AIRBORNE COMMUNICATION SYSTEMS IN THE PROCESS OF INCREASING THE EFFICIENCY OF AIR TRAFFIC

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Master thesis „Airborne communication systems in the process of increasing the efficiency of air traffic“ is focusing on the issue of the airborne radio communication systems and audio systems. The thesis takes into account the problems and failures of communication and communication equipment in aviation, which are an important cause and contributing factor to many accidents and serious incidents. The aim of the thesis is to describe and analyse the airborne radio communication systems of external connection and airborne audio systems, focusing on their use in the process of increasing the efficiency of air transport.

K e y w o r d s: Effectivity, frequency, communication, communication system

1 INTRODUCTION

Traditional aircraft communications are based on analog voice on either a Very High Frequency (VHF) or High Frequency (HF) radio waves. In the mid 1980s the use of data-based communications became a reality. Airspace management is transcending into the computer age and as new requirements evolve and the choice of communications technologies expand, regulating the world´s air traffic flow can safely become more automated.

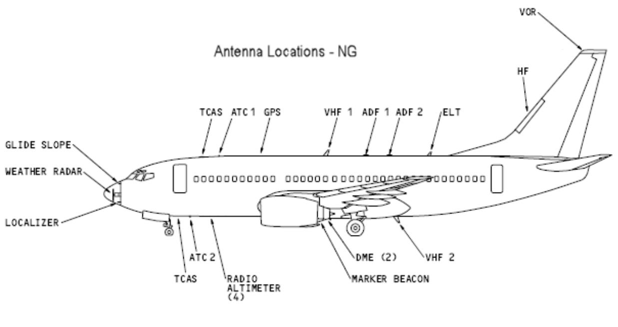

Figure 1 Antenna locations

2 COMMUNICATION IN AVIATION

2.1 Communication in general

Communication can be defined as the process of transmission, reception and interpretation of information. We know five types of communications: verbal (as between crew members), non-verbal (body language, such as hand signals from the ground to the cockpit), written (issuing manuals, technical bulletins, SOPs, checklists), graphic (diagrams, charts, schemes), communication with and between computers in the airplane (PC technology). Communication has long been suggested as a critical issue in all aspects of human interaction, which is reported to be the major contributing factor into aviation accidents. Effective communication is a basic human requirement and in the aviation operational contexts, communication is an essential pre-requisite to safety. Communication is essential for organizational and managerial performance and success in any endeavour, including aviation environment. If aviation industry manage to find ways of handling all these communication problems, aviation will be free of accidents. However, due to the fact that humans are still operators and are prone to making mistakes, human factors will still be exist. Nevertheless with the successful implementation of the recommended solutions discussed hereunder may contribute to the minimizing of the existing communication problems. Hence the importance of communication may then be optimized.

2.2 Radio communication and radio waves

Communication by radio was the first use of radio frequency transmissions in aviation. A radio wave is invisible to the human eye. It is electromagnetic in nature and part of the electronic spectrum of wave activity that includes gamma rays, x-rays, ultraviolet rays, infrared waves, and visible light rays, as well all radio waves. HF radio waves travel in a straight line and do not curve to follow the earth´s surface. As a result, transoceanic aircraft often use HF radios for voice communication. The frequency range is between 3 to 30 MHz. These kinds of radio waves are known as sky waves.

3 AIRBORNE COMMUNICATION SYSTEMS

3.1 Airborne radio communication systems

HF provides ATC coverage in the polar regions where SATCOM coverage is unreliable, mainly in polar regions and also for personal phone calls over long distances, for flight following and for the receipt of pertinent weather forecasts and communications.

VHF communication radios are the primary communication radios used in aviation. They operate in the frequency range from 30 to 300 MHz with 25 kHz spacing between each channel, but in Europe is 8, 33 kHz. VHF radios are used for communications between aircraft and air traffic control, as well as air-to-air communication between aircrafts. When using VHF, each party transmits and receives on the same channel. Only one party can transmit at any one time.

There are many satellites in orbit around the earth being used for relying telephone and television signals, weather sensing, observation and military navigation and communication. Unfortunately none so far are used by civil aircraft and it is not known when such use will occur. SATCOM is a communication system, which utilizes satellites for transcontinental flight communications between the aircraft and ground station. It uses three subsystems, such as ground earth station, aircraft earth station and satellite system.

Emergency locator transmitter ELT is an independent battery powered transmitter activated by the excessive G-forces experienced during crash. It is required on all aircraft to provide a signal on crash landings that will enable search aircraft or ground stations to locate the aircraft. ELT is located in an area of the aircraft where impact damage will be minimal, such as tail cone area or aft top of cabin. Modern ELTs may also transmit a signal on 121.5 MHz. This is an analog transmission that can be used for homing, but it has been replaced by the 406 MHz standard. Transmission on 121.5 MHz are no longer received and relayed via satellite, but is still an active emergency frequency and is monitored by over- flying aircraft and control towers.

