty	5A	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3A	Acceptable
						Ensure a resting period of at least 48 hours before next duty	DOV/Rosters	1A	Acceptable

General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty from 4 to 6 hours	Crew not acclimatised to the time zone until 72 hours of time elapsed which can lead to crews' fatigue during its duty	4B	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3A	Acceptable
						Ensure a resting period of at least 72 hours before next duty	DOV/Rosters	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty from 6 to 9 hours	Crew not acclimatised to the time zone until 96 hours of time elapsed which can lead to crews' fatigue during its duty	3C	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3B	Tolerable
						Ensure a resting period of at least 96 hours before next duty	DOV/Rosters	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty from 9 to 12 hours	Crew not acclimatised to the time zone until 120 hours of time elapsed which can lead to crews' severe fatigue during its duty	3D	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3C	Tolerable
						Ensure a resting period of at least 120 hours before next duty	DOV/Rosters	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Crew's FDP exceeded	Flight cancelation or delay	3E	Intolerable	Operate with Augmented Flight Crew	DOV/Rosters	2B	Acceptable
						Ensure a stand-by crew fit for duty in the considered home-base	DOV/Rosters	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Crew's FDP almost exceeded	Flight cancelation or delay	2D	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1B	Acceptable
						Ensure a stand-by crew fit for duty in the considered home-base	DOV/Rosters	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Multpiple Sectors Operated	Increased fatigue levels and reduced FDP	4A	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1B	Acceptable

General Operational Hazard	Flight Time Limitations	Disruptive Schedules	Crew's fatigue and reduced alertness	3D	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3B	Tolerable
General Operational Hazard	Flight Time Limitations	Flights performed during night	Crew's fatigue and reduced alertness	4A	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	2A	Acceptable

Appendix 3 – DME Risks and Mitigation Procedures

Classification	Category	Hazard Identification	Possible Consequences	Risk Assessment		Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation	
Airport Related Hazard	Approach Aids and Patterns	Lack of navigation capability	Inoperative navigation equipment can lead to route deviation and ultimately to a CFIT.	4D	Intolerable	All EAA aircraft are equiped with redundant navigation equipment.	DME	1D	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Fog in airports vicinity	Loss of sufficient RVR to perform the landing	3D	Tolerable	All EAA aircraft are certified to perform up to CAT IIIB Landing	DME	1D	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Heavy Dust/Sand Storm	Accumulation of impurities that can reduce lifespan or damage to aircraft's components	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training DME/MOP	2D	Tolerable
Airport Related Hazard	Handling Services	No air starter available in case of APU inoperative	With no APU neither Air Starter the aircraft engines cannot be started	3E	Intolerable	In case of APU Inop, maintenance coordinator shall priorly guarantee Air Starter availability in arrival/departure airport	DME/MOP and DOV	2E	Tolerable
Airport Related Hazard	Handling Services	Untrained aircraft marshaller	Wrong aircraft clearance can be inducted by marshall	4D	Intolerable	Crews must reduce taxiing speed and maintenance may support aircraft pushback	DOV/Crew training DME/MOP	2D	Tolerable

General Operational Hazard	Cargo Transportation Cabin	**YES**	Further Weight considerations shall be addressed	4B	Tolerable	If this operation requires cargo transportation in main cabin, please consider MoC 002/2020 for further risk mitigation strategies	DOV, DOT and DME	3B	Tolerable
General Operational Hazard	Employees Needs	Employees duty periods do not comply with regulatory requirements for resting days between shifts	Employees stress and tiredness will increase affecting their effectiveness on duty	3E	Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods that comply with regulations	DME/MOP DOV/Roasters DOT	1E	Tolerable
General Operational Hazard	Employees Needs	Employees duty periods do not allow an efficient rest	Employees stress and tiredness will increase affecting their effectiveness on duty	4E	Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods	DME/MOP DOV/Roasters DOT	2D	Tolerable
General Operational Hazard	Employees Needs	Duty period out of home over 21 days	Employees stress and tiredness will increase affecting their effectiveness on duty	3E	Intolerable	Ensure an efficient rotation plan for all employees before each operation	DME/MOP DOV/Roasters DOT	1B	Acceptable
Airport Related Hazard	Employees Needs	Maintenance personnel access to airport with permanent badge	No consequences	1A	Acceptable	Not required	DME/MOP	1A	Acceptable

Airport Related Hazard	Employees Needs	Maintenance personnel access to airport with temporary badge	Could lead to aircraft delays due to maintence actions required to release the aircraft to service	3C	Tolerable	Increase the number of maintenance personnel allocated to the operation	DME/MOP	2C	Tolerable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Wrong density/weight indication by the supplier	Can lead to wrong weight calculus	2E	Tolerable	Fuel calculations must always be performed in aircraft technical logbook and cross-checked along with fuel supplier information and aircraft's fuel quantity indicating system	DME/MOP and DOV	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	No base maintenance facilities to perform major maintenance	Could result in longstanding AOG	4D	Tolerable	Ensure capability and client's support to perform the considered deffect rectification in line before the aircraft departs to any other location	DME/PCO	2D	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Non climatized storage facilities available	Aircraft AOG in case of spare part or consummable needed and not available	3E	Intolerable	If the client does not have or support in arranging a climatized storage warehouse, it shall be subcontracted	DME/MOP	1E	Tolerable

Airport Related Hazard	Aircraft Maintenance Considerations	No line maintenance room for troubleshooting, upload and print data	Could cause delays or AOG situations	2D	Tolerable	A nearby room with electricity, desk and internet must be loaned or granted along with the client	DME/MOP	1D	Acceptable
Airport Related Hazard	Aircraft Maintenance Considerations	No tools available for line maintenance works	Could result in delays or AOG's	3E	Intolerable	Have a fly away kit on board with spare parts and tools for defect rectification	DME/MOP	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Lack of EASA certified organizations to perform any corrective maintenance required	Could result in delays or AOG's	3C	Tolerable	Ensure EAA Part 145 certified technician is on board along with the crew to perform any corrective maintenance, if required, in the destination	DME/MOP	1C	Acceptable
Airport Related Hazard	Aircraft Maintenance Considerations	Lack of spare parts and consummables for defect rectification	Could result in delays or AOG's	3E	Intolerable	Have a fly away kit on board with spare parts and tools for defect rectification	DME/LOG and DME/MOP	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Difficulty to get EASA certified parts in case of AOG	Could result in longstanding AOG	3E	Intolerable	Ensure cooperation between EAA's and client's Logistic before the beginning of the operation to ensure smooth parts delivery and clearance from customs	DME/LOG	1E	Tolerable

Airport Related Hazard	Aircraft Maintenance Considerations	Installation/usage of non-EASA certified components or comsummables, in case of line maintenance provided by another EASA Part 145 with other approvals besides EASA	Could result in AOG, damage to property	3E	Intolerable	All parts must be purchased by EAA Logistic's	DME/LOG, DME/MOP and DCM	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Lack of specialized ground handling equipment to support maintenance	Could result in delays or AOG's	2E	Tolerable	Alternative service providers as well as support on equipment's airport access (in case the client does not operate in the considered airport) must be ensured with the client before contract signature	DME/MOP	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Inability to upload flight data from FDR	Could result in delays or AOG's	2E	Tolerable	Ensure all required equipment to upload flight data is available in each aircraft	DME/MOP	1B	Acceptable
Airport Related Hazard	Aircraft Maintenance Considerations	Inability to update FMC database	New airport procedures will not be included in the database	2D	Tolerable	Ensure all required equipment to upload FMC is available in each aircraft	DME/MOP	1B	Acceptable

