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GRADUATION WORK

FOR THE DEGREE OF MASTER
SPECIALITY 173 'AVIONICS'

Theme:
"Operational factors influencing the maintenance of airworthiness of the aircraft"

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ABSTRACT

Explanatory notes to the thesis "Operational factors influencing the maintenance of airworthiness of the aircraft " contained 56 pages, 21 drawings, 1 table, 3 flowcharts, and 0 reference books.

Actuality of the graduate work: modern aircraft are subject to a multitude of influences, making it imperative to delve into this subject to preserve both human and material resources. Investigating these factors is crucial not only for understanding their impact but also for facilitating the integration of new technologies aimed at minimizing adverse effects on aircraft.

Keywords: airworthiness, weather factor, technical factor, human factor, aviation.

The purpose of the thesis: the primary objective of this thesis is to explore the operational factors that significantly affect aircraft.

The object of research: this study focuses on examining the repercussions of operational factors on aircraft.

The subject of research: the research entails a comprehensive analysis of the various factors influencing aircraft and a detailed examination of the consequences stemming from their impact.

Research method: a thorough analysis of relevant theories, statistical data, and applicable laws.

The scientific novelty of the study: these materials are recommended for use in cases of research and study of the effects on the aircraft

The importance of the thesis, conclusions, and recommendations for the implementation of the results: the thesis considers the impact of various factors on the aircraft, research, and information about these effects.

6. Planned schedule

№	Task	Duration	Signature of supervisor
1.	Validate the rationale of graduation work theme		
2.	Carry out a literature review		
3.	Develop the first chapter of diploma		
4.	Develop the second chapter of diploma		
5.	Develop the third chapter of diploma		
6.	Develop the fourth chapter of diploma		
7.	Tested for anti-plagiarism and obtaining a review of the diploma		

7. Date of assignment: ‘____’___________ 2022

Supervisor _______________

(signature) (surname, name, patronymic)

The task took to perform _______________

(signature) (surname, name, patronymic)

CONTENTS

LIST OF ABBREVIATIONS

Chapter 1.

1.1

What do we mean by airworthiness?

In aviation, airworthiness is a measure of the suitability of an aircraft for safe flight. Initial airworthiness is confirmed by an airworthiness certificate issued by the civil liability authority of the state in which the aircraft is registered, and continued airworthiness is achieved through emergency maintenance.

Certification is based on standards applied by civil aviation authorities. Compatibility is ensured when national tests adopt the standards of international civil and military organizations such as the International Civil Aviation Organization (ICAO), the European Aviation Safety Agency (EASA), NATO and the European Defense Agency (EDA).

The definition used by the UK Ministry of Defense is more explanatory to include people on the ground (third parties) – “Airworthiness is the ability of an aircraft or other on-board equipment or system to be used in flight and on the ground without significant safety to the crew, ground crew, passengers or third parties; it is a technical attribute of material means during the entire life cycle."

Webster's Dictionary gives a much simpler definition of airworthiness as "airworthiness," but begs the question of what such airworthiness actually means.

"Status of the airplane, engine, propeller or part if they conform to the approved design and are in a condition for safe operation." - ICAO Annex 8

These definitions have common elements that emphasize the importance of safe conditions, compliance with necessary requirements and acceptable limitations in aviation. Normal operation and successful flight completion can be assumed to contribute to safe conditions. In this context, safety is defined as the absence of factors that could lead to death, injury, illness, property damage/loss, or environmental damage.

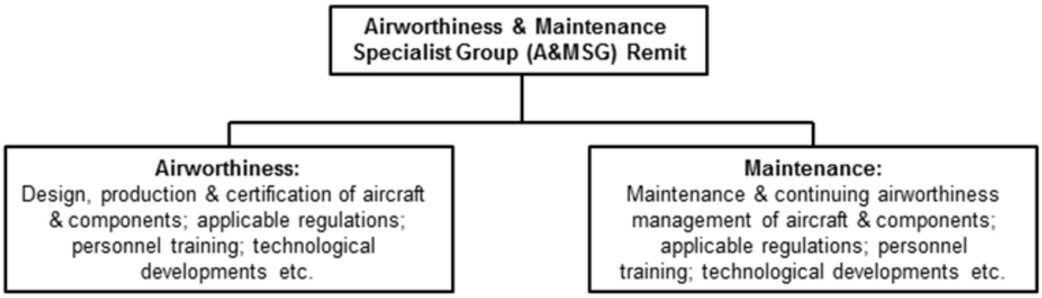
Ensuring compliance with the necessary requirements involves the design and construction of the aircraft or its components in accordance with carefully studied and verified criteria for safe flight. These criteria, established by designated airworthiness authorities, aim to improve safety by eliminating or mitigating conditions that could lead to harm. The airworthiness standards published by these bodies cover a variety of design requirements, from structural strength to flight and maintenance procedures, reflecting good design practice and addressing issues such as systems, fatigue and flutter. It is important to note that these standards differ for different aircraft types.

In aviation, standards typically develop in response to technological progress rather than in front of it, sometimes adapting to or accompanying progress. Static standards can hinder aviation progress by emphasizing the need to constantly align regulations with technological progress. Accident analysis often leads to additional regulations aimed at preventing or mitigating accidents, which is a form of "hindsight" or, more positively, "learning by experience". Although the adaptation of standards requires additional costs, it is considered a necessary investment in security.

Permissibility limits play a key role in the operation of aircraft, defining their capabilities and limitations. Airplanes are designed to perform certain "flights" that depend on speed and structural load. The maximum weight of the aircraft may vary depending on the type of flight, and there are also special operating conditions, such as the rules for visual flight during the day and night, flying by instruments, as well as flying in icing conditions.

Exceeding the specified conditions and restrictions can lead to serious accidents. For example, take-offs with excessive weight, maneuvers with unexpected loads, dangerous flights in icy conditions or exceeding the maximum speed are just a few examples of the importance of following the established limits. Pilots are made aware of these limitations during training, aircraft markings, cockpit instructions and practical training.

Faults can have a significant impact on safety and, if not detected or partially rectified, can lead to accidents. The wrong reaction of the crew to a malfunction that occurred during the flight can also lead to negative consequences. In such cases, the investigation carries out an analysis of the crew's answers and considers the main issues of airworthiness. However, in many cases the crew successfully resolves the anomalies and exits the aircraft safely after the situational test.



The relationship between airworthiness and flight safety is clear but complex. Design efforts, in addition to meeting the relevant certification standards, often focus on improving the economic efficiency of the aircraft, benefiting both manufacturers and operators. Consequently, certification bodies scrutinize all aspects of aircraft design and construction, even if improvements exceed minimum standards. When an aircraft type meets all certification requirements, it is approved.

Deficiencies in airworthiness may become apparent after an incident or accident, including unknown failures, errors, or deviations from standard design that result in non-compliance with safe operating conditions. In 2001, the FAA brought in experts from various sectors, including the US aerospace industry, the Department of Defense, Sandia National Laboratories, and NASA, to scrutinize the series of accidents and obtain information for the certification process. Their collaborative effort, known as the Commercial Aircraft Certification Process Study, serves as a valuable meta-analysis of the interaction between certification, operations, and maintenance. The study revealed 15 findings and two observations that suggest areas for improvement.

1.2

The International Civil Aviation Organization (ICAO), founded in accordance with the Chicago Convention on Civil Aviation in 1944, functions as a specialized agency of the United Nations whose task is to organize and promote international cooperation between states in various aspects of civil aviation. About 190 states are members of the ICAO, including Ukraine on the basis of legal succession. The USSR became a member of ICAO on November 10, 1970, and the headquarters of the organization is located in Montreal, Canada.

ICAO deals with a number of matters related to international civil aviation, including air routes, the establishment of airports and air navigation facilities, and the development of international standards for the construction and operation of aircraft, the use of equipment, means of communication and air traffic control rules. It also helps to standardize customs, immigration and sanitary regulations. Projects of international conventions are being developed under the auspices of ICAO.

The main statutory purpose of ICAO is to ensure the safe and orderly development of international civil aviation throughout the world, as well as the organization and coordination of international cooperation on all matters of civil aviation, including international transportation. ICAO rules dictate the division of international airspace into flight information zones, the boundaries of which are established taking into account the capabilities of navigation and air traffic control.

The ICAO Statute, defined as the ninth edition of the 1944 Convention on International Civil Aviation, consists of 19 chapters (appendices), including amendments made between 1948 and 2006. Commonly known as ICAO Doc 7300/9, it is a comprehensive document that sets out the regulatory framework for international civil aviation.

According to Article 3 of the Convention, the provisions apply only to civil aircraft and do not apply to government aircraft used for military, customs and police services. At the same time, it is emphasized that no state aircraft can fly or land on the territory of another state without prior permission, compliance with a specific agreement and compliance with its provisions.

The convention led to the establishment of the International Civil Aviation Organization (ICAO), set out in 44 articles, whose purpose is to ensure the safe and orderly development of global international civil aviation and to promote flight safety in international air navigation. According to Article 37, the signatory States undertake to cooperate in achieving a high level of uniformity of rules, standards, procedures and organization relating to aircraft, personnel, air routes and support services, if such uniformity improves air navigation.

The Chicago Convention, together with the bilateral and multilateral agreements derived from it, mainly regulates scheduled international civil aviation services operated by duly authorized States and their national airlines for commercial purposes, including the carriage of passengers, baggage, cargo and mail for reward. These agreements grant certain fundamental rights, known as the five "freedoms of the air", which include transit flights, non-commercial refueling landings, the carriage of passengers and cargo to and from the aircraft's country of registry, and the carriage of passengers, cargo and mail between states. In addition, two additional freedoms include the right to transport between third countries through one's territory and to transport between third countries bypassing one's territory.

Since the foundation of ICAO, the main technical task of the organization has been to achieve standardization in the operation of safe, regular and efficient air services. This has resulted in a high level of reliability in the many areas that together make up international civil aviation, including aircraft, their crews, and ground assets and services.

Standardization was achieved through the creation, adoption and amendment of 18 annexes to the Convention, identified as international standards and recommended practices.

Standards are directives that ICAO members agree to follow. If a member has a standard that is different from the ICAO standard, that member must notify ICAO of the difference. Recommended practices are preferred but not required. The basic principle for deciding whether a particular matter should be the standard is to answer the question in the affirmative: "Is it necessary to apply it equally to all Contracting States?"

In accordance with the Convention, Contracting States shall participate in achieving the highest practicable level of uniformity of rules throughout the world in the organization of procedures for aircraft, personnel, airways and support services, if this will promote and improve the safety, efficiency and regularity of flights.

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The 18 programs are described as follows:

- Appendix 1 Personnel Licensing - contains information on the licensing of flight crew, air traffic controllers and aircraft maintenance personnel, including medical standards for flight crew and air traffic controllers.

- Appendix 2. Flight rules - contains rules related to visual and instrument flights.

- Annex 3. Meteorological service of international air navigation - provides meteorological service of international air navigation and reports of meteorological observations from aircraft.

- Appendix 4. Aeronautical charts - contains specifications for aeronautical charts used in international aviation.

- Annex 5. Units of measurement to be used in air and ground operations - lists the measurement systems to be used in air and ground operations.

- Appendix 6. Aircraft Operation - contains a list of specifications to ensure a level of safety above the established minimum during similar operations worldwide.

- Appendix 7. Nationality of the aircraft and registration marks - defines the requirements for registration and identification of the aircraft.

- Appendix 8. Airworthiness of aircraft - defines uniform procedures for certification and inspection of aircraft.

- Annex 9. Simplification – provides standardization and simplification of border crossing formalities.

- Annex 10. Aeronautical Telecommunications - Volume 1 standardizes communication equipment and systems, and Volume 2 standardizes communication procedures.

- Appendix 11. Air traffic service - contains information on the installation and operation of air traffic control (ATC), flight information and notification services.

- Appendix 12. Search and rescue operations - provide information on the organization and operation of facilities and services necessary for search and rescue operations.

- Appendix 13. Investigation of aviation events and incidents - provides uniformity in the notification, investigation and reporting of aviation accidents.

- Appendix 14. Aerodromes - contains technical conditions for the design and equipment of airfields.

- Appendix 15. Aeronautical Information Services - includes methods for collecting and disseminating aeronautical information necessary for flights.
- Annex 16. Environmental Protection - Volume 1 contains specifications for airborne noise certification, noise monitoring and noise impact units for land use planning, and Volume 2 contains specifications for aircraft engine emissions.
- Appendix 17. Security - Protection of international civil aviation from acts of unlawful interference defines the methods of protection of international civil aviation from acts of unlawful interference.
- Annex 18. Safe carriage of dangerous goods by air - defines the requirements necessary to ensure the safe carriage of dangerous materials in an aircraft, providing a level of safety that protects the aircraft and its passengers from undue risk.