ACARS is a digital data link system for the transmission of messages between aircraft and ground stations, which has been in use since 1978. At first it relied exclusively on VHF channels but more recently, alternative means of data transmission have been added which have greatly enhanced its geographical coverage. There has also been a rapid trend towards the integration of aircraft systems with the ACARS link. Both have led to rapid growth in its use as an operational communications tool.

SELCAL is a signalling method which can alert an individual aircraft that a ground station wishes to communicate with it. SELCAL signals can be transmitted over either HF or VHF RTF frequency. A SELCAL transmission consists of a combination of four preselected audio tones which takes approximately two seconds to transmit. The tones are generated by a SELCAL encoder at the ground stations and received by a decoder connected to the audio output of the aircraft receiver. SELCAL can relieve a flight crew from maintaining a listening watch on assigned frequencies, which can be especially helpful where ATC RTF still relies upon noisy HF channels.

3.2 Airborne audio communication systems

As well as systems for communication with ground stations, modern passenger aircraft require a number of facilities for local communication within the aircraft. In addition, there is a need for communications with those who work on the aircraft when it is being serviced on the ground. Systems used for local communications need to consist of nothing more than audio signals, suitably amplified, switched and routed, and incorporating a means of alerting appropriate members of the crew and other personnel.

Personnel´s audio communication of the aircraft consists of audio communication of pilots, crew members and technical personnel. Audio communication of pilots allows the Flight interphone system (INTERKOM), which provides the essential connecting link between the aircraft´s communication systems, navigation receivers and flight deck crew members. It also extends communication to ground personnel at external stations (e.g. the nose gear interphone station). It also provides the means by which members of the flight crew can communicate witch the cabin crew and also make passenger address announcements.

The cabin interphone system provides facilities for communication among cabin attendants, and between the flight compartment crew members and attendants. The system can be switched to the input of the PA announcements. The call may come from the flight compartment via the audio control panel through headphones or from the cabin crew station.

The service interphone system provides the crew and ground staff with interior and exterior communication capability. Circuits in the system connect service interphone jacks to the flight compartment. The ground crew call system provides a signalling capability (through the ground crew call horn) between the flight compartment and nose landing gear area.

Audio communication of passengers involves the passenger address system, telephone and means of entertainment on the board. The passenger address system provides the flight crew and cabin crew with means of making announcements and distributing music to passengers through cabin speakers. Airborne telephone provides the passengers contact with cabin crew. Digital player is located in area for cabin crew and allows playing audio signals, transmitting announcements to passengers, music, video and movies. It also allows to save high quality audio data and transmit them quickly and easily.

3.3 Additional audio systems

This group of audio systems includes Cockpit voice recorder CVR and Cabin intercommunication data system CIDS. CVR records direct conversations between crew members in the cockpit, all aural warnings sounded in the cockpit, communications received and transmitted by radio, intercommunication conversations between crew members, announcements transmitted over the PA system. The recorder unit is located at the other end of the aircraft where it is least likely to suffer damage in the event of an accident. The CVR is constructed so as to withstand shock and fire damage, and additionally is painted in a fire-resistant orange paint to assist in recovery from a wreck. It can provide valuable information that can be later be analysed in the event of an accident or serious malfunction of the aircraft or any of its systems. CIDS transmits, controls and processes signals for the cabin and service interphone, passenger lighted signs, reading lights, general cabin illumination, emergency evacuation signalling, lavatory smoke detectors and indicators, passenger entertainment, escape slide bottle pressure monitoring.

3.4 Control of airborne communication systems

Audio control panel ensures transmission and reception of all communication, emergency-navigation, interphone (flight and cabin) systems and passenger address system. It may be fitted in the central pedestal console or in the overhead panels. Each audio control panel contains microphone selector switches which connect microphone circuits to the interphone systems, to the radio communication systems or to the passenger address system. The push-to-talk switch on the audio panels can be used to key the flight compartment microphones. Volume control is provided by switches on each audio selector panel.

Calls panel provides making calls from flight compartment to cabin crew through cabin interphone system and to ground personnel through flight interphone system. Recorder panel comprise two systems, a CVR and a flight data recorder, which records specific aircraft performance parameters.

Service panel enables communication between cockpit and ground personnel. It is located on the bottom of the fuselage next to the nose gear. Radio management panel is located on the overhead panel with two frequencies displayed, which serves for communication between pilots and air traffic control.