Airport Related Hazard	Aircraft Maintenance Considerations	Fly-Away-Kit Unavailable	Could result in delays or AOG's	3D	Tolerable	Ensure there are expendable parts and consummables in each destination the aircraft is operating	DME/MOP	1B	Acceptable
Airport Related Hazard	Airport Pavement	Existance of FODs	Could cause aircraft systems technical failures as well as extra wear in aircraft wheels	3D	Tolerable	Airport and National Authority must be notified and further measures must be considered	DME/MOP, DOV and SAF	2D	Tolerable

Appendix 4 – Ground Operations Risks and Mitigation Procedures

Classification	Category	Hazard Identification	Possible Consequences	Risk Assessment		Mitigation Measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation	
Airport Related Hazard	Approach Aids and Patterns	Incapacity to update iPad's EFB	Updated charts may not be available	3C	Tolerable	Ensure all equipment to update EFB is available in all aircraft/operations	DOT	2C	Acceptable
Airport Related Hazard	Handling Services	Inappropriate handling and carriage of dangerous goods	Uncontained fire, leakage of corrosive materials	3E	Intolerable	Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1E	Tolerable
Airport Related Hazard	Handling Services	Unrestrained/misloaded cargo	Weight Shift	2E	Tolerable	An IO must be part of the crew	DOT and DOV	1E	Tolerable
Airport Related Hazard	Handling Services	Handling provider unexperienced in aircraft type	Damage to cargo goods, and property	2E	Tolerable	An IO must be part of the crew	DOT and DOV	1E	Tolerable
Airport Related Hazard	Handling Services	Old/innapropriate handling equipment	Departure delays and/or unaccomplishment of certain services	2D	Tolerable	During contract negotiation ensure further ground time along with the client	DOT and DOV	1B	Acceptable
Airport Related Hazard	Handling Services	Incorrect cargo loading	Pilots will calcute aircraft's performance and weight and balance based on wrong data	3E	Intolerable	An IO must be part of the crew	DOT and DOV	1D	Acceptable
Airport Related Hazard	Handling Services	No potable water servicing available	No potable water available during next flight	2C	Tolerable	Crew must ensure full water servicing before depart to the concerned airport	DOV/Crew Training DOT	1C	Acceptable
Airport Related Hazard	Handling Services	No waste tank servicing available	Lavatories cannot be operated during the flight in case of full waste tank(s)	3D	Tolerable	Crew must ensure full waste servicing before depart to the concerned airport	DOV/Crew Training DOT	2C	Tolerable

Airport Related Hazard	Handling Services	Lack of catering equipment	No catering available	3D	Tolerable	Carry EAA catering equipment in aircraft's galleys	DOT	1D	Acceptable
Airport Related Hazard	Handling Services	No/inappropriate catering provider available	No catering available	3D	Tolerable	Organize with the client (or directly with the service provider in case of a full charter) to load catering for two flights in case the arrival airport does not have any appropriate catering provider	DOT	1D	Acceptable
General Operational Hazard	Cargo Transportation Cabin	**YES**	Further Weight considerations shall be addressed	4B	Tolerable	If this operation requires cargo transportation in main cabin, please consider MoC 002/2020 for further risk mitigation strategies	DOV, DOT and DME	3B	Tolerable
General Operational Hazard	Employees Needs	Employees duty periods do not comply with regulatory requirements for resting days between shifts	Employees stress and tiredness will increase affecting their effectiveness on duty	3E	Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods that comply with regulations	DME/MOP DOV/Roasters DOT	1E	Tolerable
General Operational Hazard	Employees Needs	Employees duty periods do not allow an efficient rest	Employees stress and tiredness will increase affecting their effectiveness on duty	4E	Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods	DME/MOP DOV/Roasters DOT	2D	Tolerable

General Operational Hazard	Employees Needs	Duty period out of home over 21 days	Employees stress and tiredness will increase affecting their effectiveness on duty	3E	Intolerable	Ensure an efficient rotation plan for all employees before each operation	DME/MOP DOV/Roasters DOT	1B	Acceptable
Airport Related Hazard	Employees Needs	Catering - no crew meals	Lack of crew meals may lead the crew members to higher strees and fatigue level	2D	Tolerable	Ensure that meals for crews are available and adequate	DOT	1D	Acceptable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Incorrect Loading of Fuel	This hazard can only occur in B737, as B767 and B777 fleets are equiped with fuel load selector. Can lead to delays due to the removal of the exceeding fuel and/or cargo	3E	Intolerable	Ensure the reffueling is performed by the maintenance personnel or by the flight crew	DOT and DOV/Flight Dispatch	1E	Tolerable

Appendix 5 – Long-term Operation Hazard Log

Long-term Operations Hazard Log														
Classification	Category	Hazard Identification	Possible Consequences	Risk Assessment				Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation			
				Likelihood	Severity	Risk	Tolerability			Likelihood	Severity	Risk	Tolerability
Airport Related Hazard	Terrain and Obstacles in Approach	No relevant obstacles	None	1	A	1A	Acceptable	Not required	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Terrain and Obstacles in Approach	Surrounded by mountains	Can cause winshear, turbulence, updrafts, downdrafts and mountain waves	2	D	2D	Tolerable	EGPWS installed in all EAA's fleet Crew briefing before departure required Follow EAA SOP's guidance for operating in airports surrounded by mountains	DOV/Crew Training	1	D	1D	Acceptable

Airport Related Hazard	Terrain and Obstacles in Approach	High Airport Elevation (more than 5000ft)	Unpredictable weather conditions, reduced air density detriorating aircraft's performance, probable need of special training for operating crew	3	C	3C	Tolerable	EGPWS installed in all EAA's fleet Crew briefing before departure required Follow EAA SOP's guidance for operating in airports with high elevations	DOV/Crew Training	2	C	2C	Tolerable
Airport Related Hazard	Terrain and Obstacles in Approach	High Airport Elevation (more than 10000ft)	Unpredictable weather conditions, reduced air density detriorating aircraft's performance, probable need of special training for operating crew	4	C	4C	Tolerable	EGPWS installed in all EAA's fleet Crew briefing before departure required Follow EAA SOP's guidance for operating in airports with high elevations	DOV/Crew Training	3	C	3C	Tolerable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class A airspace	Only IFR flights allowed and ATC services provided	1	A	1A	Acceptable	Not required	DOV/Crew Training	1	A	1A	Acceptable

Airport Related Hazard	Airspace classification	Aerodrome located in a Class B airspace	IFR and VFR flights allowed and ATC services provided	1	B	1B	Acceptable	Follow ATC instructions to identify VFR operators	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class C airspace	IFR and VFR flights allowed and ATC services provided separately for IFR and VFR flights	2	A	2A	Acceptable	Follow ATC instructions for any VFR flight intersecting IFR routes	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class D airspace	IFR and VFR flights allowed and ATC services provided however IFR flights are separated from other IFR flights and from VFR flights. The same occurs with VFR flights.	2	B	2B	Acceptable	Follow ATC instructions for any VFR or IFR flight intersecting IFR routes	DOV/Crew Training	1	B	1B	Acceptable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class E airspace	IFR and VFR flights permitted, IFR flights are provided with ATC service and separated from other IFR flights. Unreliable traffic information.	3	C	3C	Tolerable	Give special attention to traffic collision avoidance systems and reported attitudes from other aircraft	DOV/Crew Training	2	C	2C	Tolerable
Airport Related Hazard	Airspace classification	Aerodrome located in a Class F airspace	Only ATC separation as far as practical for IFR flights. Traffic information may be provided by relaying in other flights	3	D	3D	Tolerable	Give special attention to traffic collision avoidance systems and reported attitudes from other aircraft	DOV/Crew Training	2	D	2D	Tolerable