As aviation technology is constantly evolving, programs are constantly being reviewed and updated as needed. The typical content of the application is based on the following:

- Standards developed as specifications when their application is considered necessary for the safety and regularity of international air navigation.
- The recommended methods are intended as specifications when their application is considered as a recommendation in the interests of the safety, regularity and efficiency of international air navigation.
- Appendices relating to previous paragraphs.
- Definition of used terminology.

Contracting States have issued regulations that do not fully copy the content of the Annex, which essentially sets out certain principles or objectives to be achieved. Standards contain requirements that are used to achieve objectives.

Also, while the principles remain the same, the requirements are often influenced by the current state and are likely to evolve and change.

The Federal Aviation Administration (FAA) is the largest transportation agency in the United States government, overseeing and regulating various aspects of civil aviation both domestically and in surrounding international waters. Its broad mandate includes responsibilities such as air traffic control, certification of both personnel and aircraft, setting standards for airports, and protecting U.S. assets during the launch or re-entry of commercial spacecraft. The FAA's jurisdiction extends over adjacent international waters through a delegation from the International Civil Aviation Organization.

Created in August 1958, originally as the Federal Aviation Agency, it assumed the role of the Civil Aeronautics Administration (CAA). In 1967, as part of the newly created US Department of Transportation, it was renamed the Federal Aviation Administration.

FAA roles include:

- Regulation of US commercial space transportation
- Standardization of geometric and flight checks of aeronautical equipment
- Promotion and development of civil aeronautics, including new aviation technologies
- Issuance, suspension or cancellation of pilot certificates

- Regulation of civil aviation to promote transportation safety in the United States, particularly through local offices called District Flight Standards Offices
- Development and operation of air traffic control and navigation systems for civil and military aircraft
- Research and development of the national airspace system and civil aeronautics
- Development and implementation of programs to control aviation noise and other impacts of civil aviation on the environment

In addition, although the fundamental principles remain consistent, the requirements often undergo refinements and changes influenced by the current state of aviation practice.

Airworthiness standards for international aircraft certification established by the Joint Aviation Authorities (JAA), the Federal Aviation Administration (FAA) and the European Aviation Safety Agency (EASA) are consistent with the ICAO Annexes. In practice, the certification process is based on these airworthiness standards, rather than direct compliance with international ICAO standards.

Four programs directly related to airworthiness are of particular importance:

Annex 6 - Operation of aircraft: this annex sets out standards and guidelines for the operation of aircraft in international commercial air transport, including provisions on operator certification. It also includes technical and operational regulations for the general activity of international aviation, including maintenance. The main purpose of Annex 6 is to standardize the operation of aircraft engaged in international air transport, ensuring the highest level of safety and efficiency. The Annex aims to improve the safety and efficiency of international air navigation by establishing criteria for safe operation, encouraging ICAO Contracting States to facilitate the passage of compliant commercial aircraft through their territories. Regulations are subject to regular reviews and revisions to align with industry developments.

Annex 8 - Aircraft Airworthiness: This annex establishes standards defining minimum levels of airworthiness for the development of type certification requirements, which is the basis for the international recognition of aircraft airworthiness certificates for take-offs and landings in government contracts. Each State has the option of formulating its own comprehensive and detailed airworthiness code or accepting the existing code of another Contracting State. The general standards set out in Annex 8 define the level of airworthiness to be maintained by the national code, contributing to the overall safety and reliability of international aviation.

Technical standards related to aircraft certification cover a number of requirements related to various aspects of aircraft performance. They include specifications for flight performance, structural design and construction, design and installation of engines, propellers, systems and equipment. Operational limitations covering the procedures and general information contained in the aircraft operations manual are also covered. Factors affecting the flight crew's ability to maintain controlled flight are considered, emphasizing a flight crew cockpit layout that minimizes the risk of malfunctions due to disorientation, fatigue, or obstructions while providing a clear, wide, and undistorted field of view for safe operation.

Appendix 13 - Investigation of aircraft accidents and incidents:

This annex establishes international requirements for the investigation of aviation events and incidents. The main purpose of accident investigation is prevention, aimed at determining the causes of an accident or serious incident in order to prevent future occurrences. According to Annex 13, the State where the accident or incident occurred leads the investigation, with the possibility of delegating aspects to another State. Representatives of the state of registration, the operator and the manufacturer may participate. The result of the investigation process is a final report with safety recommendations to prevent similar incidents.

ICAO operates the Accident/Incident Reporting System, a computerized database that facilitates the exchange of safety information between Contracting States. Safety recommendations are evaluated by airworthiness authorities, resulting in the publication of airworthiness directives, updates to relevant airworthiness requirements, and dissemination of useful information and guidance as necessary.

Appendix 16 - Environmental protection:

This application sets the standard for airborne noise certification by classifying noise levels based on aircraft types and defining test procedures for accurate measurements. Usually, the standard is applied in the proposed form, directly referring to the technical requirements. In addition, Annex 16 contains a standard for certification of aircraft engine emissions with respect to the toxicity of specific chemical components such as nitrogen oxides.

The European Union Aviation Safety Agency (EASA) is the European Union (EU) agency responsible for civil aviation safety. It carries out certification, regulation and standardization, as well as research and monitoring. It collects and analyzes safety data, develops and advises on safety legislation and coordinates work with similar organizations in other parts of the world.

The idea of a European aviation safety authority dates back to 1996, but the agency was legally established only in 2002 and started its work in 2003.

EASA is an independent body of the European Community, which is a legal entity and has autonomy in legal, administrative and financial matters. The main tasks of the Agency at the moment are:

- Regulatory activities: development of aviation safety legislation and provision of technical advice to the European Commission and member states;

- Verification, training and standardization programs to ensure uniform implementation of European legislation on aviation security in all member states;
- Safety and environmental certification of aircraft, engines and parts;
- Approval of aviation design organizations worldwide and production and technical organizations outside the EU;
- Authorization of operators from third countries (non-EU);
- Coordination of the European Community's security assessment program for foreign aircraft using Community airports;
- Data collection, analysis and research to improve aviation safety.

According to Regulation (EC) No. 1592, EASA is responsible for the design approval of products, parts and appliances designed, manufactured or used by persons under the supervision of EU Member States, except those excluded by Annex II7.

After that, the European Commission adopted Regulation (EC) 1702/2003, which defines the requirements for products, parts and devices and facilitates the transfer of existing certificates to align with the safety levels provided by the Basic Regulation (EC) No. 1592/2002 and its implementing rules.

Recognizing the need for transition, the Basic Regulation allows Member States to continue to issue certificates during this period under certain conditions set out in its implementing rules, in particular Commission Regulation 1702/2003. This transition period ended on March 28, 2007.

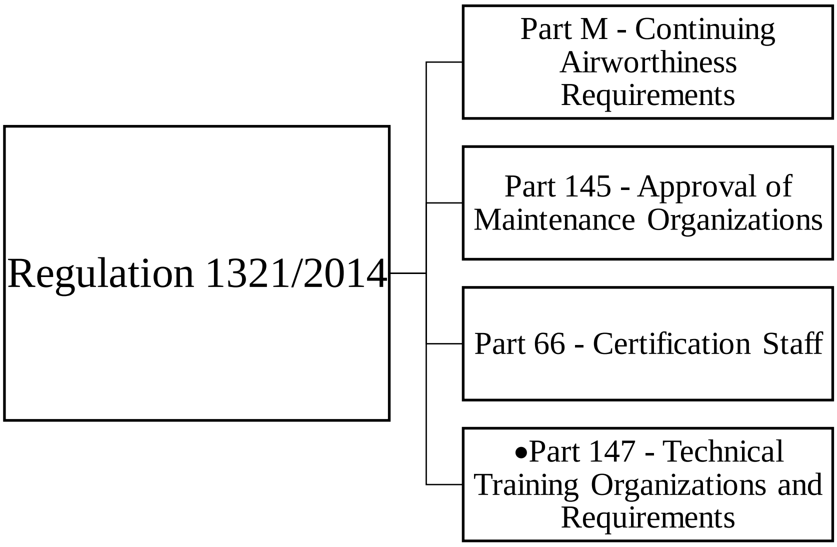
Consequently, the Agency's responsibility for design activities such as type certificates, supplementary type certificates and post-type certification activities now includes:

- Products with type certificates issued by EASA in accordance with Commission Regulation 1702/2003 of March 30, 2007.
- Products with type certificates issued by EU member states are recognized as complying with Commission Regulation (EC) 1702/2003.

- Products with airworthiness specifications from EASA in accordance with Regulation (EC) No. 1592/2002 to support limited certificates of airworthiness.
- In addition, EASA is responsible for the approval of parameters of flight conditions for the issuance of permission to fly by the authorized body of the Member State of registry.

Part M specifically addresses the continuing airworthiness of aircraft, aeronautical products, parts and appliances, and the approval of organizations and personnel involved in these tasks. EASA created EU Regulation No. 2042/2003 in 2002 based on EU Regulation No. 1592/2002, which sets out the airworthiness requirements for EU air carriers and private aircraft owners for continuing airworthiness management. In 2014, this was reinforced by the updated Regulation 1321/2014, which entered into force in June 2016 with further amendments.

EASA initiates proposed changes through notifications, and once approved, they become "Commission Regulations". After the transition period, the applicable legislation (implementing rule) and the corresponding means of compliance become legally binding for all Member States.



Part M is divided into two sections for different purposes. Section A, commonly referred to as "Technical Requirements", is applicable to the industry. By contrast, Section B, known as the 'Procedure for Competent Authorities', applies to the Regulator or Competent Authority.

An Airworthiness Management Manager (CAM) is designated under each Part M. This person is responsible for establishing and overseeing airworthiness management (CAMO) in accordance with the regulatory requirements set out in Part M and the procedures detailed in the Airworthiness Management Annex.

Part M –Section A:

- Subpart A –General
- Subpart B –Accountability
- Subpart C –Continuing Airworthiness
- Subpart D –Maintenance Standards
- Subpart E –Components
- Subpart F–Maintenance organization
- Subpart G–Continuing Airworthiness Management organization
- Subpart H –Certificate of Release to Service
- Subpart I –Airworthiness Review Certificate

Part 145 - Approval of Maintenance Organizations:

- 145.A.25.Facilities
- 145.A.30.Personnel
- 145.A.35.Staff
- 145.A.40.ToolingandMaterials
- 145.A.42.AcceptanceofComponents
- 145.A.45.MaintenanceData
- 145.A.47.ProductionPlanning
- 145.A.50.Certification of Maintenance
- 145.A.60.OccurrenceReporting.
- 145.A.65.QualitySystem
- 145.A.70.ExpositionandProcedures

Chapter 2.

2.1

Aviation safety is largely dependent on maintenance practices, and if performed incorrectly, it becomes a significant factor in aviation accidents and incidents. Maintenance errors such as improperly installed parts, missing components, and failure to perform necessary inspections can have serious consequences. Unlike many other threats to aviation safety, errors made by aviation maintenance technicians (AMTs) can be difficult to detect, often go unnoticed and potentially affect the safe operation of an aircraft over a long period of time.

AMTs face unique human factors in the aviation environment. They often work at odd hours, in confined spaces, on elevated platforms, and in a variety of adverse temperature and humidity conditions. The work is physically demanding and requires meticulous attention to detail. Due to the nature of maintenance tasks, AMTs often spend more time preparing for the task than actually performing it. Thorough documentation of all maintenance work is critical, as AMT spends as much time updating maintenance logs as performing actual tasks.

Recognizing the impact of human factors can lead to improved quality, a work environment that ensures continued safety for both workers and aircraft, and a more committed and accountable workforce. In particular, reducing even minor errors can yield tangible benefits, including reduced costs, fewer missed deadlines, fewer work-related injuries, fewer warranty claims, and a reduction in more significant maintenance error events.

The term "human factors" is gaining importance in the commercial aviation industry as it recognizes that human error, rather than mechanical failure, is often the primary cause of aviation accidents and incidents. Human factors science or technology involves a multidisciplinary approach, drawing knowledge from psychology, engineering, industrial design, statistics, operations research, and anthropometry. It encompasses the scientific understanding of human capabilities, the application of this knowledge to the design, development and implementation of systems and services. In addition, it includes the art of ensuring the successful application of human factors principles in the service work environment.

