KALMUN'26

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Agenda items will be announced in the first session.

"Aviation rules are written in blood 🩸."

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1. Key Terms

State of Registry: It shows where the aircraft is registered.

State of Operator: It shows the airline which operates the flight.

State of Design: The state that the aircraft was designed.

State of Manufacture: The state that the aircraft was built.

Hull Loss: An aviation accident that damages the aircraft beyond economic repair, resulting in a total loss.

Pilot Flying (PF): The pilot that operates the flight controls of the aircraft.

Pilot Monitoring (PM): The pilot that monitors the flight management and aircraft control actions of the PF and carry out support duties such as communications and check-list reading.

Auxiliary Power Unit (APU): A device on a vehicle that provides energy for functions other than propulsion.

Propulsion: The generation of force by any combination of pushing or pulling to modify the translational motion of an object.

Quick Reference Handbook (QRH): A standalone document containing all the procedures applicable for abnormal and emergency conditions in an easy to use format.

Fly-By-Wire Systems: A system that replaces the conventional manual flight controls of an aircraft with an electronic interface.

Visual Meteorological Conditions(VMC): Weather conditions that allow pilots to fly and navigate by visual reference outside the cockpit.

Instrument Meteorological Conditions(IMC): Weather conditions that require pilots to fly using only the aircraft's instruments, due to poor visibility.

Terrain Awareness and Warning System (TAWS): An on-board system aimed at preventing unintentional impacts with the ground

Flight Data Recorder (FDR): Captures hundreds of flight parameters, including speed, altitude, engine performance and control inputs.

Voice Cockpit Recorder (VCR): Records conversations between pilots, communications with air traffic control, and background noises in the cockpit.

2. Aircraft Warnings

***a.*Ground Proximity Warning System**

"Terrain, terrain!": Initial warning of approaching terrain.

"Pull Up, Pull Up": Immediate action required to climb to avoid terrain or an obstacle.

"Sink Rate": Excessive rate of descent.

"Don't Sink": Aircraft is descending when it should be climbing.

b.Traffic Collision Avoidance (TCAS - Traffic Collision Avoidance System)

"Traffic, Traffic": Another aircraft is nearby and could pose a risk.

"Climb, Climb" / "Descend, Descend": Required vertical maneuver to avoid collision.

"Increase Climb" / "Increase Descent": More aggressive maneuvering needed.

"Clear of Conflict": Resolution is successful; no further action needed.

c.Stall & Speed Warnings

"Stall, Stall": Aircraft is at risk of stalling (losing lift).

"Airspeed, Airspeed": Speed is dangerously low.

"Overspeed": Aircraft is exceeding safe speed limits.

d.Wind Shear & Weather Warnings

"Windshear, Windshear, Windshear": Sudden change in windspeed/direction.

"Severe Turbulence Ahead": Warning for upcoming turbulence.

Fire & System Warnings

"Engine Fire": Fire detected in an engine.

"Cargo Fire": Fire detected in the cargo hold.

"Master Caution": General warning for a non-critical system failure.

"Master Warning": Critical system failure requiring immediate action.

3.Introduction to the Committee

a. Overview of International Civil Aviation Organization

International Civil Aviation Organization is a specialized agency under the United Nations which was established back in 1944 with the Chicago Convention. ICAO is responsible for ensuring safe, efficient and sustainable air transport worldwide with its regulations and coordinations.

The Air Navigation Commission (ANC) is a technical body within ICAO, with the goal of developing international standards related to air navigatşon and safety. It ensures that ICAO's standards meet the evolving needs of global aviation. The ANC's key function is to create and update technical regulations, however it also works on improving Airspace and Air Traffic Management (ATM); ensures the standards of Communication, Navigation and Surveillance (CNS) technologies, reviews safety and security measures and lastly the future of aviation with innovation.

b.ICAO's Role in Aviation Safety and Accident Investigations

ICAO decides international standards and recommended practices (SARPs) in its 19 Annexes which the 193 member states of ICAO must follow in order to maintain global aviation safety.

One of its most critical regulations is Annex 13 which emphasizes the procedures for aircraft accidents and incident investigations.

In the annex the purpose of investigation is explained with:

"The sole objective of an investigation conducted under this Annex shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."

which clearly shows the report must be about improving the procedures rather than blaming the reason.