Airport Related Hazard	Airspace classification	Aerodrome located in a Class G airspace	Uncontrolled airspace. ATC has no authority in considered airspace	5	C	5C	Intolerable	Give special attention to traffic collision avoidance systems and reported attitudes from other aircraft	DOV/Crew Training	4	C	4C	Tolerable
Airport Related Hazard	Approach Aids and Patterns	CAT I/II/III Approach	No potential consequences	1	A	1A	Acceptable	Not required	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	VMC approach only	Damage to property due to no instrument approach and landing systems available	2	B	2B	Acceptable	Crew briefing before departure required Additional navigation charts must be available	DOV/Crew Training	1	B	1B	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Non Precisision Approach required	Damage to property due to no vertical guidance instrument approach and landing systems available	2	A	2A	Acceptable	Crew briefing before departure required Additional navigation charts must be available	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	SDF approach required	Damage to property due to no vertical guidance instrument approach and landing systems available	2	A	2A	Acceptable	Crew briefing before departure required	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Precision Approach	None	1	A	1A	Acceptable	Not required	DOV/Crew Training	1	A	1A	Acceptable

Airport Related Hazard	Approach Aids and Patterns	Circling	Maneuvers at low altitude, low airspeed and adverse weather conditions, which can result in loss of aircraft's control	2	C	2C	Tolerable	Crew briefing before departure to make sure flight crew is fully aware of aircraft performance to determine the exact circling maneuver considering the weather, unique airport design and aircraft position, altitude and airspeed	DOV/Crew Training	1	B	1B	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Incapacity to update iPad's EFB	Updated charts may not be available	3	C	3C	Tolerable	Ensure all equipment to update EFB is available in all aircraft/operations	DOT	2	C	2C	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Charts Available	None	1	A	1A	Acceptable	Not required	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Deficiences in RWY Lights	Can cause visual misunderstandings during the approach	2	D	2D	Tolerable	These deficiences are always spreaded through NOTAM's which shall be analyzed before perform any flight to/from the related airport	DOV/Flight Dispatch	1	D	1D	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Deficiences in RWY Approach Instruments	Can cause inadvert aircraft atittude change due to wrong inputs provided by	4	D	4D	Intolerable	Follow ATC Instructions	DOV/Flight Dispatch	2	C	2C	Tolerable

			the approach instruments					These deficiences are always spreaded through NOTAM's which shall be analyzed before perform any flight to/from the related airport					
Airport Related Hazard	Approach Aids and Patterns	ATC fast and abbreviated talks	Non-standard phraseology	3	C	3C	Tolerable	Request ATC to clarify instructions in accordance with ICAO standards	DOV/Crew Training	2	C	2C	Tolerable
Airport Related Hazard	Approach Aids and Patterns	ATC with High Workload	Complex arrivals and busy ATC environment	3	D	3D	Tolerable	Avoid to occupy the radio transmission, however request clearance clarification if required	DOV/Crew Training	1	D	1D	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Runway gradient exceeded	Unstable approach	3	E	3E	Intolerable	Follow ATC instructions Follow EAA SOP's guidance	DOV/Crew Training	2	E	2E	Tolerable
Airport Related Hazard	Approach Aids and Patterns	Unusual Approach Required	May require crew awareness and preventive training	3	C	3C	Tolerable	Different types of approaches are often trained in simulator Follow EAA SOP's guidance for operating in airports unusual approach procedures	DOV/Crew Training	2	B	2B	Acceptable

Airport Related Hazard	Approach Aids and Patterns	Airport Category A	Approved instrument approach procedure, at least one runway with no performance limited procedure for take-off and/or landing, published circling minima not higher than 1000ft and night operations capability	1	A	1A	Acceptable	Not required	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Airport Category B	Non Standard Approach aids and / or approach patterns, or unusual local weather conditions, characteristics or performance limitations, or any other relevant considerations including obstructions, physical layout, lighting etc.	3	B	3B	Tolerable	Crew briefing before departure required Follow EAA SOP's guidance for operating in CAT. B airports	DOV/Crew Training	2	B	2B	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Airport Category C	Requires additional considerations to a Category B aerodrome and is considered to pose certain problems for the approach and / or landing and / or take-off. Further training shall be required to flight crew.	4	B	4B	Tolerable	Specific training for the concerned airport shall be given and approved by chief pilot Follow EAA SOP's guidance for operating in CAT. C airports	DOV/Crew Training	3	B	3B	Tolerable

Airport Related Hazard	Approach Aids and Patterns	Lack of navigation capability	Inoperative navigation equipment can lead to route deviation and ultimately to a CFIT.	4	D	4D	Intolerable	All EAA aircraft are equiped with redundant navigation equipment.	DME	1	D	1D	Acceptable
Airport Related Hazard	Airport Category vs. Aircraft Approach Category	Aircraft of category less than or equal to that of the airport	None	1	A	1A	Acceptable	Not required	DOV/Flight Dispatch	1	A	1A	Acceptable
Airport Related Hazard	Airport Category vs. Aircraft Approach Category	Aircraft of a higher category than the airport	Aircraft cannot operate in this airport	5	E	5E	Intolerable	Flight cannot be performed	DOV/Flight Dispatch	5	E	5E	Intolerable
Airport Related Hazard	Approach Aids and Patterns	Night Flight Restritions	Restrictions in airport operating hours due to limit levels of noise	2	C	2C	Tolerable	Flight dispatch must ensure airport curfew hours before perform the flight plan	DOV/Flight Dispatch	1	C	1C	Acceptable
Airport Related Hazard	Approach Aids and Patterns	Joint Civilian/Military AD	Military traffic information unavailable	3	C	3C	Tolerable	Be aware of traffic information and follow ATC instructions	DOV/Flight Dispatch	1	C	1C	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	No phenomena selected	None	1	A	1A	Acceptable	Not required	DOV/Flight Dispatch	1	A	1A	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Fog in airports vicinity	Loss of sufficient RVR to perform the landing	3	D	3D	Tolerable	All EAA aircraft are certified to perform up to CAT IIIB Landing	DME	1	D	1D	Acceptable

								Previous approval shall be granted before aircraft's departure	DOV/Flight Dispatch	1	D	1D	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Squall Line and Hail	Loss of aircraft's control	3	D	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions Each EAA aircraft is equiped with weather radar which will inform the upcoming weather in advance	DOV/Crew Training	1	D	1D	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Severe Turbulence	Loss of aircraft's control	2	E	2E	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions Each EAA aircraft is equiped with weather radar which will inform the upcoming weather in advance	DOV/Crew Training	1	E	1E	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Tropical Cyclones	Loss of aircraft's control	3	D	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions Each EAA aircraft is equiped with weather radar which will inform the upcoming weather in advance	DOV/Crew Training	2	E	2E	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Severe Ice	Loss of aircraft's control	3	D	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2	E	2E	Tolerable

								Each EAA aircraft is equiped with weather radar which will inform the upcoming weather in advance					
Airport Related Hazard	Seasonal Weather Phenomena	Heavy Dust/Sand Storm	Accumulation of impurities that can reduce lifespan or damage to aircraft's components	3	D	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions Maintenance team must cover all pitot probes and engine inlet cowls to prevent accumulation of impurities Each EAA aircraft is equiped with weather radar which will inform the upcoming weather in advance	DOV/Crew Training DME/MOP	2	D	2D	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Wake Turbulence	Loss of aircraft's control	2	D	2D	Tolerable	Follow ATC instructions Respect the traffic separation when behind a wide-body aircraft	DOV/Crew Training	1	D	1D	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Wind Shear	Loss of aircraft's control	2	D	2D	Tolerable	Follow ATC instructions Each EAA aircraft is equiped with EGPWS which alerts the crew for wind shear ahead	DOV/Crew Training	2	C	2C	Tolerable