The range of human factors affecting aviation maintenance and performance is broad and encompasses a variety of challenges that affect people differently due to differences in capabilities, strengths, weaknesses or limitations. Ignoring these human limitations during aviation maintenance tasks can lead to technical errors and injuries, some more serious than others. In many cases, a combination of three or four factors can cause and contribute to accidents or incidents.

Clinical psychology involves the application of psychological principles to understand, prevent, and alleviate psychological stress or dysfunction while promoting subjective well-being and personal development. It is specifically aimed at improving a person's mental well-being, addressing issues such as stress management, coping mechanisms, improving self-esteem and responding to criticism from colleagues.

Experimental psychology delves into the study of fundamental behavioral processes, which are often conducted in laboratory settings. These processes include learning, sensation, perception, human performance, motivation, memory, language, thinking and communication. In addition, experimental research in this field helps evaluate the effectiveness of work policies and procedures by measuring performance, productivity, and identifying deficiencies.

Anthropometry focuses on the study of the dimensions and capabilities of the human body, a crucial aspect in aviation maintenance due to the unique work environment and spaces in which aircraft maintenance technicians (AMTs) navigate. This includes considerations of size, weight and space limitations, ensuring that equipment and tools are suitable for people with different physical characteristics.

Computer science, by its technical definition, covers the study of theoretical foundations of information and calculations, as well as practical methods of their implementation in computer systems. In the context of aviation maintenance, this means the need to provide AMT with convenient and reliable computer workstations. Software and computer tools must be user-friendly and accessible to individuals with varying levels of computer literacy.

Cognitive science, as an interdisciplinary scientific study, examines how the mind functions as an information processor, covering different levels of analysis from low-level learning to high-level logic and planning. It is critical for AMTs to have strong problem-solving skills, as they must identify faults and react quickly in high-stress situations. Cognitive science helps to understand how to support AMTs during stressful situations, ensuring that their mental processes are uninterrupted and their work performance is not impaired.

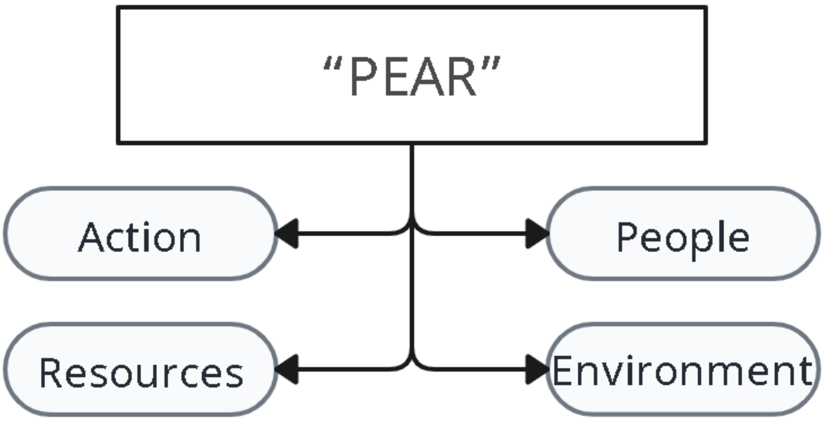
Safety engineering ensures that a vital system functions properly even in the event of component failure. Ideally, safety engineers analyze the initial system design to identify potential failures, propose safety requirements in preliminary design specifications, and recommend changes to existing systems to improve safety. In aviation maintenance, safety is paramount, affecting the design of maintenance rooms, hazardous material storage containers, heavy lifting equipment and floor layouts to prevent accidents such as slips, trips or falls. Compliance with Occupational Safety and Health Administration (OSHA) guidelines is critical in industrial work environments.

Medicine, as the science and art of healing, encompasses a variety of health care practices aimed at maintaining and restoring health through the prevention and treatment of disease. Physical well-being is closely related to human factors, given the diversity of individuals in terms of body physiology, physical structures and biomechanics, resulting in different responses to different situations.

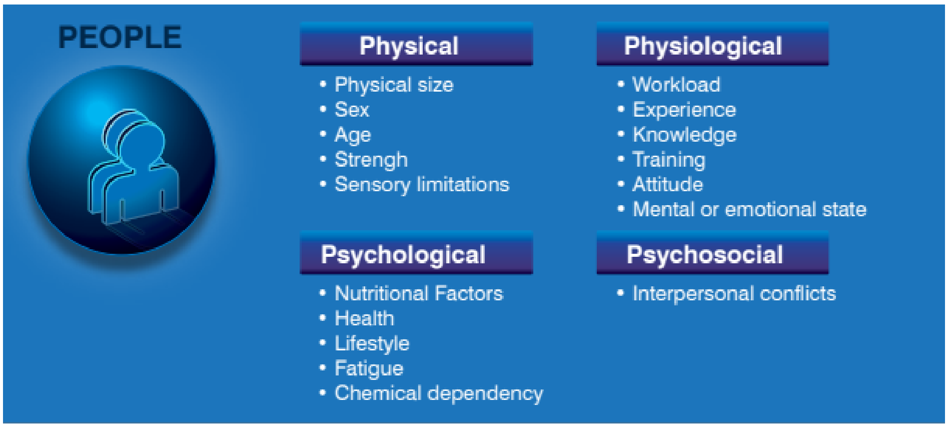
Organizational psychologists deal with the dynamics between people and work, covering areas such as organizational structure, change, employee productivity, job satisfaction, consumer behavior, and personnel selection, placement, training, and development. An understanding of organizational psychology helps aviation maintenance inspectors promote a positive work environment and productivity through initiatives such as rewarding employees for good safety performance, fostering motivated and collaborative work teams, and ensuring that all employees are treated equally.

Educational psychologists focus on how people learn and develop teaching methods and materials that are appropriate for different learning styles and paces. Leaders are encouraged to create learning blocks that meet different learning preferences.

Industrial engineering involves the organized study of work, including the establishment of reasonable work standards to prevent unnecessary stress and error. Effective room planning contributes to the creation of a favorable working environment, and clean and uncluttered spaces increase work efficiency. Statistical analysis of job performance provides specific data that can reveal contributing factors during task performance, whether positive or negative.



The science and application of human factors involve different concepts, and for practical purposes it is useful to take an integrated view of the key aspects of aviation maintenance. One effective approach is to use a model, and for more than a decade the acronym "PEAR" has served as a mnemonic to encapsulate the important aspects of human factors in aviation maintenance.

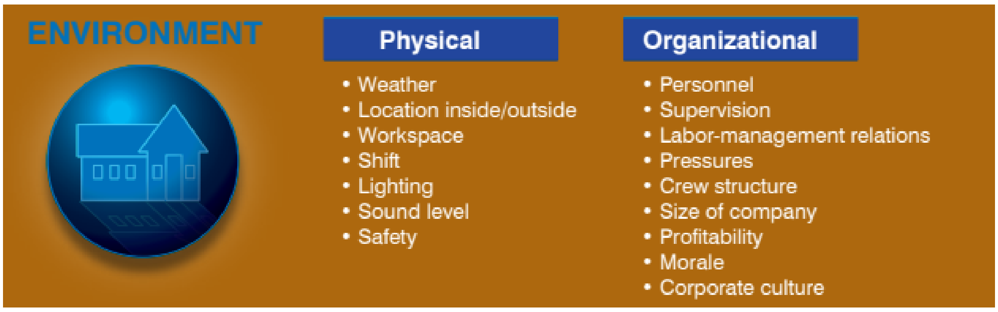


Aviation maintenance programs focus on the workforce with consideration of physical, physiological, psychological, and psychosocial factors. Emphasis is placed on understanding people, including their physical capabilities, mental states, cognitive abilities, and the factors that influence their interactions with others. These programs are tailored to the company's existing workforce, recognizing diversity in strength, size, experience, motivation and certification standards among employees. An important aspect is the correspondence of the physical characteristics of each person to the specific tasks they perform.

Considerations such as size, strength, age, eyesight, etc. are taken into account to ensure that each individual is physically capable of performing the demands of their job. Effective human factors programs also recognize human limitations and design workplaces accordingly, including scheduled rest breaks to prevent physical and mental fatigue. Adequate task lighting, especially for older workers, is another environmental factor.

In addition to physical ability, a comprehensive human factors program addresses the physiological and psychological factors that affect performance. Companies are encouraged to promote good physical and mental health by offering health and fitness education programs. Initiatives such as providing healthy food, snacks and beverages have been proven to reduce sick days and increase productivity.

In addition, addressing chemical dependency issues, particularly tobacco and alcohol, is a vital aspect of the human factors program. Encouraging teamwork and communication is critical to creating a safe and effective work environment. Companies can incentivize employees to contribute to system improvements, waste elimination, and ongoing safety measures.



ENVIRONMENT

Physical

- Weather
- Location inside/outside
- Workspace
- Shift
- Lighting
- Sound level
- Safety

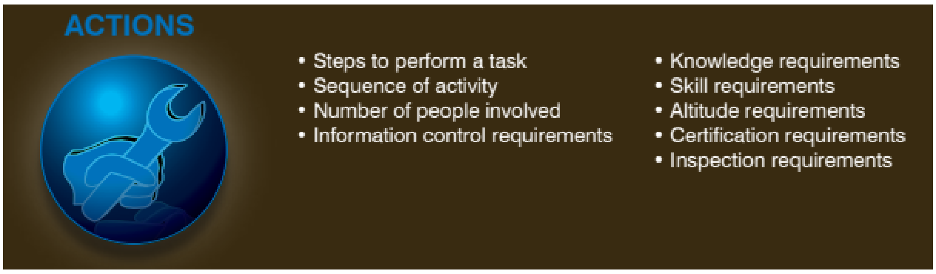
Organizational

- Personnel
- Supervision
- Labor-management relations
- Pressures
- Crew structure
- Size of company
- Profitability
- Morale
- Corporate culture

Aviation maintenance consists of two distinct environments: the physical workplace, which encompasses areas such as a ramp, hangar, or workshop, and the organizational environment within the company. An effective human factors program must address both areas.

The physical environment includes considerations such as temperature, humidity, lighting, noise control, cleanliness, and workplace design. Companies must recognize these conditions and work with their workforce to change or adapt the physical environment. A corporate commitment to protecting the physical environment is essential, aligning it with the resource aspect of PEAR, providing necessary equipment such as portable heaters, coolers, lighting, appropriate clothing, and optimizing workspace and task design.

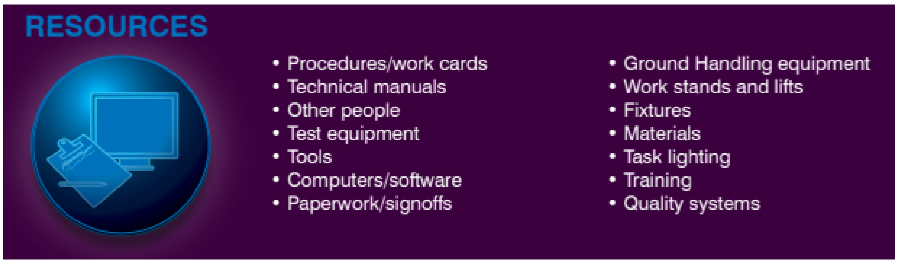
The organizational environment, although less tangible, is equally important. Key factors in this environment include collaboration, communication, shared values, mutual respect and corporate culture. A positive organizational environment fosters effective leadership, communication and shared goals, including safety, profitability and other critical aspects. Leading companies guide and support their personnel by fostering a safety-focused culture where each individual recognizes their role in ensuring the overall safety of the mission.



ACTIONS

- Steps to perform a task
- Sequence of activity
- Number of people involved
- Information control requirements
- Knowledge requirements
- Skill requirements
- Altitude requirements
- Certification requirements
- Inspection requirements

Effective human factors programs scrutinize all activities necessary to perform work efficiently and safely. Job Task Analysis (JTA) acts as a recognized human factors methodology for determining the knowledge, skills, and attitudes required to perform each task within a specific position. JTA helps identify the instructions, tools, and other resources needed to perform tasks optimally. Adhering to JTA guidelines helps ensure that every employee receives the proper training and that workplaces are equipped with the necessary resources to perform their tasks. Numerous regulatory bodies recognize JTA as a fundamental element of a company's comprehensive service management and training plan. Solving human factor issues related to the use of work cards and technical documentation is mostly included in the "Actions" component. A clear and well-documented understanding of the steps ensures that instructions and checklists are accurate and user-friendly.



