FLIGHT CHECKING FOR SELECTED CNS SYSTEMS AND VISUAL AIDS

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Abstract *– Radio and visual navigation aids available for use by aircraft engaged in International air navigation are the subject of periodic ground and flight test. This paper deals with the selected navigation aids tested by the Air transport department in collaboration with the Air Training and Education Centre of the University of Žilina.*

Key words – flight inspection, ILS, NDB, VOR, PAPI

INTRODUCTION

What is the flight inspection and calibration? According to the ICAO doc. 8071. Inspection is a series of tests carried out by a State authority or an organization as authorized by the State to establish the operational classification of the facility. [1]

This paper considers the flight inspection unit to be comprised of three parts:

a) The flight inspection aircraft,
b) the flight inspection crew,
c) the position-fixing system.

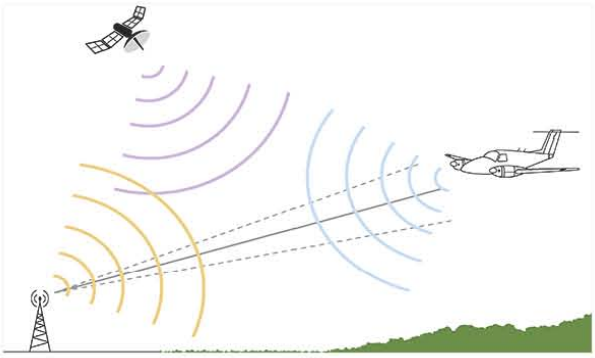

Figure 1*- Flight inspection scheme [3]*

The figure 1 shows simplified scheme of the flight inspection. To supplement, the regular and safe operation of civil and military air traffic entirely depends on the availability of reliable navigational facilities, Instrument Landing System (ILS), Radars and Visual Approach Aids. To ensure this aspect, it is necessary that these navigational facilities are flight inspected on regular basis to examine the resulting signal-in-space as they are presented to an aircraft receiving system.

BACKGROUND

On the field of university this area solves project supported by structural funds of European Union called *THE CENTRE OF EXCELLENCE FOR AIR TRANSPORT.*

The specific aim of the project is the laboratory construction for the flight verifying of the aviation support equipment and for increasing its safety. This will increase the quality of the research workplace. This flight laboratory is able to monitor the Slovak airspace with the vertical coverage in range from ground to FL 100 (approx. 3000m). The monitoring equipment is supposed to be able operate under more difficult meteorological conditions too, as well as the avionics equipment for precise landing including certification for CAT I, resp. CAT II with ability to proceed measurements during light icing. Minimal technical requirements for **AeroLab 1** require the horizontal coverage min 600km, the time of continual measuring without interlanding min 4 hours, sensors and antennas for electromagnetic field measuring, common distribution panel, and electrical installation concerning distribution and connection network, installation of data collector. Equipment for flight under IFR conditions is supposed to be installed on board according to the valid ICAO (SR) requirements. [5]

FLIGHT CHECKING

As mentioned in the introductionthe Flight checking consist of three parts**which are discussed in this section.**

AIRCRAFT

The flight inspection aircraft (A/c) is PA-34-220T the fifth generation of Piper Seneca. It is twin-engined light aircraft with the following specifications:

- Crew: Three (two pilots and one operator)
- Length: 28 ft 7.44 in (8.72 m)
- Wingspan: 38 ft 10.87 in (11.86 m)
- Height: 9 ft 10.8 in (3.02 m)
- Empty weight: 3212 lb (1457 kg)
- Loaded weight: 4773 lb (2165 kg)
- Useful load: 993 lb (450 kg)
- Max. takeoff weight: 4750 lb (2155 kg)

Figure 2- *Flight inspection A/c - Piper Seneca [3]*

Main equipment of the A/c is Automatic Flight Inspection System (AFIS) AT-940 developed by the Airfield Technology, Inc. AFIS interfaces with on-board equipment including oscilloscopes, advanced spectrum analysers, printers, signal generators for automatic calibration during flight, and RFI direction finding equipment.