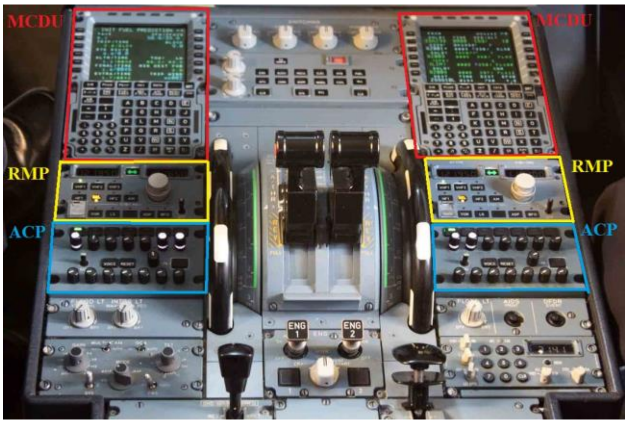

Figure 2 Control of RMP and ACP

4 COMMUNICATION IN THE PROCESS OF INCREASING THE EFFICIENCY OF AIR TRAFFIC

4.1 Factors of effective communication

The human factor in effective communication involves the flight attendant´s hesitation, over-emphasis on Sterile Cockpit Rule, unfixed team formation, separate briefing, different chain of command. The factors which make cabin crew members hesitate to convey the vital information to flight deck. There could be two possible reasons; one reason is that the flight attendants may fear to face the possibility of reprehension from the pilots, because the are not sure whether the information they reported is correct. Some of flight attendants are not confident in their ability of describing the parts of plane and mechanical failure of the aircraft. Sterile cockpit rule states that during a crucial phase of flight (e.g. taxi, take-off, landing), there is to be no any activity which may distract cockpit crew members.

Use of language and phraseology in communication is very important in safety of air traffic. Use of non-standard phraseology is a major obstacle to voice communication.

International Civil Aviation Organisation provides rules and procedures for pilot-controller communications, which are related to the intonation, speech rate and placement and duration of pauses. Frequency congestion affects the correct information flow during critical phases, such as take-off, departure, approach and landing, especially at highly busied airports.

4.2 Factors suppressing effective communication

Sleeping receiver is the term used to describe incidents when the radio apparently goes dead so that no incoming calls are heard, either those directed to the flight or those between ATC and other flights.

The process of changing frequency offers many possibilities communication failure if the pilot subsequently selects the wrong frequency. Frequency change occurrences are often of short duration because the pilot realises on checking in that he/she is on the wrong frequency: either the frequency is silent, in which case the pilot returns to the previous frequency, or it is active, in which case the controller directs the pilot to the correct frequency.

Radio interference is the term used to describe a range of different situations in which transmissions other than those from authorised users of an RTF frequency interfere with radio reception. For defence against it can be screening, frequency change or squelch.

Simultaneous transmission by two stations results in one of the two transmissions being blocked and unheard by the other station- blocked transmission. As appropriate defences can be ground ATM communication system technical solution for detection and alerting, airborne radio anti-blocking devices, optimising and limiting frequency coupling.

Loss of communication most often occurs because of inadvertent mismanagement of aircraft equipment by flight crew.

Physical barriers such as noise, technical difficulties, illness and fatigue. Accent, idiom, technical jargon, tone and ambiguity are among semantic barriers. Psychological barriers include individual differences, readbacks and hearbacks, perceptual ability and other psychological barriers.

4.3 Possibilities to increase efficiency of communication in aviation

The term flight deck integration refers to the integration of aviation systems, technologies and processes external to the aircraft with the systems, technologies and processes of the flight deck. Examples of flight deck integrated ATC: Controller-Pilot Data link Communications CPDLC is a communications system allowing ATC to communicate with flight crew by data link. The Future Air Navigation Systems FANS are CPDLC systems, which uses satellite based ACARS communications. Maastricht UAC-ATN-CPDLC system uses CPDLC technology for the control of the upper airspace of Belgium, Germany and the Netherlands.

Next Generation Air Transportation System is the name of the new airspace system that due to be implemented across the United States in stages between 2012 and 2015. Among the benefits discussed regarding this NextGen is communication enhancement between pilots and ATCO will be achieved. This new data link communication will allow ATCO and pilots to receive precise information regarding traffic information crossing along flight paths at a timely manner transmitted via data communication instead of voice communication. This new equipment will send out satellite signals providing more accurate information to both ATCO and pilots that will enable safer separation both at airspace and on the ground. Additionally, this new technology will increase scope, volume and widespread distribution of information which will improve decision making, enhance safety and separation. Problems experienced with the use of voice communication will be obliterated with this new technology.

Figure 3 Communication of pilots

5 CONCLUSION

The general result of master thesis is prevention against the occurrence of communication failures by following good radio discipline, in term of human factor implementation of crew training and application methods of eliminating the errors.

By evaluating the factors which restrain effective communication I summarized that the communication breakdowns associated with human factors as well as machinery failure. The human factor can contributes to minimizing the existing communication problems with successful implementation of the recommended solutions and thus dangerous situation.

The chapters of communication systems and the efficiency of communication I can say that aim of my master thesis has been done.

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