RESOURCES

- Procedures/work cards
- Technical manuals
- Other people
- Test equipment
- Tools
- Computers/software
- Paperwork/signoffs
- Ground Handling equipment
- Work stands and lifts
- Fixtures
- Materials
- Task lighting
- Training
- Quality systems

Again, clearly delineating resources from other PEAR components can be challenging. Generally, people, environment, and activities encompass the attributes of useful resources. Numerous physical resources such as lifts, tools, test equipment, computers and technical manuals. Conversely, some resources are more intangible, covering factors such as the number and qualifications of staff, the availability of overtime, and the level of communication between team members, managers, sales staff, and others. A comprehensive perspective should be applied to resources, taking into account everything that is important to the performance of the task. Resources contain everything you need to complete a task. Protective clothing, a cell phone, or even rivets can be considered resources. The importance of the resource component in PEAR is to emphasize the identified requirements for additional resources.

Weather stands out as a major cause and obvious factor in aviation accidents and incidents. The aviation industry is heavily influenced by meteorological conditions, and these conditions contribute to accidents while exacerbating the effects of other factors such as severe weather and reduced visibility. These elements, in turn, increase the risk of pilot error, terrain collisions, and encounters with other aircraft. Passengers often share the common experience of discomfort and potential injury during turbulent flights caused by adverse weather conditions. In such conditions, pilots face significant decision-making difficulties, and weather conditions often lead to flight delays.

Several important atmospheric factors contribute to major air disasters and flight disruptions. Predominant weather hazards include thunderstorms, lightning, hail, wind shear, heavy precipitation, low cloud, and more. Thunderstorms, dynamic phenomena with well-defined life cycles, can lead to a variety of accidents. Hail poses a particular hazard to aircraft engines and structures due to its solid nature and high-water content, potentially causing engine fires in extreme cases. In-flight icing is dangerous because it adds weight to the aircraft, reduces lift, distorts readings and makes control difficult. Icy and snowy runways reduce friction, affecting deceleration and directional control. Rain creates visibility problems; heavy rain creates the risk of burning aircraft engines. Wind shear, meaning rapid changes in wind speed and/or direction, contributes to turbulent flight, operational difficulties and, in some cases, irreversible loss of control, resulting in accidents.

Operating an aircraft on high-altitude plateaus with low pressure, difficult climates and rough terrain is a difficult and expensive business. Weather conditions in mountainous regions can change rapidly, requiring the pilot to understand airflow patterns and carefully study maps for the steepness of glaciers and mountain slopes during pre-flight planning. Collisions with terrain such as hills or mountains contribute to plane crashes. To prevent Controlled Flight to Ground (CFIT) accidents, accurate crew positioning and navigation system monitoring are critical.

Natural disasters, including volcanic eruptions and earthquakes, adversely affect both aircraft flights and airport infrastructure. Earthquakes pose a serious threat to airports and aircraft, causing injuries and structural damage. Volcanic ash ejected during eruptions poses a serious aviation safety hazard, causing potential damage to fuselage and engine components, as well as adversely affecting avionics systems.

Aerodynamic characteristics are closely related to height. Air density increases at lower altitudes, increasing the aircraft's performance, while decreasing altitude decreases performance. Atmospheric temperature also affects aircraft performance, affecting takeoff and landing requirements. High temperatures, especially at high altitudes, create problems that reduce aerodynamic efficiency. Factors such as humidity further affect engine power, contributing to the overall deterioration of aircraft performance. These combined elements lead to reduced aircraft efficiency and operational complications.

Mechanical failures are a significant factor in aviation accidents, with various causes contributing to these failures:

- Manufacturing defects:
    - Aircraft or component defect
    - Defects in the design of the aircraft or its components
    - Lack of proper inspection of the aircraft
    - Inadequate maintenance practices
    - Untimely replacement of components
    - Metal fatigue
    - Corrosion
- Examples of manufacturing defects:
    - Releases of the complete set
    - Areas of resin imbalance (resin rich or resin starved)
    - The presence of bubbles or air bubbles
    - Wrinkles, voids and thermal decomposition

- Industrial damage:
    - Abnormalities such as porosity, micro-cracks and delamination due to processing inconsistencies
    - Accidental damage during assembly, shipping or operation, including cuts, dents, scratches and impact damage

Research in the aviation industry has highlighted that maintenance errors cause 20% of all in-flight engine shutdowns. Common service errors include:

- Inconsistent publication compliance
- Items left unsecured on the aircraft
- Incorrect installation of components
- Using inappropriate parts
- Insufficient lubrication
- Failure to attach access panels, fairings or hoods
- Missing or improperly secured fuel/oil caps and fuel panels

Analysis of data on maintenance errors revealed that four main categories of errors accounted for 78% of cases: installation errors (39%), carelessness (damage, 16%), inadequate inspection standards (12%), and non-compliance with approved data (11%).

Corrosion is a significant threat to aircraft structures, especially metal ones. Protective measures, such as the introduction of corrosion-resistant elements, the creation of alloys or the application of surface coatings, are important at the production stage. Even with the advent of airframes made primarily of composite materials, vigilance against corrosion remains extremely important due to the use of metal components in aircraft.

Two general classifications of corrosion, direct chemical corrosion and electrochemical corrosion, cover specific forms. In both types, the metal is converted into compounds such as oxide, hydroxide, or sulfate. The corrosion process involves simultaneous changes: the exposed metal undergoes anodic changes while the corrosive agent undergoes cathodic changes. Continuous monitoring and maintenance practices are vital to mitigating the impact of mechanical failures on aviation safety.

Direct chemical corrosion, also known as pure chemical corrosion, occurs when an exposed surface comes into direct contact with aggressive liquids or gases. Unlike electrochemical attack, where anodic and cathodic changes can occur at a distance from each other, direct chemical attack involves simultaneous changes occurring at the same point. Common agents that cause direct chemical attack on aircraft include spilled battery acid or battery fumes, residual flux deposits from improperly cleaned, welded, soldered, or brazed joints, and caustic cleaning solutions. The advent of sealed lead-acid and nickel-cadmium batteries has reduced the problem of spilled battery acid, as these sealed units reduce the risk of acid spillage and evaporation.

Various fluxes used in soldering and welding processes can cause corrosion and chemically affect metals or alloys. It is important to remove flux residues from the metal surface immediately after the operation, as these residues are hygroscopic, absorb moisture and can potentially cause serious pitting.

Electrochemical attack can be compared to the electrolytic reaction during electroplating, anodizing, or dry batteries. This corrosive effect requires a conductive medium, usually water, capable of generating a small electric current. When a metal comes into contact with a corrosive agent and turns into a liquid or gaseous state through which electrons can flow, corrosion begins as the metal undergoes oxidation. The corrosive agent is reduced during the attack, and if not renewed or removed, it can completely react with the metal and become neutralized. Different parts of the same metal surface have different electrical potential. When connected by a conductor, as in salt water, several dimples are formed, which initiates corrosion.

All metals and alloys exhibit electrical activity and have specific electrical potentials in a given chemical environment, commonly referred to as the "nobility" of the metal. The less precious a metal is, the more it is prone to corrosion. The metals selected for aircraft construction represent a carefully considered compromise between factors such as strength, weight, corrosion resistance, performance and cost, carefully balanced to meet structural requirements.

The components of an alloy exhibit different electrical potentials, which are usually different from each other. When a conductive corrosive medium affects the alloy surface, the more active metal becomes the anode and the less active becomes the cathode, creating conditions for corrosion known as localized cells. The greater the difference in electrical potential between two metals, the more intense the corrosion under the appropriate conditions. Regular cleaning and grinding of the surface that removes the small electrical circuit is the basis for effective corrosion protection.

Electrochemical action is the primary cause of most forms of corrosion affecting aircraft structure and components. Surface corrosion manifests as general roughness, etching, or cracking of the metal surface, often accompanied by powdery deposits of corrosion products. This type of corrosion can be the result of both direct chemical and electrochemical exposure. Corrosion sometimes extends beneath the surface coating, remaining undetected until careful inspection reveals peeling paint or coating in the form of small bubbles caused by the pressure of accumulated corrosion products.

Filamentous corrosion appears as a series of small worms under the surface of the paint, which usually occurs on surfaces that have not been properly treated with chemicals prior to painting. Due to the contact of dissimilar metal parts in the presence of a conductor, extensive damage can occur. Galvanic action occurs at points or areas of contact where the insulation between surfaces has been broken, resulting in a serious electrochemical attack, often hidden from view.

Intergranular corrosion is an attack along the grain boundaries of an alloy that usually occurs as a result of insufficient homogeneity of the alloy structure. Aluminum alloys and some types of stainless steel are particularly susceptible to this form of electrochemical attack, which occurs due to changes in the alloy during heating and cooling during the manufacturing process.

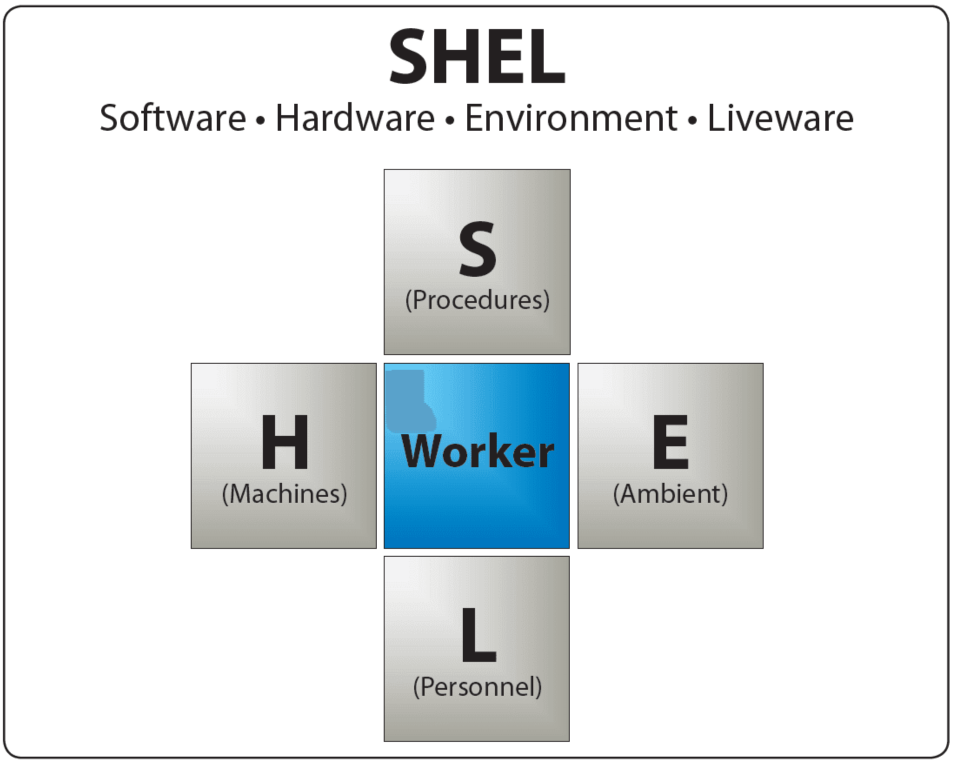
Stress corrosion occurs as a result of the joint action of long-term tensile stresses and corrosive environments. Stress corrosion cracking commonly occurs in aluminum, copper, some stainless steels, and high-strength alloys. It usually occurs along cold work lines and can be transcrystalline or intercrystallite in aluminum alloy components such as crimp sleeves, chassis and shock absorbers with grease fittings.

Fretting corrosion, a particularly harmful form, occurs when two mating surfaces, normally at rest relative to each other, undergo a slight relative displacement. It is characterized by point surfaces and the formation of small fragments, which leads to very localized abrasion. The limited movement of the surfaces prevents the easy release of debris, causing deep grooves on the friction surface. The presence of water vapor greatly exacerbates this type of damage, sometimes causing deep grooves similar to brine marks or indentations, earning it the name "false brine."

2.2

In aviation, the SHELL model is a conceptual framework for understanding human factors, helping to identify the location and origin of human error in the aviation environment.

The SHELL model uses a systems perspective, recognizing that people are rarely the sole cause of accidents. This perspective delves into the various contextual and task-related elements that interact with the human operator in an aviation system to influence operator performance. Therefore, the SHELL model takes into account both active failures occurring in real time and latent failures inherent in the entire aviation system.



The main emphasis of the model is on the human participant, called the living software, which is not only the most important, but also the most adaptable element in the system. The circuitry of this unit is complex and varied, requiring careful coordination with other system components to prevent stress and potential malfunction.

However, of all the dimensions in the model, the human element is the least predictable and most susceptible to both internal factors (such as hunger, fatigue, motivation) and external factors (including temperature, light, noise, workload). These fluctuations make human behavior difficult to predict.