Airport Related Hazard	Seasonal Weather Phenomena	Foehn	Loss of aircraft's control	2	D	2D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions Each EAA aircraft is equiped with weather radar which will inform the upcoming weather in advance	DOV/Crew Training	2	C	2C	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	Snow Storm	Loss of aircraft's control	2	D	2D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions Request de-icing and anti-icing Follow ATC instructions	DOV/Crew Training	2	C	2C	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Volcanic ash concentration below the limits of the engine manufacturer	Loss of aircraft's control	3	C	3C	Tolerable	Only perform the considered flight in case volcanic ash concentration does not impact engines and air data instruments operation	DOV/Flight Dispatch	2	D	2D	Tolerable
Airport Related Hazard	Seasonal Weather Phenomena	Volcanic ash concentration above the limits of the engine manufacturer	Loss of aircraft's control and damage to property	5	E	5E	Intolerable	Flight cannot be performed	DOV/Flight Dispatch	5	E	5E	Intolerable

Airport Related Hazard	Seasonal Weather Phenomena	Saline Atmosphere	Loss of visibility due to salt accretion on aircraft's windshield	2	C	2C	Tolerable	Follow ATC instructions	DOV/Flight Dispatch	1	C	1C	Acceptable
Airport Related Hazard	Seasonal Weather Phenomena	High temperature	Deterioration of aircraft's performance	3	C	3C	Tolerable	Review the flight plan, MTOW and W&B calculations required	DOV/Crew Training and DOV/Flight Dispatch	1	C	1C	Acceptable
Airport Related Hazard	Isolated Aerodrome	No	None	1	A	1A	Acceptable	Not required	DOV/Flight Dispatch	1	A	1A	Acceptable
Airport Related Hazard	Isolated Aerodrome	Yes	Flight requires prior approval by the competent authority	3	C	3C	Tolerable	Perform fuel tankering, and/or different further mitigation procedures established by the competent authority	DOV/Flight Dispatch	1	C	1C	Acceptable
Airport Related Hazard	Handling Services	Transportation of passengers who require native speaking languages	Difficulty in transmit safety and evacuation procedures	4	D	4D	Intolerable	Hire native speaking approved flight attendants and administer them EAA's training	DOV/Crew Training and HR	1	A	1A	Acceptable
Airport Related Hazard	Handling Services	Inappropriate handling and carriage of dangerous goods	Uncontained fire, leakage of corrosive materials	3	E	3E	Intolerable	Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1	E	1E	Tolerable
Airport Related Hazard	Handling Services	Unrestrained/misloaded cargo	Weight Shift	2	E	2E	Tolerable	An IO must be part of the crew Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1	E	1E	Tolerable
	Handling Services			2	E	2E	Tolerable	An IO must be part of the crew	DOT and DOV	1	E	1E	Tolerable

Airport Related Hazard		Handling provider unexperienced in aircraft type	Damage to cargo goods, and property					Follow EAA's Booklet for Cargo Flight recommendations					
Airport Related Hazard	Handling Services	Old/innapropriate handling equipment	Departure delays and/or unaccomplishment of certain services	2	D	2D	Tolerable	During contract negotiation ensure further ground time along with the client Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1	B	1B	Acceptable
Airport Related Hazard	Handling Services	Incorrect cargo loading	Pilots will calcute aircraft's performance and weight and balance based on wrong data	3	E	3E	Intolerable	An IO must be part of the crew Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1	D	1D	Acceptable
Airport Related Hazard	Handling Services	No air starter available in case of APU inoperative	With no APU neither Air Starter the aircraft engines cannot be started	3	E	3E	Intolerable	In case of APU Inop, maintenance coordinator shall priorly guarantee Air Starter availability in arrival/departure airport	DME/MOP and DOV	2	E	2E	Tolerable
Airport Related Hazard	Handling Services	No potable water servicing available	No potable water available during next flight	2	C	2C	Tolerable	Crew must ensure full water servicing before depart to the concerned airport	DOV/Crew Training DOT	1	C	1C	Acceptable
Airport Related Hazard	Handling Services	No waste tank servicing available	Lavatories cannot be operated during the flight in case of full waste tank(s)	3	D	3D	Tolerable	Crew must ensure full waste servicing before depart to the concerned airport	DOV/Crew Training DOT	2	C	2C	Tolerable
Airport Related Hazard	Handling Services	Lack of catering equipment	No catering available	3	D	3D	Tolerable	Carry EAA catering equipment in aircraft's galleys	DOT	1	D	1D	Acceptable
Airport Related Hazard	Handling Services	No/inappropriate catering provider available	No catering available	3	D	3D	Tolerable	Organize with the client (or directly with the service provider in case of	DOT	1	D	1D	Acceptable

								a full charter) to load catering for two flights in case the arrival airport does not have any appropriate catering provider					
Airport Related Hazard	Handling Services	Untrained aircraft marshaller	Wrong aircraft clearance can be inducted by marshall	4	D	4D	Intolerable	Crews must reduce taxiing speed and maintenance may support aircraft pushback	DOV/Crew training DME/MOP	2	D	2D	Tolerable
Airport Related Hazard	Crisis and contingency management	Delay in responding to emergencies	Delays in medical assistance response	4	E	4E	Intolerable	In case of medical assistance required inform ATC as soon as possible	DOV/Crew Training	3	C	3C	Tolerable
Airport Related Hazard	Crisis and contingency management	Unavailable resources	Lack of assistance in a crisis situation	5	E	5E	Intolerable	Report to the competent authorities and do not operate considered airport until an improvement in ERP has been proven	SAF SEC	4	C	4C	Tolerable
General Operational Hazard	Cargo Transportation Cabin	**YES**	Further Weight considerations shall be addressed	4	B	4B	Tolerable	If this operation requires cargo transportation in main cabin, please consider MoC 002/2020 for further risk mitigation strategies	DOV, DOT and DME	3	B	3B	Tolerable
General Operational Hazard	Cargo Transportation Cabin	**NO**	None	1	A	1A	Acceptable	Not required	DOV	1	A	1A	Acceptable
Airport Related Hazard	Employees Needs	No transport from/to airport	Employees security may be jeopardized.	2	E	2E	Tolerable	Ensure adequate transport conditions at the time of contract negotiation	DOV/Roasters	1	A	1A	Acceptable

General Operational Hazard	Employees Needs	No health insurance	Employee may not have the necessary medical attention in case of an emergency	3	E	3E	Intolerable	Ensure that all staff, including service providers, have health insurance	HR	1	A	1A	Acceptable
General Operational Hazard	Employees Needs	VISAs required to enter in considered country	If VISAs are required and crews do not hold it temporarily landing permits may be needid which require all employees to fly every 72 hours	4	C	4C	Tolerable	VISAs must be issued before operation's beginning In case of no VISAs available, staff allocated to the considered operation must be increased	DOV/Roasters	3	C	3C	Tolerable
General Operational Hazard	Employees Needs	Employees duty periods do not comply with regulatory requirements for resting days between shifts	Employees stress and tiredness will increase affecting their effectiveness on duty	3	E	3E	Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods that comply with regulations	DME/MOP DOV/Roasters DOT	1	E	1E	Tolerable
General Operational Hazard	Employees Needs	Employees duty periods do not allow an efficient rest	Employees stress and tiredness will increase affecting their effectiveness on duty	4	E	4E	Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods	DME/MOP DOV/Roasters DOT	2	D	2D	Tolerable