According to the annex the responsibility for investigations on:

"The State in which an accident or incident occurs is responsible for the investigation."

however, other states may participate:

State of Registry, State of Operator, State of Design, State of Manufacture.

By ICAO:

"The State of Operator must notify ICAO and other relevant states immediately."

"The state conducting the investigation shall have unrestricted access to all relevant evidence."

"Cockpit voice recordings shall not be used for purposes other than accident or incident investigations."

"States shall not use safety investigation reports for disciplinary, civil, administrative or criminal proceedings."

"A safety recommendation shall be made when appropriate to prevent recurrence."

Annex 13 ensures that the investigations focus on improving aviation safety rather than assigning blame.

As a conclusion ICAO plays a vital role in setting the global investigation standards. By regulating the safety practices and promoting transparent investigations, ICAO continues to make international aviation safer and more reliable.

4. History of Civil Aviation

The history of aviation spans over two millennia, from the earliest innovations like kites and attempts at tower jumping to supersonic and hypersonic flight in powered, heavier-than-air jet aircraft.

In the late 18th century, the Montgolfier brothers invented the hot-air balloon which soon led to manned flights. At almost the same time, the discovery of hydrogen gas led to the invention of the hydrogen balloon. Various theories in mechanics by physicists during the same period, such as fluid dynamics and Newton's laws of motion, led to the development of modern aerodynamics.

In the 19th century, especially the second half, experiments with gliders provided the basis for learning the dynamics of winged aircraft. By the early 20th century, advances in engine technology and aerodynamics made controlled, powered, manned heavier-than-air flight possible for the first time. In 1903, following their pioneering research and experiments with wing design and aircraft control, the Wright brothers successfully incorporated all of the required elements to create and fly the first aeroplane.

Digital adoption and technology techniques in the modern era have seen a massive advancement in the aviation industry. The release of computer-aided design and computer-aided manufacturing software in the 1970s facilitated the development of enhanced aircraft designs. Newer technologies like computer simulations have aided in producing lighter yet more robust materials for building airplanes.

Modern aircraft also come equipped with digital systems, eliminating most analog and mechanical instruments. During the 1980s, cathode-ray displays in the cockpit were replaced with more advanced computer-based electronic displays. Modern displays, when integrated into automatic pilots, make cockpit resource management a crucial aspect of flight safety. Also, the introduction of composite materials has significantly cut down the weight of aircraft, leading to improved fuel efficiency. Advanced composite has also led to the development of sweeping wing tips that reduce component weight and improves aerodynamics of an aircraft.

5. Aircraft Accidents

a.Definition and Classification of Aircraft Accidents

According to **Annex 13**, an aircraft accident is associated with the operation of an aircraft, which takes place from the time any person boards the aircraft with the intention of flight until all such persons have left the aircraft, and in which; a person is fatally injured, the aircraft sustains significant damage or structural failure or the aircraft goes missing or becomes completely inaccessible. A hull loss occurs if an aircraft is damaged beyond repair, is lost, or becomes inaccessible.

There are many causes of aircraft accidents. The classification of aircraft crashes and determining what causes a plane to crash can often take in-depth research and investigation to understand what happened. Flight track data could be retrieved, air traffic control transcripts could be obtained, aircraft record in-flight data that could be recovered and training records of the pilots could be examined after an accident. After gathering all of this information and blending it with the observations and experiences of the researchers the cause of the accident is determined accordingly.

b.Common Causes of Aircraft Accidents

i.Human Factor and Crew Errors

Being a crew member in the cockpit brings with it some requirements and competencies. Pilots are being trained to improve their coordination skills to effectively and safely maneuver an aircraft, have enough knowledge about the mechanical components of an aircraft and communicate effectively with other crew members by making the distribution of duties in and out of the cockpit. In addition, pilots are trained to deal with harsh weather conditions, malfunctions and momentary changes during the flight. However, the number one reason for aircraft crashes is pilot errors.

Crew Resource Management (CRM) is a set of training procedures for use in environments where human error can have devastating effects. CRM is primarily used for improving aviation safety and focuses on interpersonal communication, leadership, and decision making in aircraft cockpits. CRM training is a mandated requirement for commercial pilots working under most regulatory bodies. Every airline company has their own pilot training regulations organized in the framework of global standards determined by ICAO. Lack of CRM training, incompetence of pilots and insufficient training regulations by airline companies could lead to fatal aircraft crashes.