Human error is often seen as an adverse outcome arising from the live software dimension in this interactive system. Two simplistic alternatives are sometimes offered to solve the problem: either there is no advantage in trying to eradicate human error because it is inherent and cannot be eliminated by training, or humans, as an error-prone system, should be excluded from the adoption process solutions manufacturing in high-risk situations replaced by computer-controlled devices. However, none of these alternatives appear to be particularly effective in error management.

Liveware - Liveware serves as an interface between individuals, covering aspects of leadership, collaboration, teamwork, and individual interaction. This area includes programs such as crew resource management (CRM), its counterpart air traffic management (TRM), line-oriented flight training (LOFT), and others.

Liveware is a broad category that encompasses laws, rules, regulations, orders, standard operating procedures, customs, conventions and customary practices. In an evolving context, software is also recognized as computer programs designed to control automated systems. Achieving secure and efficient interoperability between software requires ensuring that the software, particularly in terms of policies and procedures, is suitable for implementation. You should also pay attention to phraseological units prone to errors, confusion or excessive complexity. More abstract problems can arise in the symbolism and conceptual design of systems.

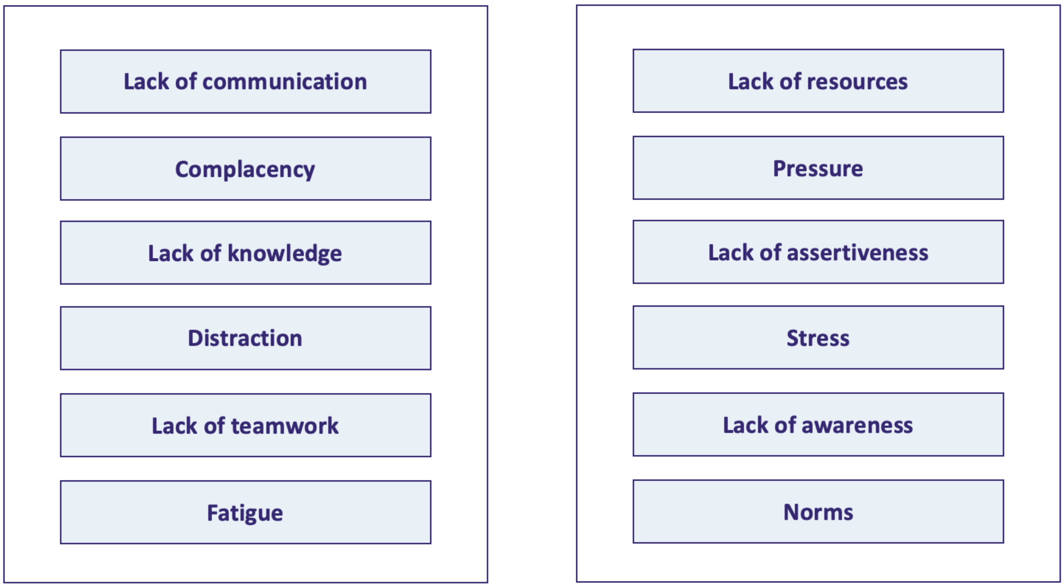
Liveware-Hardware represents another interactive component in the SHELL model, focusing on the interface between live and hardware elements. This interface is usually discussed in the context of human-machine systems, considering the design of seats based on the characteristics of the human body, displays according to sensory properties and information processing characteristics, and controls with corresponding movement, coding and positioning. In air traffic control, hardware refers to the physical features of the control environment, particularly those associated with workstations. For example, a push-to-talk switch is a hardware component that interacts with live software and is designed to meet expectations, such as having a live line available when pressed. Switches should be strategically placed for easy access to controllers in different situations without interfering with reading the displayed information or using other devices at the same time.

Liveware-Environment refers to the interface between live software and an environment that captures interactions beyond direct human control, such as the physical environment, including temperature, weather, etc., in which an aircraft operates. Human factor improvement in this area involves the development of ways to protect people or equipment, including light, noise and radiation protection systems. The interdisciplinary nature of this interface spans a variety of fields, spanning environmental studies, physiology, psychology, physics, and engineering.

2.3

In response to a significant increase in the number of aviation events and incidents in the late 1980s and early 1990s, Transport Canada identified twelve human factors that can compromise human performance and safety, potentially leading to service errors. These twelve factors, collectively referred to as the "Dirty Dozen," were subsequently adopted by the aviation industry as a direct basis for eliminating human error during maintenance. It is very important to have a comprehensive understanding of the Dirty Dozen, including recognizing their symptoms and, most importantly, knowing how to prevent or mitigate mistakes that occur due to these factors. By understanding the complex interplay between organizational factors, work group dynamics, and individual factors that can contribute to errors and accidents, aviation maintenance technicians (AMTs) can prepare to prevent or proactively manage such problems in their future endeavors.

The Dirty Dozen



Inadequate communication stands out as a critical human factor that can lead to suboptimal, inaccurate, or incorrect service practices. Communication is a complex process that involves interactions between aviation maintenance technicians (AMTs) and various stakeholders, including management, pilots, parts suppliers, and other maintenance personnel. Among these, effective communication between the AMTs themselves is paramount, especially during procedures where multiple technicians are involved in maintenance tasks. Ensuring accurate and complete information sharing becomes critical to prevent maintenance errors that could potentially lead to aviation incidents or accidents.

One high-risk scenario that highlights the importance of communication is a shift change at airlines or fixed base operators (FBOs). During this transition, the departing technician must carefully communicate the status of the partially completed work to the arriving technician. Because some maintenance steps may become unavailable after components are installed, lack of communication may result in procedures being skipped or not performed. The vacating professional should clearly articulate the critical steps, difficulties encountered, and any other relevant details to ensure full understanding by the new technician. Failure to communicate at this stage may result in operations continuing without certain critical procedures.

Following a systems approach, the approved steps in the maintenance procedure must be signed off by the performing technician in real time. If another technician takes over the job, a face-to-face meeting is critical before proceeding with the project. This involves reviewing the documentation, discussing the tasks completed and ensuring a clear understanding of the next steps. The lack of written or verbal communication should be a red flag, signaling the possibility of errors.

Emphasizing adherence to approved written procedures, technicians must view their role as an integral part of a broader system focused on the safe operation of the aircraft. Effective communication within this system, both verbal and written, is essential to overall efficiency and safety. In cases where face-to-face communication is difficult, technicians may resort to phone calls to ensure clear understanding and cooperation. In essence, effective communication is the cornerstone to ensuring the reliability and safety of aviation maintenance operations.

Complacency is a common human factor in aviation maintenance that tends to develop gradually as technicians gain knowledge and experience. As technicians become more skilled, they can inadvertently develop a false sense of confidence, especially when dealing with repetitive tasks such as inspecting items. Over time, a technician may miss or neglect the importance of checking a certain item, assuming that it will be a routine task and unlikely to reveal any problems. However, even in rare cases, malfunctions may exist, and failure to detect and correct them may lead to serious incidents or accidents. Constantly performing routine tasks gives technicians time to think, which can potentially lead to errors in performing basic tasks.

Indicators of complacency include technicians performing work without proper documentation or documenting tasks that were not actually performed. Adherence to approved written maintenance procedures is critical for all maintenance checks and repairs. Creating thorough documentation not only serves as a record, but also reinforces the importance of the task at hand.

To counter complacency, technicians must learn to anticipate deficiencies during inspections, fostering and maintaining mental engagement in their work. Each inspection item should be treated with equal importance, and no item can be considered acceptable without thorough inspection. Technicians should never sign off on work that has not been performed, and they should carefully read and confirm the pre-signature clause before signing. This proactive approach helps to instill a heightened sense of responsibility and prevents the potentially damaging consequences of complacency in aircraft maintenance.

Insufficient knowledge during aircraft maintenance creates the risk of imperfect repairs, which, in turn, can lead to serious consequences.Differences in technology between different aircraft and updates to technology and procedures within the same aircraft add complexity to the knowledge required to perform continuing airworthiness.

All maintenance activities must meet the standards set forth in approved instructions, which are formulated on the basis of knowledge acquired during the design and operation of aircraft equipment. Technicians must ensure that the most recent and relevant data are used by carefully following each step of the procedure as prescribed. In addition, technicians must recognize the differences in design and maintenance procedures for different aircraft, emphasizing the importance of their training on different types of aircraft. If there are uncertainties, it is advisable to seek the advice of an experienced aircraft technician. In situations where such experience is not available or the technician is unfamiliar with the procedure, it is recommended to contact the manufacturer's technical representative. Prioritizing accuracy over speed in maintenance procedures is critical to avoiding mistakes that can lead to accidents.

Distractions during aircraft maintenance procedures can disrupt workflow, causing technicians to miss important details. About 15 percent of maintenance errors are attributed to distractions, which can be both mental and physical. These distractions can occur on board the aircraft, in the hangar, or in the personal understanding of the technician. External factors, such as phone calls or the arrival of a new aircraft in the hangar, can distract the technician. In addition, internal distractions, such as difficult family or financial problems, can affect performance during service.

Recognizing the moment of distraction is critical for technicians to ensure the accuracy of their work. Establishing a practice of retracing the three steps in the workflow after a distraction and resuming from there can help maintain procedural integrity. Using a detailed step-by-step written procedure, technicians must sign off on each step performed. When distractions interrupt work, technicians can mark work in progress, letting themselves or others know when and where to continue work. Incomplete installations, such as disconnected connectors, should be left with visible marks. To avoid premature assumptions about completion, especially for "plugged in" components, technicians should immediately secure wires or tighten fasteners after completing a step of the maintenance procedure. This is a tangible indicator of progress in the current procedure.

In aircraft maintenance, a lack of teamwork can contribute significantly to errors. Teamwork, closely related to effective communication, plays a crucial role in various aspects of aviation maintenance. The collaborative effort involves sharing knowledge between technicians, coordinating maintenance tasks, delegating work responsibilities between shifts, and collaborating with flight crews to troubleshoot and test aircraft. Creating a teamwork environment is not only about improving safety in the workplace, but also ensures collective understanding and agreement on the necessary actions.

Activities such as gear shifting or operational inspections require the synchronized efforts of all team members to achieve consistent results. Multiple professionals work together to ensure consistent results by communicating effectively and caring for each other throughout the process. Consensus is reached on the airworthiness of individual components, which promotes a shared understanding within the team.

While technicians focus on the physical aspects of the aircraft and airworthiness, other members of the organization fulfill their respective roles, contributing to the overall functioning of the company as a cohesive team. A team's effectiveness in achieving shared goals can determine its success or failure. Not only does the lack of teamwork make the task more difficult, but in the maintenance context it can lead to misunderstandings, which will have consequences for the airworthiness of the aircraft.

Fatigue stands out as an important human factor that has been implicated in numerous service errors leading to accidents. Fatigue, whether mental or physical, also includes emotional exhaustion that affects both mental and physical performance. A fatigued person experiences decreased or impaired cognitive abilities, decision-making ability, reaction time, coordination, speed, strength, balance, and general alertness. This reduction in alertness often results in an impaired ability to focus and maintain attention on the task at hand.

Manifestations of fatigue include problems with short-term memory, focused attention on less critical issues at the expense of more important factors, and difficulty maintaining an overview of the situation. A tired person is usually easy to distract or, on the contrary, almost impossible to distract. Abnormal mood swings may also be observed. The effects of fatigue extend to an increased likelihood of making mistakes, impaired judgment, poor decision-making, or even no decision-making at all. In addition, a tired person can lower his standards.

Sleep deprivation stands out as a major cause of fatigue, emphasizing the importance of good, restful sleep without the influence of drugs and alcohol. Stress and overwork can also contribute to fatigue. Recognizing the human circadian rhythm, which encompasses fluctuations in body temperature, blood pressure, heart rate, blood chemistry, alertness, and attention throughout the day, becomes crucial. Violation of this rhythm can lead to barely noticeable fatigue, which a person does not notice at first.

In the context of aviation maintenance, where precision is paramount and lives depend on perfect procedures, working alone while fatigued poses a particular risk. Regular enough sleep is the main remedy for fatigue. It is recommended to exercise caution or take a break if insufficient sleep increases the likelihood of errors during maintenance tasks. Although anti-fatigue agents such as caffeine are widely used, their effectiveness may be short-lived, and some countermeasures may increase fatigue.

Strategies for coping with fatigue include self-monitoring for fatigue symptoms, involving others in reviewing work, avoiding difficult tasks during low points in the daily rhythm, and prioritizing daily sleep and exercise. In the aviation industry, where much of the maintenance is performed during night shifts, shift work adds an additional layer of complexity as it can disrupt natural circadian rhythms, making sleep difficult and increasing sensitivity to environmental influences. Together, these factors can contribute to reduced productivity, morale, and safety, threatening maintenance productivity.