General Operational Hazard	Employees Needs	Duty period out of home over 21 days	Employees stress and tiredness will increase affecting their effectiveness on duty	3	E	3E	Intolerable	Ensure an efficient rotation plan for all employees before each operation	DME/MOP DOV/Roasters DOT	1	B	1B	Acceptable
Airport Related Hazard	Employees Needs	Catering - no crew meals	Lack of crew meals may lead the crew members to higher strees and fatigue level	2	D	2D	Tolerable	Ensure that meals for crews are available and adequate	DOT	1	D	1D	Acceptable
Airport Related Hazard	Employees Needs	No hotel with minimum prerequisites for crews	Staying in a Hotel that does not comply with the security or with resting conditions may lead to higher levels of fatigue and stress among the crew	3	E	3E	Intolerable	Ensure adequate hotel conditions at the time of contract negotiation	DOV/Roasters	1	E	1E	Tolerable
Airport Related Hazard	Employees Needs	Maintenance personnel access to airport with permanent badge	No consequences	1	A	1A	Acceptable	Not required	DME/MOP	1	A	1A	Acceptable
Airport Related Hazard	Employees Needs	Maintenance personnel access to airport with temporary badge	Could lead to aircraft delays due to maintence actions required to release the aircraft to service	3	C	3C	Tolerable	Increase the number of maintenance personnel allocated to the operation	DME/MOP	2	C	2C	Tolerable
Airport Related Hazard	Employees Needs	Hotel more than 15km from the Airport	Additional fatigue to personnel due to the travel distance	2	D	2D	Tolerable	Request a closer Hotel during contract negotiations with the client	DOV/Roasters	1	A	1A	Acceptable

Airport Related Hazard	Fuel Quality and Refuelling Procedures	Wrong density/weight indication by the supplier	Can lead to wrong weight calculus	2	E	2E	Tolerable	Fuel calculations must always be performed in aircraft technical logbook and cross-checked along with fuel supplier information and aircraft's fuel quantity indicating system	DME/MOP and DOV	1	E	1E	Tolerable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Known contaminated Fuel	Aircraft AOG	3	E	3E	Intolerable	Perform fuel tankering if required	DOV/Flight Dispatch	1	E	1E	Tolerable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Not approved fuel type	Aircraft AOG	3	E	3E	Intolerable	Perform fuel tankering if required	DOV/Flight Dispatch	1	E	1E	Tolerable
Airport Related Hazard	Fuel Quality and Refuelling Procedures	Incorrect Loading of Fuel	This hazard can only occur in B737, as B767 and B777 fleets are equiped with fuel load selector. Can lead to delays due to the removal of the exceeding fuel and/or cargo	3	E	3E	Intolerable	Ensure the reffueling is performed by the maintenance personnel or by the flight crew	DOT and DOV/Flight Dispatch	1	E	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Airport development, construction and maintenance activities	Construction may cause impact on operations and FODs as more likely to be seen	3	C	3C	Tolerable	Ensure considered airport has reliable access routing, communication, FOD and dust control, construction signage etc.	DOV/Flight Dispatch	2	B	2B	Acceptable

Airport Related Hazard	Runway/Taxiway General Considerations	Power cuts reported in aerodrome's infrastructures	Momentaneous Loss of contact with ATC and RWY/TWY lightning	4	D	4D	Intolerable	Do not rely only on ATC instructions neither on aerodrome's lightning	DOV/Crew Training	3	D	3D	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Short field length	Cannot be inferior than the required lenght in accordance with aircraft's AFM	3	E	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	2	E	2E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Narrow field width	Cannot be inferior than the required width in accordance with aircraft's AFM	3	E	3E	Intolerable	Follow EAA SOP's guidance.	DOV/Crew Training	1	E	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Runway incursions	Damage to property	3	E	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	1	E	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Runway Excursions	Damage to property	3	E	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	1	E	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Animal Hazard	Damage to property	3	E	3E	Intolerable	Follow ATC instructions	DOV/Crew Training and DOV/Flight Dispatch	1	E	1E	Tolerable
Airport Related Hazard	Runway/Taxiway General Considerations	Bird Strike Hazard	Damage to property	4	D	4D	Intolerable	If large concentration of birds is seen on or near the aerodrome, pilots will be informed by ATS. The crew in coordination with the ATC shall take	DOV/Crew Training and DOV/Flight Dispatch	2	D	2D	Tolerable

								appropriate actions.					
Airport Related Hazard	Runway/Taxiway General Considerations	UAV Collision	Damage to property	4	D	4D	Intolerable	Follow ATC instructions	DOV/Crew Training and DOV/Flight Dispatch	2	D	2D	Tolerable
Airport Related Hazard	Rescue and Fire Fighting Category	Rescue and Fire Fighting Category at or above aircraft category	No limitations	1	A	1A	Acceptable	Not required	DOV/Flight Dispatch	1	A	1A	Acceptable
Airport Related Hazard	Rescue and Fire Fighting Category	Rescue and Fire Fighting Category lowered by maximum 2 categories	Could cause delays due to the inhability to refuel during the embark	2	D	2D	Tolerable	Request ATC for RFFS assistance during ground operations. While refueling do not embark passengers. Park in remote airport areas	DOV/Flight Dispatch	1	B	1B	Acceptable
Airport Related Hazard	Rescue and Fire Fighting Category	Rescue and Fire Fighting Category lowered by more than 2 categories	Could cause delays due to the inhability to refuel during the embark	3	D	3D	Tolerable	Request ATC for RFFS assistance during ground operations. While refueling do not embark passengers. Park in remote airport areas	DOV/Flight Dispatch	2	B	2B	Acceptable

Airport Related Hazard	Aircraft Maintenance Considerations	No base maintenance facilities to perform major maintenance	Could result in longstanding AOG	4	D	4D	Tolerable	Ensure capability and client's support to perform the considered deffect rectification in line before the aircraft departs to any other location	DME/PCO	2	D	2D	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Non climatized storage facilities available	Aircraft AOG in case of spare part or consummable needed and not available	3	E	3E	Intolerable	If the client does not have or support in arranging a climatized storage warehouse, it shall be subcontracted	DME/MOP	1	E	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	No line maintenance room for troubleshooting, upload and print data	Could cause delays or AOG situations	2	D	2D	Tolerable	A nearby room with electricity, desk and internet must be loaned or granted along with the client	DME/MOP	1	D	1D	Acceptable
Airport Related Hazard	Aircraft Maintenance Considerations	No tools available for line maintenance works	Could result in delays or AOG's	3	E	3E	Intolerable	Have a fly away kit on board with spare parts and tools for defect rectification	DME/MOP	1	E	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Lack of EASA certified organizations to perform any corrective maintenance required	Could result in delays or AOG's	3	C	3C	Tolerable	Ensure EAA Part 145 certified technician is on board along with the crew to perform any corrective maintenance, if required, in the destination	DME/MOP	1	C	1C	Acceptable

Airport Related Hazard	Aircraft Maintenance Considerations	Lack of spare parts and consummables for defect rectification	Could result in delays or AOG's	3	E	3E	Intolerable	Have a fly away kit on board with spare parts and tools for defect rectification	DME/LOG and DME/MOP	1	E	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Difficulty to get EASA certified parts in case of AOG	Could result in longstanding AOG	3	E	3E	Intolerable	Ensure cooperation between EAA's and client's Logistic before the beginning of the operation to ensure smooth parts delivery and clearance from customs	DME/LOG	1	E	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Installation/usage of non-EASA certified components or comsummables, in case of line maintenance provided by another EASA Part 145 with other approvals besides EASA	Could result in AOG, damage to property	3	E	3E	Intolerable	All parts must be purchased by EAA Logistic's Ensure that, after signing the contract agreement with the EASA Part 145 provider, all certifying staff is dully trained with related EAA procedures	DME/LOG, DME/MOP and DCM	1	E	1E	Tolerable
Airport Related Hazard	Aircraft Maintenance Considerations	Lack of specialized ground handling equipment to support maintenance	Could result in delays or AOG's	2	E	2E	Tolerable	Alternative service providers as well as support on equipment's airport access (in case the client does not operate in the considered airport) must be ensured with the client before contract signature	DME/MOP	1	E	1E	Tolerable