Checklists are tools that support flight crew airmanship and memory with ensuring that all required actions are performed without omission and in an orderly manner. Checklists are usually bundled in an easy to use Quick Reference Handbook (QRH). It could be classified as challenge and response checklists and read-do lists.

Challenge and response checklists usually relate to the general operation of the aircraft for each phase of flight. Flight-phase related actions are performed from memory following a cockpit flow pattern. Specific critical items are checked using a challenge and response checklist, whereby the pilot-non-flying/pilot monitoring reads the items to be checked and the pilot flying confirms the proper status/configuration of the appropriate items.

Read and do lists usually relate to abnormal and emergency procedures for which a cockpit flow pattern performed from memory is not suitable. Indeed,these procedures usually include pre-conditions (conditional action steps) that must be assessed and mutually agreed by both crewmembers before proceeding further.

Pilots are required to apply the checklists in the Quick Reference Handbook (QRH), in a timely and accurate manner, both during normal flight and in emergency situations. Otherwise, even the smallest forgotten detail could lead to fatal consequences.

ii.Mechanical and Technical Failures

Aircrafts are designed perfectly to fly without any problems in turbulence, harsh weather conditions, and in other types of different environments. The designs are being tested and fixed if needed before putting into production. Gathering this testing information is important for the safety of the aircrafts.

a. Electrical Instruments

Aircrafts are equipped with important instruments keeping them in the air. Instrument Landing System (ILS), Traffic Collision Avoidance System (TCAS), Enhanced Ground-Proximity Warning System (EGPWS), Autopilot Systems could be classified as important systems in an aircraft.

Instrument Landing System (ILS) is a precision radio navigation system that provides short-range guidance to aircraft to allow them to approach a runway at night or in bad weather. ILS uses two directional radio signals, the localizer, which provides horizontal guidance, and the glidescope for vertical guidance. The relationship between the aircraft's position and these signals is displayed on an aircraft instrument. Improper operation of radio transmitters on the runway or on the airplane may cause the airplane to crash during the approach.

Traffic Collision Avoidance System (TCAS) is an aircraft collision avoidance system designed to reduce the incidence of mid-air collisions between aircrafts. It monitors the airspace around an aircraft for other aircraft equipped with a corresponding active transponder, independent of air traffic control, and warns pilots of the presence of other transponder-equipped aircraft which may present a threat of mid-air collision. While the system sends the warning of "Descend" to one aircraft, it sends "Climb" to the other. The system successfully prevents the incidents however inaccurate data in cockpit instruments and damaged or clogged sensors may cause accidents.

Enhanced Ground-Proximity Warning System (EGPWS) is a system designed to alert pilots if their aircraft is in immediate danger of flying into the ground or an obstacle. The system monitors an aircraft's height above ground as determined by a radar altimeter. A computer then keeps track of these readings, calculates trends, and will warn the flight crew with visual and audio messages if the aircraft is in certain defined flying configurations. A malfunction in the radar altimeter can cause the plane to crash by calculating the plane's altitude higher than it should be.

Autopilot is a system used to control the path of a vehicle without requiring constant manual control by a human operator. Autopilots do not replace human operators. Instead, the autopilot assists the operator's control of the vehicle, allowing the operator to focus on broader aspects of operations. misuse of the autopilot, inability to notice its deactivation and malfunctions may cause aircraft accidents.

b.Engines

Most aircraft engines are either piston engines or gas turbines. They are perfectly designed to generate the necessary power by using only the minimum amount of fuel required. A commercial airplane with two engines is designed to land safely even without one of its engines. Although only 17% of all airplane accidents in the world are caused by mechanical problems, in a situation where the engine gets damaged from external or internal factors, it could cause problems to the engine's turbines, ignition system or fuel system, the aircraft might not land safely on the ground.

c. Hydraulics

Aircraft hydraulic systems are responsible for maintaining any aircraft components or devices that use fluid or gas pressure to operate. These systems are designed for reliability and efficiency, and are used in various capacities in even the smallest modern aircraft. Hydraulics use liquid, such as oil, ethylene glycol, water, or temperature-resistant fluids. The fluid in hydraulic systems also acts as a coolant, helping prevent associated components from overheating. Because the fluid is generally non-compressible so there is no delay in movement. Aircraft hydraulic systems are used in a range of applications, including braking systems, landing gear, wing flaps, flight-control surfaces, engine pumps, air turbines, and many others.