Inadequate resources can prevent the completion of the task, causing shortages of materials and support. Product quality also affects a person's ability to perform tasks effectively. In aviation maintenance, having the right tools and parts is essential to maintaining a fleet of aircraft. Not having the necessary resources to perform maintenance tasks safely can lead to both fatal and non-fatal accidents. For example, if a plane departs without a functioning system that is not normally needed for flight but unexpectedly becomes important, this can create a serious problem.

Although parts are not the only resource required to complete a task, they often become critical issues. Aviation maintenance technicians (AMTs) can take a proactive approach by checking suspicious areas or tasks that may require parts early in the inspection process. The term "aircraft on ground" (AOG) refers to a serious problem that prevents the aircraft from flying. In AOG situations, spare parts are urgently procured to quickly return the aircraft to service and prevent delays or cancellations of scheduled routes. AOG suppliers send qualified personnel and necessary spare parts for immediate repair. The term is also used for critical deliveries of aircraft parts or materials that are "out of service" (OTS) on site.

If the aircraft is designated as AOG and the required materials are not available, parts and personnel must be expeditiously delivered, transported, or dispatched to the location of the aircraft. The resolution process typically involves internal AOG services, followed by the manufacturer's AOG panel and, if necessary, the competitor's AOG panel. All major air carriers support a 24/7 AOG service staffed with personnel skilled in procurement, hazardous materials delivery, manufacturing processes and parts procurement.

Within an organization, ensuring that staff have the right tools for their jobs is just as important as having the right parts when they are needed. Using the right tools prevents the need for improvisation, which can lead to costly mistakes. For example, improper equipment was used when weighing an aircraft after an interior repair, which resulted in damage to the aircraft. The use of the correct tools is essential, and if damaged, out of calibration or missing, they should be repaired, calibrated or replaced immediately.

Technical documentation is another critical resource that can create problems in aviation maintenance. When searching for information about a task or troubleshooting a system, the information you need may not be available due to the lack of manuals or schematics. In such cases, personnel should seek guidance from a supervisor or contact the technical representative or technical publications department of the aircraft manufacturer concerned. Manuals are constantly being revised, and identifying missing information is critical to updating the documentation. Resources such as publications departments and manufacturer technical support should be used, not ignored.

Aviation engineering jobs come with constant pressure to perform tasks more efficiently and quickly while ensuring that there are no errors or oversights. Unfortunately, such work pressures can affect the ability of service workers to perform their duties accurately. Airlines, due to strict financial requirements and tight flight schedules, require mechanics to quickly identify and solve mechanical problems to keep the aviation industry efficient. It should be noted that aircraft mechanics bear a critical responsibility for the overall safety of anyone who relies on flight as a mode of transportation.

Organizations must recognize the time constraints on aircraft mechanics and help them manage their tasks, ensuring that repairs are performed not only on time, but correctly, with safety as the primary objective. Sacrificing quality and safety for the sake of time is unacceptable. Similarly, aviation maintenance technicians (AMTs) must recognize when time constraints cloud their judgment and lead to avoidable errors. Self-directed pressure occurs when a person takes responsibility for a situation that is not their fault. To cope with self-inflicted pressures, technicians should seek help if they feel overwhelmed and have limited time to repair. Another approach is to conduct a thorough inspection of the repair to verify that all maintenance tasks have been performed correctly.

Ultimately, if repairs are being made in a time frame that is considered unrealistic or poses a safety risk, it is important to communicate this to the organization's management and openly discuss alternative courses of action.

Assertiveness is the ability to express one's feelings, thoughts, beliefs, and needs in a positive, productive manner and should not be confused with aggressiveness. It is important for AMTs to be assertive when it comes to aviation repair, rather than being judgmental or prohibitive in voicing their concerns and opinions. The direct result of lack of confidence can ultimately cost people their lives.

When you're facing difficulties with colleagues or management, it's a good idea to tackle one issue at a time rather than trying to tackle multiple issues at once.

Additionally, having documentation and factual support for your arguments can visually illustrate your points. Failure to speak up when something doesn't seem right due to lack of confidence has led to numerous fatal accidents. This can be remedied by promoting open communication between colleagues and maintaining transparent relationships with supervisors and management.

Maintenance managers must familiarize themselves with the behavioral styles of their team members, using their talents, experience and wisdom. When employees understand their behavior styles and understand how they may be inadvertently contributing to certain problems, they can make adjustments. While persistence may not come naturally to everyone, it is a critical skill for effectiveness. Aviation Maintenance Technicians (AMTs) must provide supervisors and management with the necessary feedback to help mechanics perform their duties.

Getting involved in aviation maintenance is a challenging task due to various factors. Aircraft operational efficiency is critical to airlines' profitability, requiring timely maintenance tasks to prevent delays and cancellations. The rapid development of technology in this industry contributes to the stress experienced by technicians, requiring them to stay up-to-date with the latest equipment through continuous training. Working in confined and poorly lit areas, lack of adequate repair resources and long working hours are additional stressors in aviation maintenance. The main stress factor, however, is the realization that any inadequacy in the performance of one's tasks can lead to tragic consequences.

People use different mechanisms to cope with stress, and different situations can pose different degrees of difficulty for different people. For example, following a strict schedule may be stressful for one person, but considered routine for another. These factors that cause stress are called stressors and are divided into physical, psychological and physiological stressors. Below is a description of each category and how they may affect aviation maintenance professionals.

Lack of awareness is defined as the inability to realize the full consequences of an action or the lack of foresight. In aviation maintenance, it is not unusual to repeat the same maintenance tasks. After performing the same task multiple times, it is easy for technicians to become less alert and unaware of what they are doing and what is around them. Each time a task is performed, it should be treated as if it were the first time.

Norms derived from "normal" are unwritten rules that are commonly followed in organizations. These norms, serving as a frame of reference, help people navigate ambiguous situations by observing the behavior of others. Group norms develop over time, influencing how newcomers are accepted based on their conformity to established norms. Newcomers rarely initiate change in groups with established norms.

Although norms often emerge to solve problems, some of them can be counterproductive or compromise group performance. Unsafe practices, such as cutting back during aircraft maintenance or neglecting procedures, can pose significant risks. Newcomers may be better able to identify these dangerous norms, but their acceptance into the group depends on compliance with existing norms.

Trust in newcomers depends on their assimilation into the group, which in turn depends on compliance with established norms. Recognizing the susceptibility of newcomers to identifying unhealthy norms, fostering a positive attitude towards potential changes in norms is crucial. As newcomers gain trust in the group, they can gradually influence change. However, implementing change is difficult and largely depends on the group's perception of the newcomer's reliability.

In aviation maintenance, the unsafe practices identified as part of the Dirty Dozen can range from relatively benign, such as scheduling an appointment, to inherently dangerous practices, such as approving incomplete work tasks. It is imperative for managers to adhere to consistent standards and reject unsafe norms. Aviation Maintenance Technicians (AMTs) should prefer the following procedures to unsafe practices that may have become routine but present an inherent risk.

Chapter 3.

3.1Tenerife airport disaster

The Tenerife Airport disaster occurred on March 27, 1977, when two Boeing 747 passenger aircraft collided on the runway of Los Rodeos Airport (now Tenerife North Airport) on the Spanish island of Tenerife. This tragic incident occurred when KLM Flight 4805 began takeoff in heavy fog while Pan Am Flight 1736 was still on the runway. The collision resulted in a devastating impact and subsequent fire that killed everyone on board KLM 4805 and most of the passengers on Pan Am 1736. Only 61 people in the front of the Pan Am plane survived, marking it as Spain's worst aviation disaster and the deadliest accident in history aviation with a total of 583 victims.

The complex circumstances that led to the disaster began with a bomb planted by the Canary Islands' Independence Movement at Gran Canaria airport, causing numerous flights to be diverted to Los Rodeos. The stream of diverting planes congested the airport, obstructing the single taxiway and forcing departing planes to use the runway for taxiing. Dense fogs further worsened visibility problems for both pilots and the control tower.

A subsequent investigation by Spanish authorities attributed the main cause of the crash to the KLM captain's decision to take off, mistakenly assuming clearance from air traffic control (ATC). While Dutch investigators emphasized a mutual misunderstanding in the radio communication between the KLM crew and ATC, KLM eventually accepted the responsibility of its crew. The airline agreed to provide financial compensation to the relatives of all those killed.

The consequences of the disaster greatly affected the aviation industry. This highlighted the critical importance of standardized phraseology in radio communication, leading to a revision of cockpit procedures. This tragic event was instrumental in promoting crew resource management as an integral aspect of airline pilot training, challenging the perception of the captain as infallible and promoting shared decision-making among the flight crew.

Tenerife was an unscheduled stopover for both KLM Flight 4805 and Pan Am Flight 1736. Their destination was Gran Canaria Airport (also known as Las Palmas Airport or Gando Airport), which serves Las Palmas on the neighboring island of

Gran Canaria. Both islands belong to the Canary Islands, an autonomous community of Spain located in the Atlantic Ocean off the southwest coast of Morocco.

KLM Flight 4805, a Holland International Travel Group charter flight, arrived from Amsterdam Schiphol Airport in the Netherlands. The crew in the cockpit included Captain Jakob Veldhuizen van Zanten (50), First Officer Claas Meers (42) and Flight Engineer Willem Schroeder (48). At the time of the incident, Van Zanten served as KLM's chief flight instructor with 11,700 flight hours, with 1,545 hours in the 747. Mears had accumulated 9,200 hours, including 95 hours in the 747, while Schrader had 17,031 hours, with 543 hours in the 747. 747.

It was a Boeing 747-206B, registered as PH-BUF and named Rijn (Rhine). A KLM plane with 14 crew members and 235 passengers, including 52 children, most of whom were Dutch, landed in Tenerife. After landing, passengers were escorted to the airport terminal and one passenger, Robina van Lanschot, chose not to board, leaving 234 passengers on the plane.

Pan Am Flight 1736 departed from Los Angeles International Airport with a stopover at John F. Kennedy International Airport (JFK) in New York. A Boeing 747-121 with registration N736PA named Clipper Victor was the first 747 delivered to the airline. Of the 380 passengers, mostly pensioners, with two children, 14 landed in New York, where there was also a crew change. All but five passengers were American, and the non-American passengers were Canadian citizens. The new crew consisted of Captain Victor Grubbs (56), First Officer Robert Bragg (39), Flight Engineer George Varnes (46) and 13 flight attendants. Grubbs had 21,043 hours, including 564 hours on the 747. Bragg had 10,800 hours, with 2,796 hours on the 747, and Warnes had 15,210 hours, including 559 hours on the 747.

This particular aircraft, in its first year of service, made the first commercial 747 flight on January 22, 1970. Notably, on August 2, 1970, it became the first 747 to be hijacked on a flight from JFK to Luis Munoz Marin International. The airport in San Juan, Puerto Rico was eventually diverted to José Martí International Airport in Havana, Cuba.

Both flights went smoothly until they approached the Canary Islands. At 1:15 p.m., an explosive device planted by the separatist Movement for the Independence of the Canary Islands detonated in the Gran Canaria airport terminal, injuring eight people. A bomb threat phone call that was initially mistaken for two bombs prompted civil aviation authorities to temporarily close Gran Canaria's airport after the explosion. As a result, all inbound flights destined for Gran Canaria were diverted to Los Rodeos, including the two planes involved in the crash. The Pan Am crew expressed a preference for circling in standby mode until cleared to land because they had enough fuel for an additional two hours in the air. However, they were directed to Tenerife.

Los Rodeos, being a regional airport, faced problems with the increase in traffic from Gran Canaria, which included five large airliners. The airport had one runway and a large parallel taxiway connected by four short taxiways. Because of the traffic jams caused by the diverted aircraft, they had to be parked along a long taxiway, making regular taxiing impossible. Hence, departing aircraft had to taxi along the runway to reach the take-off location, a procedure known as reverse taxiing.

Gran Canaria Airport has been reopened after the threat of an explosion was contained. The Pan Am plane was prepared to take off from Tenerife, but access to the runway was blocked by a KLM plane and a refueller. The KLM captain decided to refuel completely in Los Rodeos instead of Las Palmas, supposedly to save time. However, the Pan Am plane was unable to bypass the KLM gas station to gain access to the runway for takeoff due to the insufficient safety gap between the two planes, which was only 3.7 meters. The refueling process lasted approximately 35 minutes, and after refueling, the passengers were allowed back on the plane. The search for a Dutch family of four who failed to return to a waiting KLM plane caused further delays. It is noteworthy that Robina van Lanschot, the tour guide, decided not to change the flight to Las Palmas because she lived in Tenerife and did not think it was practical to fly to Gran Canaria to return to Tenerife the next day. Consequently, she was not on-board KLM flight 4805 at the time of the accident, making her the sole survivor of the flight from Amsterdam to Tenerife.