Airport Related Hazard	Aircraft Maintenance Considerations	Inability to upload flight data from FDR	Could result in delays or AOG's	2	E	2E	Tolerable	Ensure all required equipment to upload flight data is available in each aircraft	DME/MOP	1	B	1B	Acceptable
Airport Related Hazard	Aircraft Maintenance Considerations	Inability to update FMC database	New airport procedures will not be included in the database	2	D	2D	Tolerable	Ensure all required equipment to upload FMC is available in each aircraft	DME/MOP	1	B	1B	Acceptable
Airport Related Hazard	Aircraft Maintenance Considerations	Fly-Away-Kit Unavailable	Could result in delays or AOG's	3	D	3D	Tolerable	Ensure there are expendable parts and consummables in each destination the aircraft is operating	DME/MOP	1	B	1B	Acceptable
Airport Related Hazard	Airport Pavement	ACN lower than PCN	No weight limitations (besides its structural ones)	1	A	1A	Acceptable	Not required	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Airport Pavement	ACN greater than PCN	Weight limitations	2	D	2D	Tolerable	Follow SOP's guidance to calculate the new MRW	DOV/Crew Training	1	A	1A	Acceptable
Airport Related Hazard	Airport Pavement	Existance of FODs	Could cause aircraft systems technical failures as well as extra wear in aircraft wheels	3	D	3D	Tolerable	Airport and National Authority must be notified and further measures must be considered	DME/MOP, DOV and SAF	2	D	2D	Tolerable
Airport Related Hazard	De-icing and anti-icing	Not required or no safety related warning	No consequences	1	A	1A	Acceptable	Not required	DOV	1	A	1A	Acceptable
Airport Related Hazard	De-icing and anti-icing	Lack of equipment for aircraft type	Aircraft AOG	3	E	3E	Intolerable	Ensure with the client during contract negotiations that a solution	DCO	1	E	1E	Tolerable

General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty up to 2 hours	No consequences	1	A	1A	Acceptable	Not required	DOV/Rosters	1	A	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty inferior than 4 hours	Crew not acclimatised to the time zone until 48 hours of time elapsed, which can lead to crews' fatigue during its duty	5	A	5A	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3	A	3A	Acceptable
								Ensure a resting period of at least 48 hours before next duty	DOV/Rosters	1	A	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty from 4 to 6 hours	Crew not acclimatised to the time zone until 72 hours of time elapsed which can lead to crews' fatigue during its duty	4	B	4B	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3	A	3A	Acceptable
								Ensure a resting period of at least 72 hours before next duty	DOV/Rosters	1	A	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty from 6 to 9 hours	Crew not acclimatised to the time zone until 96 hours of time elapsed which can lead to crews' fatigue during its duty	3	C	3C	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3	B	3B	Tolerable
								Ensure a resting period of at least 96 hours before next duty	DOV/Rosters	1	A	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Time difference between reference time and local time where the crew	Crew not acclimatised to the time zone until 120 hours of time elapsed	3	D	3D	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3	C	3C	Tolerable

		member starts the next duty from 9 to 12 hours	which can lead to crews' severe fatigue during its duty					Ensure a resting period of at least 120 hours before next duty	DOV/Rosters	1	A	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Crew's FDP exceeded	Flight cancelation or delay	3	E	3E	Intolerable	Operate with Augmented Flight Crew	DOV/Rosters	2	B	2B	Acceptable
								Ensure a stand-by crew fit for duty in the considered home-base	DOV/Rosters	1	A	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Crew's FDP almost exceeded	Flight cancelation or delay	2	D	2D	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1	B	1B	Acceptable
								Ensure a stand-by crew fit for duty in the considered home-base	DOV/Rosters	1	A	1A	Acceptable
General Operational Hazard	Flight Time Limitations	Multpiple Sectors Operated	Increased fatigue levels and reduced FDP	4	A	4A	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1	B	1B	Acceptable
General Operational Hazard	Flight Time Limitations	Disruptive Schedules	Crew's fatigue and reduced alertness	3	D	3D	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3	B	3B	Tolerable
General Operational Hazard	Flight Time Limitations	Flights performed during night	Crew's fatigue and reduced alertness	4	A	4A	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	2	A	2A	Acceptable

Appendix 6 - Operated Aerodromes OBO Client A Risk Assessment Results

Airports	Category	Hazard Identification	Possible Consequences	Risk Assessment		Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation	
AMS/EHAM BOS/KBOS CDG/LFPG KEF/BIKF OSL/ENGM	Approach Aids and Patterns	Airport Category B	Non Standard Approach aids and / or approach patterns, or unusual local weather conditions, characteristics or performance limitations, or any other relevant considerations including obstructions, physical layout, lighting etc.	3B	Tolerable	Crew briefing before departure required	DOV/Crew Training	2B	Acceptable
AMS/EHAM OSL/ENGM	Approach Aids and Patterns	Circling	Maneuvers at low altitude, low airspeed and adverse weather conditions, which can result in loss of aircraft's control	2C	Tolerable	Crew briefing before departure to make sure flight crew is fully aware of aircraft performance to determine the exact circling maneuver considering the weather, unique airport design and aircraft position, altitude and airspeed	DOV/Crew Training	1B	Acceptable
AMS/EHAM CPH/EKCH KEF/BIKF OSL/ENGM	Seasonal Weather Phenomena	Snow Storm	Loss of aircraft's control	2D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2C	Tolerable
BOS/KBOS	Seasonal Weather Phenomena	Saline Atmosphere	Loss of visibility due to salt accretion on aircraft's windshield	2C	Tolerable	Follow ATC instructions	DOV/Flight Dispatch	1C	Acceptable

BOS/KBOS CDG/LFPG	Runway/Taxiway General Considerations	Runway incursions	Damage to property	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	1E	Tolerable
KEF/BIKF	Seasonal Weather Phenomena	Fog in airports vicinity	Loss of sufficient RVR to perform the landing	3D	Tolerable	All EAA aircraft are certified to perform up to CAT IIIB Landing	DME	1D	Acceptable
CDG/LFPG	Seasonal Weather Phenomena	Severe Turbulence	Loss of aircraft's control	2E	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	1E	Tolerable
KEF/BIKF OSL/ENGM	Seasonal Weather Phenomena	Severe Ice	Loss of aircraft's control	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2E	Tolerable
CPH/EKCH KEF/BIKF	Seasonal Weather Phenomena	Wind Shear	Loss of aircraft's control	2D	Tolerable	Follow ATC instructions Each EAA aircraft is equiped with EGPWS which alerts the crew for wind shear ahead	DOV/Crew Training	2C	Tolerable
OSL/ENGM	Handling Services	Handling provider unexperienced in aircraft type	Damage to cargo goods, and property	2E	Tolerable	An IO must be part of the crew Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1E	Tolerable