A hydraulic failure may or may not result in loss of some primary or secondary control surfaces such as flaps, slats, aileron, rudder and elevator. It may also result in the loss of the autopilot. Therefore, it is critical that the pilot flying (PF) maintain focus on the continued safe control of the aircraft. With multiple hydraulic system or component failures, control of the aircraft may be difficult. The extreme, but highly unlikely, case of a total loss of aircraft hydraulics could necessitate the non-standard use of engine thrust to maintain aircraft control.

d.Fuel System

An aircraft fuel system allows the crew to pump, manage, and deliver aviation fuel to the propulsion system and auxiliary power unit (APU) of an aircraft. Fuel is piped through fuel lines to a fuel control valve. This valve serves several functions. The first function is to act as a fuel shut-off valve. This is required to provide the crew with a means to prevent fuel reaching the engine in case of an engine fire. The second function is to allow the pilot to choose which tank feeds the engine. Many aircraft have the left tank and right tank selections available to the pilot.

There is a limit of fuel that an aircraft may carry while taking off and landing and generally the landing limit is way lower than taking off limit. In an emergency situation, in order to land the aircraft safely pilots start the eviction of excess fuel from the pipes located at the wings of the aircraft. After evicting excess fuel by circling at the hold points in air given by the ATC, the aircraft can land safely.

A malfunction in the fuel gauges may cause the pilots to think that they have enough fuel and the aircraft may run out of fuel in the air, leaving only a limited amount of time for the aircraft to glide. In addition, any leakage in the fuel system makes it very difficult for pilots to control the fuel system and may cause a fire in the aircraft.

iii. Weather and Environmental Conditions

The impact of weather conditions on aviation has undoubtedly been very essential throughout aviation history. Pilots are being trained to avoid big storms, examine weather conditions and forecasts and handle the aircraft in harsh conditions by task distribution inside the cockpit.

Pilots are mandated to check weather briefings, forecasts, and updates from meteorological sources or flight operations departments before taking off. In addition, With the help of advanced systems on board aircraft and Air Traffic Control (ATC), large cloud masses, storms and possible bad conditions on the aircraft's route can be predicted and the route of the aircraft can be changed at the initiative of the pilots to avoid bad weather conditions.

One of the most important elements of aviation is visibility. In aviation, Visual Flight Rules (VFR) is a set of regulations under which a pilot operates an aircraft in weather conditions generally clear enough to allow the pilot to see where the aircraft is going. Specifically, the weather must be better than basic VFR weather minima, as specified in the rules of the relevant aviation authority. The pilot must be able to operate the aircraft with visual reference to the ground, and by visually avoiding obstructions and other aircraft. If the visibility value is lower than the minimum value, pilots must follow Instrument Flight Rules (IFR), in which they use the facilities that the airplane offers them to safely land.

In addition to the conditions in the air, conditions on the ground, especially altitude, affect the process of flying an aircraft. Before taking off, pilots use maps and data to determine their route, depending on how high above sea level the area they are flying over is. Pilots particularly try to avoid high or mountainous areas on the approach line. If the aircraft is closer to the ground than it should be, Enhanced Ground-Proximity Warning System (EGWPS) gets activated. This system on aircrafts warns pilots to throttle up and raise the nose of the aircraft if the aircraft dangerously gets too close to the ground.

When all these conditions are put together, the use of inaccurate weather forecasting sources, inadequate pilot judgment in the face of bad weather, miscalculation of altitude values, or a malfunction in the EGWPS system could directly or indirectly cause an airplane to crash due to weather and environmental conditions.

iv. Air Traffic Control and Communication Issues

Air traffic control (ATC) is a service provided by ground-based air traffic controllers who direct aircraft on the ground and through a given section of controlled airspace, and can provide advisory services to aircraft in non-controlled airspace. The primary purpose of ATC is to prevent collisions, organise and expedite the flow of traffic in the air, and provide information and other support for pilots.

Air traffic controllers are entrusted with critical responsibilities aimed at maintaining safe air traffic operations. Providing clear and timely air traffic clearances and instructions to pilots, ensuring proper separation between aircraft to prevent collisions, issuing radar safety alerts and traffic advisories to enhance situational awareness, monitoring weather conditions and providing relevant information to pilots and coordinating with other air traffic control facilities to facilitate seamless flight operations are their main responsibilities.