The control tower ordered the KLM aircraft to taxi along the entire length of the runway and then perform a 180° U-turn for take-off. As KLM was taxiing on the runway, the controller asked the crew to let them know when they would be ready to receive air traffic control (ATC) clearance. The KLM flight crew, busy completing their checklist, delayed copying the permit until the plane was ready for takeoff.

Pan Am was then instructed to follow KLM on the same runway, exit using the third left turn and then use the parallel taxiway. At first, the Pan Am crew did not know whether the controller had instructed them to go first or third. Seeking clarification, the crew asked, and the controller replied emphatically, “Third, sir; one two Three; third". The Pan Am crew began taxiing, attempting to identify the unmarked taxiways using the airport map as they were encountered.

While the crew successfully identified the first two taxiways (C-1 and C-2), their cockpit conversation revealed an oversight regarding the third taxiway (C-3) they were assigned to use. The runway exits were either unmarked or marked and difficult to distinguish in poor visibility. The Pan Am crew appeared to remain unsure of their position on the runway prior to the collision, which occurred near the intersection with taxiway number four (C-4).

The angle of the third taxiway required a 148° U-turn, potentially leading back to the congested main platform. At the end of the C-3, Pan Am will have to make another 148° turn to continue taxiing to the start of the runway, forming a mirrored "Z" shape. A post-accident analysis by the Airline Pilots Association (ALPA) found that a second 148° turn at the end of the C-3 would have been "virtually impossible". An official report by Spanish authorities explained that the controller ordered the Pan Am plane to use the third taxiway because it was the earliest departure point to reach an unobstructed section of the parallel taxiway.

Immediately after leveling off on the runway, the KLM captain applied the throttle, setting the plane into motion. First Officer Mears advised the captain that ATC clearance had not yet been received. In response, Captain Van Zanten said, “No, I know that. Come on, ask." Mears then radioed the tower saying they were "ready to take off" and awaiting clearance. The KLM crew received instructions detailing the route after take-off, using the term "take-off" without clear indication of permission.

As Mears read the clearance to the controller, concluding with the words, "We're about to take off," Captain Van Zanten interrupted him, declaring, "We're going." The controller, unable to visually confirm the runway due to fog, initially replied "OK" using non-standard language, inadvertently reinforcing the KLM captain's mistaken belief that they were cleared to take off. The controller quickly added, "Prepare for takeoff, I'll call you," clarifying that he did not intend the instruction to be interpreted as permission to take off.

Simultaneously, a radio transmission from the Pan Am crew caused interference, which was heard in the KLM cockpit as a three-second high-pitched sound. This interference caused the KLM team to miss the crucial final part of the tower's response. Message to Pan Am crew: "We're still taxiing down the runway, Clipper 1736!" was also blocked due to interference and was not heard by the KLM team. Any information about this message could have prompted the KLM crew to abort the takeoff attempt.Because of the fog, none of the crews could visually identify the other aircraft on the runway. In addition, the planes were not visible from the control tower, and the airport had no ground radar.

After the KLM plane took off, the tower instructed the Pan Am crew to "report that the runway is clear." The Pan Am crew confirmed this by saying, "Okay, I'll let you know when it's clear." In response, a KLM flight engineer expressed concern over Pan Am's delay in getting onto the runway, asking, "Doesn't he understand that Pan American?" Captain Van Zanten confirmed, "Oh, yes," and continued the takeoff.

According to the cockpit voice recorder (CVR), the Pan Am captain shouted, "There he is!" spotting the KLM landing lights through the fog as his plane approached exit C-4. Noticing the imminent departure of the KLM plane, Captain Grubbs yelled, "Damn, that son of a bitch is coming!" while First Officer Robert Bragg called out, “Get down! Get out of here!!” Grubbs applied full power to the throttles and made a sharp left turn toward the grass in an attempt to avoid a threatened collision.

When the KLM pilots visually identified the Pan Am plane, their plane was moving too fast to stop takeoff. In a desperate maneuver, the KLM pilots raised the nose of the plane prematurely in an attempt to climb and avoid the Pan Am plane. However, the tail struck the Pan Am aircraft at a height of 22 meters (72 ft). The KLM 747 was about 100 meters (330 ft) from Pan Am, traveling at about 140 knots (260 km/h; 160 mph) after takeoff. While its nose landing gear extended beyond the Pan Am, the left engines, lower fuselage, and main landing gear collided with the right upper fuselage of the Pan Am, tearing the center of the Pan Am jet just above the wing. The starboard engines crashed into the upper deck of the Pan Am directly behind the cockpit.

Although the KLM aircraft remained in the air for some time, the impact severed the outer left engine, caused significant damage to the inner left engine due to ingested shredded material, and caused damage to the wings. The aircraft immediately banked and rolled sharply, making contact with the ground approximately 150 meters (500 ft) after impact and skidding an additional 300 meters (1,000 ft) down the runway. The full fuel load that had caused the earlier delay exploded in an uncontrollable fireball that lasted several hours. One of the 61 survivors of the Pan Am flight credited his position in the nose of the plane as what probably saved his life, saying, "We were all sitting down and the next moment there was an explosion and the whole left side of the plane just blew apart."

Jacob Veldhuizen van Zanten, a KLM captain, served as KLM's head of flight training and was one of their most senior pilots. Approximately two months prior to the accident, he was conducting the copilot qualification check of Flight 4805 on a Boeing 747. His photograph was used in promotional material, including a magazine ad and the logbook aboard PH-BUF. At first, KLM assumed that Van Zanten would help with the investigation, not knowing that he was the captain who died in the crash.

The collision resulted in the complete destruction of both aircraft. All 248 passengers and crew aboard the KLM plane were killed, along with 335 passengers and crew aboard the Pan Am plane. Most of the fatalities are related to subsequent fires and explosions caused by fuel spilled and ignited on impact. Of the 61 passengers and crew of the Pan Am plane, only the captain, first officer and flight engineer survived. Initially, 70 people survived, but later 9 passengers died from their injuries. It is noteworthy that the survivors of the Pan Am plane climbed onto the intact left wing, away from the crash site, using openings in the fuselage structure.

After the crash, the Pan Am's engines continued to run for several minutes, despite First Officer Bragg's attempts to shut them down. The impact destroyed the top of the cockpit, where the engine switches were located, and severed all control lines, leaving the crew unable to operate the aircraft's systems. Survivors waited for rescue, which was delayed because firefighters initially focused on the wreckage of the KLM plane hundreds of meters away in thick fog and smoke, unaware that the two planes had collided. Eventually many of the survivors on the wing descended to the ground.

The Spanish Commission for the Investigation of Civil Aviation Accidents and Incidents (CIAIAC) led the investigation into the accident, involving about 70 personnel, including representatives from the United States, the Netherlands and the airlines involved. The results of the investigation revealed incorrect interpretations and false assumptions that contributed to the tragic event. Analysis of the transcript of the cockpit voice recorder (CVR) showed that the KLM pilot had mistakenly believed that he had been cleared to take off, while the control tower in Tenerife believed that the KLM 747 was stationary at the end of the runway awaiting clearance to take off.

The investigation ultimately determined that the primary cause of the accident was Captain Van Zanten's decision to initiate takeoff without obtaining proper clearance. Investigators suggested that these actions may have been motivated by a desire to comply with KLM's operating hours rules introduced earlier that year and to depart before weather conditions worsened.

Several significant factors contributing to the accident were identified:

- the sudden thick fog significantly reduced visibility, preventing visual contact between the control tower and the crews of both aircraft.
- simultaneous radio transmissions created interference, making it difficult for the parties involved to clearly distinguish messages.

In addition, the following factors were recognized as contributors, although not considered critical:

- the use of ambiguous and non-standard phrases by the KLM co-pilot ("We're taking off") and the Tenerife control tower ("OK").
- deviation of the Pan Am aircraft from the specified departure point.

- due to the terrorist incident, the airport faced problems receiving a large number of large aircraft that changed their route, disrupting the typical use of the taxiways.

The accident led to significant changes in international aviation rules and procedures. Aviation authorities around the world have introduced requirements for standardized phrases and placed greater emphasis on English as a common working language.

Acknowledgment of an air traffic briefing was no longer considered sufficient with colloquial phrases such as "OK" or "Roger". Instead, crews had to repeat key parts of the instruction to confirm understanding. The term "takeoff" was now reserved for situations where actual takeoff clearance had been granted or revoked. Until then, the word "departure" replaced the word "takeoff" in communication (for example, "ready for departure"). In addition, clearances issued by controllers to aircraft already lined up on the runway are now prefixed with "hold position".

After the accident, the cockpit procedures were revised. Hierarchical relationships between crew members were downplayed, and greater emphasis was placed on consensual team decision-making. Less experienced crew members were encouraged to challenge captains when they felt something was wrong, and captains were instructed to carefully consider the crew's concerns when making decisions. This approach evolved into what is now called Crew Resource Management (CRM), emphasizing that all pilots, regardless of experience, are allowed to ask each other questions. This was especially true in the crash when the flight engineer asked if they were unclear, but Captain Van Zanten, who had many hours of flight time, confirmed the clarity, forcing the flight engineer to refrain from arguing with the captain. Since 2006, CRM training has been mandatory for all airline pilots.

In 1978, the new Tenerife South Airport (TFS) opened on the island, serving most international tourist flights. Los Rodeos, renamed Tenerife North Airport (TFN), served mainly domestic and inter-island flights until 2002, when a new terminal allowed Tenerife North to resume international flights.

As a safety measure, the Spanish government installed a ground-based radar system at Tenerife Norte Airport after the accident.

3.2 Japan Air Lines Flight 123

Japan Air Lines Flight 123 was a scheduled domestic passenger flight from Tokyo to Osaka, Japan. On August 12, 1985, a Boeing 747 operating this service suffered a major structural failure and decompression after only 12 minutes of flight. Continuing the flight with limited control for another 32 minutes, the 747 eventually crashed near Mount Takamagahara, about 100 kilometers from Tokyo.

Despite the fact that it was a large-capacity aircraft with 524 people on board, the disaster resulted in significant loss of life. Of the 15 crew members and 505 passengers on board, all perished. Some passengers initially survived, but died of their injuries while waiting for help. All four survivors were seriously injured. The Flight 123 crash is considered the deadliest single-plane crash in aviation history.

Japan's Air Accidents Investigation Commission (AAIC), assisted by the US National Transportation Safety Board, determined that the structural failure was the result of faulty repairs by Boeing technicians after the plane's tail section incident seven years ago. The improperly repaired portion subsequently loosened, resulting in a rapid decompression that tore off a large portion of the tail. This event caused the loss of all hydraulic systems on board, rendering the aircraft's flight controls inoperable.

The incident involved a Boeing 747SR-46 aircraft with registration number JA8119 (serial number 20783, line number 230). It was built and delivered to Japan Air Lines in 1974, having accumulated just over 25,000 flight hours and 18,800 cycles (one cycle includes takeoff, cabin pressurization, depressurization, and landing) before the accident.

On June 2, 1978, the same aircraft, JA8119, was involved in an incident with Japan Air Lines Flight 115 on an identical route. During an instrument approach to runway 32L at Itami Airport, the aircraft experienced significant bounce during landing. The pilot subsequently made a hard pitch, resulting in a severe tail strike during the second landing. Despite the fact that there were no fatalities among the 394 people, 25 people were injured — 23 light and 2 serious. The tail impact caused damage to the aft pressure bulkhead. Boeing technicians carried out repairs and the aircraft was returned to working order. At the time of the incident with the tail part, the aircraft had accumulated 8,830 flight hours.

At the time of the incident, the aircraft was on its fifth scheduled flight of the day and was carrying 15 crew members, including 3 cabin crew members and 12 flight attendants.

The cockpit crew consisted of:

1. Captain Masami Takahama, 49, who was First Officer Yutaka Sasaki's training instructor during the flight. Captain Takahama supervised First Officer Sasaki in radio communications and also acted as First Officer. With extensive experience, Captain Takahama was an experienced pilot who had accumulated approximately 12,423 total flight hours, of which approximately 4,842 hours were spent flying 747s.
2. First Officer Yutaka Sasaki, age 39, was training for promotion to captain and flew Flight 123 as one of his final training/evaluation flights, assuming the role of captain. He accumulated about 3,963 total flight hours, of which about 2,665 hours were logged on the 747.
3. Flight Engineer Hiroshi Fukuda, 46, was an experienced flight engineer with approximately 9,831 hours of flight time, including approximately 3,846 hours spent flying 747s.