Appendix 7 – Client A Operation Hazard Log

Client A Operation Hazard Log										
Classification	Airports	Category	Hazard Identification	Possible Consequences	Risk Assessment		Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation	
Airport Related Hazard	AMS/EHAM BOS/KBOS CDG/LFPG KEF/BIKF OSL/ENGM	Approach Aids and Patterns	Airport Category B	Non-Standard Approach aids and / or approach patterns, or unusual local weather conditions, characteristics or performance limitations, or any other relevant considerations including obstructions, physical layout, lighting etc.	3B	Tolerable	Crew briefing before departure required	DOV/Crew Training	2B	Acceptable
Airport Related Hazard	AMS/EHAM OSL/ENGM	Approach Aids and Patterns	Circling	Manoeuvres at low altitude, low airspeed and adverse weather conditions, which can result in loss of aircraft's control	2C	Tolerable	Crew briefing before departure to make sure flight crew is fully aware of aircraft performance to determine the exact circling manoeuvre considering the weather, unique airport design and aircraft position, altitude and airspeed	DOV/Crew Training	1B	Acceptable
Airport Related Hazard	AMS/EHAM CPH/EKCH KEF/BIKF OSL/ENGM YYZ/CYYZ	Seasonal Weather Phenomena	Snow Storm	Loss of aircraft's control	2D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2C	Tolerable

Airport Related Hazard	BOS/KBOS	Seasonal Weather Phenomena	Saline Atmosphere	Loss of visibility due to salt accretion on aircraft's windshield	2C	Tolerable	Follow ATC instructions	DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	BOS/KBOS CDG/LFPG	Runway/Taxiway General Considerations	Runway incursions	Damage to property	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	1E	Tolerable
Airport Related Hazard	KEF/BIKF	Seasonal Weather Phenomena	Fog in airports vicinity	Loss of sufficient RVR to perform the landing	3D	Tolerable	All EAA aircraft are certified to perform up to CAT IIIB Landing	DME	1D	Acceptable
Airport Related Hazard	CDG/LFPG	Seasonal Weather Phenomena	Severe Turbulence	Loss of aircraft's control	2E	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	1E	Tolerable
Airport Related Hazard	KEF/BIKF OSL/ENGM	Seasonal Weather Phenomena	Severe Ice	Loss of aircraft's control	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2E	Tolerable
Airport Related Hazard	CPH/EKCH KEF/BIKF	Seasonal Weather Phenomena	Wind Shear	Loss of aircraft's control	2D	Tolerable	Follow ATC instructions Each EAA aircraft is equipped with EGPWS which alerts the crew for wind shear ahead	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	OSL/ENGM	Handling Services	Handling provider unexperienced in aircraft type	Damage to cargo goods, and property	2E	Tolerable	An IO must be part of the crew Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1E	Tolerable
General Operational Hazard		Employees Needs	VISAs required to enter in considered country	If VISAs are required and crews do not hold it temporarily landing permits may be needed which require all employees to fly every 72 hours	4C	Tolerable	VISAs must be issued before operation's beginning	DOV/Roasters	3C	Tolerable

General Operational Hazard		Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty from 4 to 6 hours	Crew not acclimatised to the time zone until 72 hours of time elapsed which can lead to crews' fatigue during its duty	4B	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3A	Acceptable

Appendix 8 - Client B Operation Hazard Log

Client B Operation Hazard Log										
Classification	Airports	Category	Hazard Identification	Possible Consequences	Risk Assessment		Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation	
Airport Related Hazard	ABV/DNAA	Terrain and Obstacles in Approach	Surrounded by mountains	Can cause windshear, turbulence, updrafts, downdrafts and mountain waves	2D	Tolerable	EGPWS installed in all EAA's fleet Crew briefing before departure required Follow EAA SOP's guidance for operating in airports surrounded by mountains	DOV/Crew Training	1D	Acceptable
Airport Related Hazard	LOS/DNMM KAN/DNKN YOL/DNYO	Approach Aids and Patterns	Deficiencies in RWY Lights	Can cause visual misunderstandings during the approach	2D	Tolerable	These deficiencies are always spreaded through NOTAM's which shall be analysed before perform any flight to/from the related airport	DOV/Flight Dispatch	1D	Acceptable
Airport Related Hazard	ABV/DNAA LOS/DNMM KAN/DNKN YOL/DNYO	Approach Aids and Patterns	Airport Category B	Non-Standard Approach aids and / or approach patterns, or unusual local weather conditions, characteristics or performance	3B	Tolerable	Crew briefing before departure required Follow EAA SOP's guidance for operating in CAT. B airports	DOV/Crew Training	2B	Acceptable

				limitations, or any other relevant considerations including obstructions, physical layout, lighting etc.						
Airport Related Hazard	ABV/DNAA LOS/DNMM YOL/DNYO	Approach Aids and Patterns	Joint Civilian/Military AD	Military traffic information unavailable	3C	Tolerable	Be aware of traffic information and follow ATC instructions	DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	LOS/DNMM	Seasonal Weather Phenomena	Fog in airports vicinity	Loss of sufficient RVR to perform the landing	3D	Tolerable	All EAA aircraft are certified to perform up to CAT IIIB Landing	DME	1D	Acceptable
							Previous approval shall be granted before aircraft's departure	DOV/Flight Dispatch	1D	Acceptable
Airport Related Hazard	KAN/DNKN	Seasonal Weather Phenomena	Squall Line and Hail	Loss of aircraft's control	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	1D	Acceptable
							Each EAA aircraft is equipped with weather radar which will inform the upcoming weather in advance			
Airport Related Hazard	ABV/DNAA LOS/DNMM KAN/DNKN PHC /DNPO QOW/ DNIM YOL/DNYO	Seasonal Weather Phenomena	Heavy Dust/Sand Storm	Accumulation of impurities that can reduce lifespan or damage to aircraft's components	3D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training DME/MOP	2D	Tolerable
							Maintenance team must cover all pitot probes and engine inlet cowls to prevent			

							accumulation of impurities			
							Each EAA aircraft is equipped with weather radar which will inform the upcoming weather in advance			
Airport Related Hazard	KAN/DNKN	Seasonal Weather Phenomena	Wind Shear	Loss of aircraft's control	2D	Tolerable	Follow ATC instructions Each EAA aircraft is equipped with EGPWS which alerts the crew for wind shear ahead	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	ABV/DNAA LOS/DNMM PHC/DNPO	Handling Services	Incorrect cargo loading	Pilots will calcute aircraft's performance and weight and balance based on wrong data	3E	Intolerable	An IO must be part of the crew Follow EAA's Booklet for Cargo Flight recommendations	DOT and DOV	1D	Acceptable
Airport Related Hazard	YOL/DNYO	Handling Services	No air starter available in case of APU inoperative	With no APU neither Air Starter the aircraft engines cannot be started	3E	Intolerable	In case of APU Inop, maintenance coordinator shall priorly guarantee Air Starter availability in arrival/departure airport	DME/MOP and DOV	2E	Tolerable
Airport Related Hazard	YOL/DNYO	Handling Services	No potable water servicing available	No potable water available during next flight	2C	Tolerable	Crew must ensure full water servicing before depart to the concerned airport	DOV/Crew Training DOT	1C	Acceptable

Airport Related Hazard	LOS/DNMM	Handling Services	Untrained aircraft marshaller	Wrong aircraft clearance can be inducted by Marshall	4D	Intolerable	Crews must reduce taxiing speed and maintenance may support aircraft pushback	DOV/Crew training DME/MOP	2D	Tolerable
Airport Related Hazard	LOS/DNMM	Employees Needs	Maintenance personnel access to airport with temporary badge	Could lead to aircraft delays due to maintenance actions required to release the aircraft to service	3C	Tolerable	Increase the number of maintenance personnel allocated to the operation	DME/MOP	2C	Tolerable
Airport Related Hazard	LOS/DNMM	Runway/Taxiway General Considerations	Airport development, construction and maintenance activities	Construction may cause impact on operations and FODs as more likely to be seen	3C	Tolerable	Ensure considered airport has reliable access routing, communication, FOD and dust control, construction signage etc.	DOV/Flight Dispatch	2B	Acceptable
Airport Related Hazard	LOS/DNMM	Runway/Taxiway General Considerations	Power cuts reported in aerodrome's infrastructures	Momentaneous Loss of contact with ATC and RWY/TWY lightning	4D	Intolerable	Do not rely only on ATC instructions neither on aerodrome's lightning	DOV/Crew Training	3D	Tolerable
Airport Related Hazard	ABV/DNAA	Runway/Taxiway General Considerations	Animal Hazard	Damage to property	3E	Intolerable	Follow ATC instructions	DOV/Crew Training and DOV/Flight Dispatch	1E	Tolerable
Airport Related Hazard	ABV/DNAA LOS/DNMM KAN/DNKN PHC /DNPO QOW/ DNIM YOL/DNYO	Runway/Taxiway General Considerations	Bird Strike Hazard	Damage to property	4D	Intolerable	If large concentration of birds is seen on or near the aerodrome, pilots will be informed by ATS. The crew in coordination with the ATC shall take appropriate actions.	DOV/Crew Training and DOV/Flight Dispatch	2D	Tolerable