Air traffic controllers may be held liable for errors or negligence that contribute to aviation accidents by routing two flight plans too closely together, leading to the risk of mid-air collisions, not being able to keep the capacity of airport runways under control, causing congestion and potential runway incursions, misinterpreting radar data, resulting in incorrect instructions to pilots, failing to provide timely traffic advisories or safety alerts, compromising flight safety.

v. Terrorism

Aviation terrorism is powerful and symbolic, and will likely remain a staple target for terrorists aiming to inflict chaos and cause mass casualties. The majority of international and domestic aviation terrorist attacks involve outsiders, or people who do not have direct access to or affiliation with a target through employment. However, several significant attacks and plots against the industry involved malicious employees motivated by suicide or devotion to a terrorist organization.

6.The Aircraft Accident Investigation Process

Aviation accidents demand systematic investigations to understand the causes and prevent future occurrences. It is conducted by specialized organizations including ICAO. The process of aircraft accident investigation is a highly structured procedure that involves emergency response, meticulous evidence collection, data analysis, and a comprehensive review of both technical and human factors.

a.Immediate Response and Emergency Procedures

The immediate response is critical for both saving lives and preserving evidence. Emergency responders(firefighters, paramedics, law enforcement, aviation safety investigators) secure the scene and provide medical assistance while the investigators ensure both physical and electronic evidence remains intact. This phase includes the process of documenting the accident scene and the environmental conditions, recording the positions of wreckage and debris.

In cases where the aircraft has crashed in remote locations like underwater or in combat zones, specialized recovery teams may be required to retrieve the crucial evidence.

b.Data Collection and Preservation of Evidence

After the initial response, the investigation team shifts its focus to evidence collection. This stage has a big importance due to the impact of the physical evidence at the crash site in the determination of the cause of the accident. Gathering physical artifacts from the accident site, including parts of the aircraft, personal belongings and any other material that might have contributed to or been affected by the accident. Investigators meticulously record the scene through photographs and detailed notes.

Preservation of evidence is paramount; items are carefully labeled, stored, and transported to secure facilities for further analysis. This phase also involves the collection of maintenance records, air traffic control communications, and eyewitness testimonies which provide context and help to reconstruct the sequence of events leading to the accident.

c.Analysis of Flight Data and Cockpit Voice Recorders

Modern aircrafts are equipped with FDR and CVR often referred to as "black boxes". By analyzing this data investigators can determine how the aircraft was operating before, during and after the accident with the records of parameters such as speed, altitude and pilot communications. Together these recordings can reveal technical malfunctions, procedural errors or external factors that might have contributed to the accident.

d.Investigation of Technical and Human Factors

A thorough accident investigation examines both technical and human factors. Technical factors include any mechanical failures, design flaws, or maintenance issues that might have compromised the aircraft's performance. Investigators examine the engineering process of the aircraft, reviewing design documents, maintenance logs, and manufacturer recommendations.

Equally important is the analysis of human factors; the pilot behavior, crew coordination, and decision-making under stress may have contributed to the accident. This part of the investigation often involves interviews with surviving crew members, ground personnel, and experts in aviation psychology. Understanding the interplay between technology and human performance helps in constructing a complete picture of the accident's root causes.

e.Writing the Final Report and Safety Recommendations

The culmination of the investigation is the final report, which details the findings, conclusions, and recommendations for improving aviation safety. This comprehensive document outlines the timeline of events, identifies causal factors, and discusses both technical and human-related deficiencies. It also includes recommendations aimed at preventing similar accidents in the future.

These safety recommendations might involve changes in aircraft design, modifications to maintenance procedures, updates to pilot training programs, or improvements in air traffic control practices. The final report is disseminated among regulatory authorities, industry stakeholders, and the public, fostering transparency and contributing to the ongoing evolution of aviation safety standards.

7.For Further Reading

https://www.icao.int/safety/Pages/default.aspx

https://skybrary.aero/articles/icao-laws-and-regulations

https://www.ntsb.gov/investigations/process/Pages/default.aspx

https://en.wikipedia.org/wiki/Aviation_accidents_and_incidents

https://asn.flightsafety.org/investigation/

We advise you to watch Mayday from National Geographic if you want to feel the spirit :) 🛬