The aircraft, identified as JL366, completed landing at Haneda Airport in Ota, Tokyo, Japan, arriving from Fukuoka Airport at 5:12 p.m. After spending nearly an hour on the ground, Flight 123 departed from Gate 18 at 6:04 p.m. and began takeoff from runway 15L at 6:12 p.m., 12 minutes late. About 12 minutes into the flight, at 6:24 p.m., while cruising over Sagami Bay, 3.5 miles east of Higashiizu, Shizuoka, the aircraft experienced sudden decompression. The event collapsed the ceiling near the rear lavatories, damaged the leaky aft fuselage, ejected the aircraft's vertical stabilizer, and ruptured all four hydraulic lines. The ground photo shows the absence of a vertical stabilizer.

In response to the situation, the pilots activated the transponder to transmit a distress signal. Captain Takahama contacted the Tokyo District Control Center, declaring an emergency and requesting a return to Haneda Airport. The aircraft descended and followed the emergency landing vectors to Oshima. Tokyo control cleared a right turn to a course of 090° east back to Oshima, and in the process the aircraft began an initial roll to the right of 40°, several degrees greater than that previously observed. Captain Takahama ordered First Officer Sasaki to reduce bank, expressing confusion when the aircraft did not respond to turning the rudder to the left. The flight engineer reported a drop in hydraulic pressure. Despite the captain's repeated orders to reduce the roll, the autopilot disengaged. He then ordered the first officer to hook him again and then ordered him to pull himself up. None of these maneuvers proved effective. Recognizing that the aircraft had become almost uncontrollable, Captain Takahama ordered the co-pilot to begin a descent.

Over the Izu Peninsula at 6:26 p.m., the aircraft reversed course away from the Pacific Ocean, turning back toward the coast, but turning right just enough to maintain a northwesterly course. Noticing that the aircraft was still west of Haneda, Tokyo Control resumed contact. After confirming the announcement of an emergency, the dispatcher inquired about the nature of the emergency. At this point, signs of hypoxia became apparent as the pilots became unresponsive. Moreover, the captain and copilot repeatedly asked the flight engineer for information regarding the drop in hydraulic pressure, demonstrating an apparent inability to understand the situation. Tokyo Control made further attempts to contact the aircraft, repeating the descent and instructing it to turn 90°, heading for Oshima. Only at this moment did the captain report the uncontrollable state of the plane.

While crossing Suruga Bay and passing over Yaizu, Shizuoka, at 18:31:02 the controller asked if the descent could be initiated. Captain Takahama replied in the affirmative, stating that they were descending and giving an altitude of 24,000 feet (7,300 m). However, the flight recorder showed that the plane was not descending;

instead, it exhibited uncontrolled ups and downs. Struggling with a total loss of hydraulic control and malfunctioning control surfaces, the aircraft entered a fugoid oscillation that lasted about 90 seconds. During this oscillation, the airspeed fluctuated, causing alternating ups and downs. Shortly after the stabilizer and rudder separated, the airplane entered a Dutch roll, oscillating between right and left turns and vice versa. At times the oscillations reached significant slopes, with arcs of about 50° and cycles lasting 12 seconds.

Despite the complete loss of controllability of the aircraft, the pilots continued to manipulate the control wheel, pull the control column and adjust the rudder pedals until the moment of impact. The pilots also attempted to regain control using differential thrust from the engines as the aircraft slowly turned back toward Haneda. However, their efforts met with limited success. The leaky aircraft climbed and descended between 20,000 and 25,000 feet (6,100–7,600 m) for 18 minutes from when decompression began until about 6:40 p.m. The pilots seemed unable to develop a controlled descent without functional flight controls, possibly due to hypoxia at such altitudes. Instead of focusing on their predicament, the pilots may have focused on the cause of the explosion and the associated problems in controlling the jet. Despite being told in the cockpit that the rear passengers' oxygen masks had stopped working, the pilots did not put on oxygen masks. The captain, in response to the flight engineer's suggestions to put on oxygen masks, simply answered "yes." The accident report identified the captain as dismissing the suggestion as one of several indicators "considered to be related to hypoxia in the CVR recording." Throughout the flight, their voices remained clearly audible on the cockpit microphone, indicating that they had refrained from using oxygen masks.

At 6:35 p.m., a flight engineer responded to multiple Japan Air Tokyo calls through the selective call system. After learning that the oxygen masks had malfunctioned, the flight engineer assumed that the R-5 doors had been damaged and informed the company that they were beginning an emergency descent. When asked by Japan Air Tokyo if they were going to return to Haneda, the flight engineer clarified that they were making an emergency descent and were constantly monitoring the situation.

Gradually, the pilots managed to partially restore control of the plane by adjusting the thrust of the engines. This action helped soften the fugoid cycle and somewhat stabilize the height. However, due to the inertia of the jet engines and the corresponding reaction time (to throttle changes), "the pilot's ability to suppress the Dutch roll mode using differential thrust between the right and left engines is considered virtually impossible." Shortly after 18:40, the landing gear was deployed using the emergency extension system to further mitigate the fugoid cycles and dutch rolls. Although this was successful in mitigating the fugoid cycles and significantly reducing the Dutch roll, the landing gear retracting also reduced the directional control gained by applying power to one side of the aircraft, impairing the crew's ability to control the aircraft.

Shortly after lowering the landing gear, the flight engineer asked about the use of the speed brakes, but the pilots did not confirm the request. The aircraft began a right turn of 420°, changing course to 040° at 6:40 pm. to 100° at 6:45 p.m., looping over Otsuki. This turn was affected by the thrust imbalance caused by the higher power of engine 1 compared to the other three engines. Simultaneously, the aircraft began to descend from 22,400 feet (6,800 m) to 17,000 feet (5,200 m) as the pilots reduced engine thrust to near idle between 6:43 and 6:48 p.m. After descending to 13,500 feet (4,100 m) at 18:45:46, the pilots again reported an uncontrollable aircraft. During this period, the aircraft gradually turned to the left, continuing its descent. The denser air at that altitude provided more oxygen, and the pilots' hypoxia seemed to lessen somewhat as they communicated more often. Captain Takahama expressed a sense of hopelessness at 18:46:33. At 18:47, the pilots admitted that they were turning towards the mountains. Despite the crew's attempts to steer the aircraft to the right, it veered left, heading directly into the mountainous terrain in a westerly direction.

Around 6:50 p.m., a ground photographer took an image of the aircraft, which revealed the absence of a vertical stabilizer.

Continuing its westward trajectory, the aircraft descended below 7,000 feet (2,100 m) and came dangerously close to the mountains. The denser air at low altitude temporarily disabled the cabin altitude warning, only to re-enable it for the rest of the flight. The captain briefly ordered more engine power in an attempt to climb and avoid the mountains. At 18:48 power was suddenly added, then reduced to near idle, and at 18:49 another climb order was given. This caused a significant disturbance in the phugoid motion as the aircraft pitched up and then turned down as the power was reduced. Regaining power, the aircraft banked sharply to 40° and airspeed dropped to 108 knots (200 km/h; 124 mph) at 18:49:30, immediately stabilizing at 9,000 ft (2,700 m). The captain immediately called for maximum power at 18:49:40 when the shaker was activated. The speed of the aircraft increased, which led to an unstable climb. To prevent a stall, the captain lowered the flaps to 5 units at 18:51 using an alternate electrical system due to a hydraulic failure in an attempt to regain control. Trailing edge flaps took 3 minutes 10 seconds to reach 5 units. The leading-edge flaps, except for the left and right outer groups, were also extended, completing the stretch at 18:52:39. From 18:49:03 to 18:52:11, Japan Air Tokyo attempted to contact the aircraft via the selective call radio system. During this period, the SELCAL alert remained, but was ignored by the pilots.

At 6:53 p.m., the aircraft climbed to an altitude of 13,000 feet (4,000 m), and the captain reported for the third time that the aircraft was out of control. Shortly thereafter, the controller requested a radio frequency switch to 119.7 for the approach to Tokyo. Although the pilots did not acknowledge the request over the radio, they switched frequencies as instructed. Tokyo Approach then contacted the flight via the SELCAL system, briefly activating the appropriate alarm until the flight engineer responded. At this point the crew was asked to report their position, which at 18:54 was reported as 45 nautical miles (83 km) northwest of Haneda and 25 nautical miles (46 km) west of Kumagai. At 18:55 the captain requested flap extension and the copilot requested 10 units, but at 18:54:30 the flaps had already exceeded 5 units and reached 20 units 1 minute and 2 seconds later. At the same time, the aircraft began to roll unusually to the right, probably due to the lift imbalance created by the left and right flaps. Meanwhile, the power has increased. As the flaps continued to extend, the differential thrust setting caused the port engine power to be slightly higher than the starboard engine power, impairing the starboard roll.

After a minute, the flaps extended to about 25 units, the roll angle exceeded 60°, and the nose began to descend. It appears that the flaps did not extend symmetrically, resulting in an imbalance of lift between the left and right wings. Captain Takahama urgently ordered the flaps retracted and a sharp increase in power, even though the left engines were maintaining higher power than the right. Asymmetric thrust conditions intensified as the bank angle exceeded 80° and the captain audibly pleaded with the CVR to retract the flaps and apply more power in a last-ditch effort to raise the nose. In the final moments, when the airspeed exceeded 340 knots (630 km/h; 390 mph), the roll leveled out and the aircraft stopped descending. The passengers and crew experienced an upward vertical acceleration of 3g as the aircraft entered a non-recoverable right descent into the mountains, with the roll angle recovering to approximately 70° and the engines operating at full power. During this critical phase, the ground approach warning system sounded.

While maintaining a 40° right bank, the aircraft's rightmost (#4) engine collided with trees on top of a ridge located 1.4 kilometers (0.87 mi) northwest of Mount Mikuni at an altitude of 1,530 meters (5,020 ft), which was heard recorded on the CVR. The recoil from this impact, registered at 0.14g, combined with the loss of thrust on the 4th engine, caused a rapid roll to the right and a subsequent dive. This trajectory was maintained for 3 seconds until the right wing encountered another ridge with a "U-shaped ditch" located 520 meters (1,710 ft) west-northwest of the previous ridge at an altitude of 1,610 meters (5,280 ft). The impact likely caused the remaining tailplane to separate, along with the outer third of the right wing and three remaining engines, from the airframe, scattering them 500–700 meters (1,600–2,300 ft) ahead. After this impact, the aircraft rolled over, collided with another ridge located 570 meters (1,870 ft) northwest of the second ridge, near Mount Takamagahara, and subsequently burst into flames.

The seismic event as a result of the accident was recorded by the seismometer of the Shin-Etsu Earthquake Observatory of the University of Tokyo. A minor tremor was observed at 18:56:27, followed by a larger tremor at 18:56:32, believed to be related to the last catastrophic event. The shock waves took about 2.0–2.3 seconds to reach the seismometer, which means that the estimated time of last descent was

18:56:30. 32 minutes passed from the breakdown of the partition to the actual accident.

The official cause of the crash, as stated in a report released by the Japan Aviation Accident Investigation Commission, is as follows:

Seven years before the tragic incident, during JAL Flight 115 at Osaka International Airport, the aircraft was struck by the tail section, resulting in damage to the aft bulkhead. Subsequent repairs to the bulkhead deviated from Boeing's approved methods. According to Boeing's repair protocol, a single continuous connection plate with three rows of rivets is required to reinforce the damaged bulkhead. However, repair technicians used two parallel plates to join along the stress crack instead of the established method. This deviation compromised the effectiveness of the repair because it caused one row of rivets to fail, reducing the fatigue cracking resistance of the part to approximately 70% of the strength of the correct repair. Notably, JAL's post-repair inspection did not detect this defect because it was hidden by the overlapping plates.

During the investigation process, the Accident Investigation Board estimated that this faulty installation would fail after approximately 11,000 boost cycles. It is noteworthy that from the time of the faulty repair to the disaster, the plane made 12,318 successful flights. As a result of repeated sealing cycles during normal flight, the bulkhead gradually developed cracks near one of the two rows of rivets that hold it together. When the bulkhead finally failed, the subsequent rapid decompression ruptured the lines of all four hydraulic systems and ejected the vertical stabilizer. This catastrophic event caused many of the aircraft's controls to be disabled, rendering the aircraft uncontrollable.

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