Airport Related Hazard	QOW/DNIM YOL/DNYO	Rescue and Fire Fighting Category	Rescue and Fire Fighting Category lowered by maximum 2 categories	Could cause delays due to the inability to refuel during the embark	2D	Tolerable	Request ATC for RFFS assistance during ground operations. While refuelling do not embark passengers. Park in remote airport areas	DOV/Flight Dispatch	1B	Acceptable
Airport Related Hazard	KAN/DNKN QOW/DNIM YOL/DNYO	Aircraft Maintenance Considerations	No base maintenance facilities to perform major maintenance	Could result in longstanding AOG	4D	Tolerable	Ensure capability and client's support to perform the considered defect rectification in line before the aircraft departs to any other location	DME/PCO	2D	Tolerable
Airport Related Hazard	KAN/DNKN QOW/DNIM YOL/DNYO	Aircraft Maintenance Considerations	No tools available for line maintenance works	Could result in delays or AOG's	3E	Intolerable	Have a fly away kit on board with spare parts and tools for defect rectification	DME/MOP	1E	Tolerable
Airport Related Hazard	KAN/DNKN PHC/DNPO QOW/DNIM YOL/DNYO	Aircraft Maintenance Considerations	Lack of EASA certified organizations to perform any corrective maintenance required	Could result in delays or AOG's	3C	Tolerable	Ensure EAA Part 145 certified technician is on board along with the crew to perform any corrective maintenance, if required, in the destination	DME/MOP	1C	Acceptable
Airport Related Hazard	KAN/DNKN PHC/DNPO QOW/DNIM YOL/DNYO	Aircraft Maintenance Considerations	Difficulty to get EASA certified parts in case of AOG	Could result in longstanding AOG	3E	Intolerable	Ensure cooperation between EAA's and client's Logistic before the beginning of the operation to ensure smooth parts delivery and clearance from customs	DME/LOG	1E	Tolerable

Airport Related Hazard	YOL/DNYO	Aircraft Maintenance Considerations	Lack of specialized ground handling equipment to support maintenance	Could result in delays or AOG's	2E	Tolerable	Alternative service providers as well as support on equipment's airport access (in case the client does not operate in the considered airport) must be ensured with the client before contract signature	DME/MOP	1E	Tolerable
General Operational Hazard		Employees Needs	Employee's duty periods do not comply with regulatory requirements for resting days between shifts	Employee's stress and tiredness will increase affecting their effectiveness on duty	3E	Intolerable	Ensure enough crew members, maintenance technicians and coordinators to guarantee effective rest periods that comply with regulations	DME/MOP DOV/Roasters DOT	1E	Tolerable
General Operational Hazard		Flight Time Limitations	Multiple Sectors Operated	Increased fatigue levels and reduced FDP	4A	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1B	Acceptable
General Operational Hazard		Employees Needs	VISAs required to enter in considered country	If VISAs are required and crews do not hold it temporarily landing permits may be needid which require all employees to fly every 72 hours	4C	Tolerable	VISAs must be issued before operation's beginning	DOV/Roasters	3C	Tolerable

Appendix 9 – Client C Operation Hazard Log

Client C Operation Hazard Log										
Classification	Airports	Category	Hazard Identification	Possible Consequences	Risk Assessment		Mitigation measures	Department Responsible for Risk Mitigation	Risk Assessment After Mitigation	
Airport Related Hazard	BOS/KBOS CDG/LFPG EWR/KEWR JFK/KJFK	Approach Aids and Patterns	Airport Category B	Non-Standard Approach aids and / or approach patterns, or unusual local weather conditions, characteristics or performance limitations, or any other relevant considerations including obstructions, physical layout, lighting etc.	3B	Tolerable	Crew briefing before departure required	DOV/Crew Training	2B	Acceptable
Airport Related Hazard	CPH/EKCH EWR/KEWR JFK/KJFK	Seasonal Weather Phenomena	Snow Storm	Loss of aircraft's control	2D	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	BOS/KBOS	Seasonal Weather Phenomena	Saline Atmosphere	Loss of visibility due to salt accretion on aircraft's windshield	2C	Tolerable	Follow ATC instructions	DOV/Flight Dispatch	1C	Acceptable
Airport Related Hazard	BOS/KBOS CDG/LFPG	Runway/Taxiway General Considerations	Runway incursions	Damage to property	3E	Intolerable	Follow EAA SOP's guidance	DOV/Crew Training	1E	Tolerable

Airport Related Hazard	EWR/KEWR	Seasonal Weather Phenomena	Fog in airports vicinity	Loss of sufficient RVR to perform the landing	3D	Tolerable	All EAA aircraft are certified to perform up to CAT IIIB Landing	DME	1D	Acceptable
Airport Related Hazard	CDG/LFPG	Seasonal Weather Phenomena	Severe Turbulence	Loss of aircraft's control	2E	Tolerable	Follow EAA SOP's guidance for operating in adverse weather conditions	DOV/Crew Training	1E	Tolerable
Airport Related Hazard	CPH/EKCH	Seasonal Weather Phenomena	Wind Shear	Loss of aircraft's control	2D	Tolerable	Follow ATC instructions Each EAA aircraft is equipped with EGPWS which alerts the crew for wind shear ahead	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	EWR/KEWR JFK/KJFK	Approach Aids and Patterns	ATC fast and abbreviated talks	Non-standard phraseology	3C	Tolerable	Request ATC to clarify instructions in accordance with ICAO standards	DOV/Crew Training	2C	Tolerable
Airport Related Hazard	EWR/KEWR JFK/KJFK	Approach Aids and Patterns	ATC with High Workload	Complex arrivals and busy ATC environment	3D	Tolerable	Avoid to occupy the radio transmission, however request clearance clarification if required	DOV/Crew Training	1D	Acceptable
General Operational Hazard		Employees Needs	VISAs required to enter in considered country	If VISAs are required and crews do not hold it temporarily landing permits may be needed which require all employees to fly every 72 hours	4C	Tolerable	VISAs must be issued before operation's beginning	DOV/Roasters	3C	Tolerable
General Operational Hazard		Flight Time Limitations	Time difference between reference time and local time where the crew member starts the next duty	Crew not acclimatised to the time zone until 96 hours of time elapsed which can lead to crews' fatigue during its duty	3C	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	3B	Tolerable
							Ensure a resting period of at least 96 hours before next duty	DOV/Rosters	1A	Acceptable

			from 6 to 9 hours							
General Operational Hazard		Flight Time Limitations	Crew's FDP almost exceeded	Flight cancelation or delay	2D	Tolerable	Operate with Augmented Flight Crew	DOV/Rosters	1B	Acceptable
							Ensure a stand-by crew fit for duty in the considered home-base	DOV/Rosters	1A	Acceptable