FLIGHT INSPECTION CREW

The flight inspection crew normally consist of two pilots and one or two technicians or engineers. The members of the flight inspection crew should be experts in their individual fields, have sound knowledge and experience in flight testing/ inspection procedures and requirements and be capable of working as a team.

The State authority of flight inspection organization, as authorized by the State authority, should formally certify flight inspection personnel. The objectives are to:

a) grant authority to the flight crew member who ensures the satisfactory operation of air navigational facilities,
b) provide a uniform method for examining employee competence,
c) issue credentials that authenticate inspection authority.

POSITION-FIXING SYSTEM

Modern flight inspection measurement systems combine multiple sensor inputs to establish position fixing. A state-of-the-art solution that provides position sensing for all phases of flight inspection is the combination of different sensors, such as inertial navigation systems (INS), barometric altimeters, scanning distance measure equipment (DME) receivers, and global navigation satellite system (GNSS) receivers. A high degree of automation can be achieved for the flight inspection equipment since continuous position reference information is available. In addition to position fixing capability, modern flight inspection systems also provide data processing, display, and recording functions, and may provide guidance to the crew for accurately positioning the aircraft for measurements.

SELECTED RADIO AND VISUAL NAVIGATION AIDS

For the purposes this paper we will sequentially introduce the various radio and visual navigation aids and examples of their checking.

ILS

An instrument landing system (ILS) is a radio beam transmitter that provides a direction for approaching aircraft that tune their receiver to the ILS frequency. It provides both lateral and vertical signals. It is a ground-based instrument approach system that provides precision guidance to an aircraft approaching and landing on a runway. Radio-navigation aids must provide a certain accuracy (set by international standards of CAST/ICAO); to ensure this is the case, flight inspection organizations periodically check critical parameters with properly equipped aircraft to calibrate and certify ILS precision. [4]

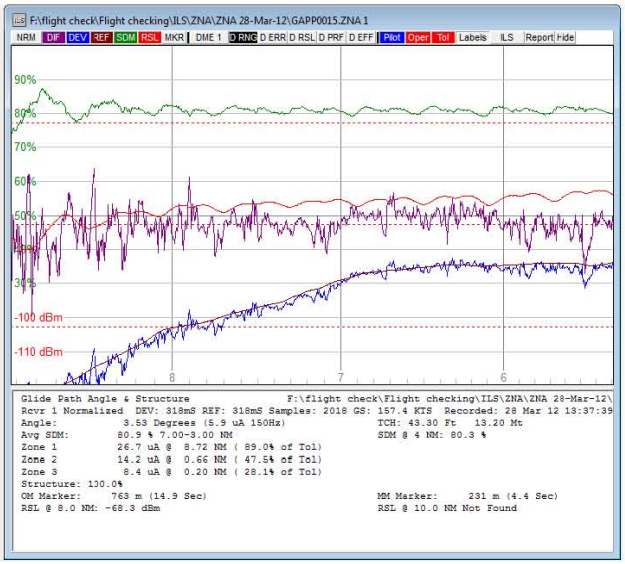

Figure 3- *Win FIS-ILS/GP [2]*

Manual evaluation ripple glide lines Glide path (GP) is carried out in accordance with the requirements of ICAO Annex 10 / I according to the following rules:

At the figure 3 is the reference value which evaluates the amplitude of the ripple is the middle line of descent, not elongated rectilinear portion glide lines or line 0 (blue line). A nominal glide angle. Middle line of descent can be mathematically defined between points A and B. ILS arithmetic mean between points B and T lines, as measured by the method of least squares. Practically, it is preferable to space the two sections of a line passing the center of the corrugated GP record.

NDB

A non-directional beacon (NDB) is a radio transmitter at a known location, used as an aviation or marine navigational

aid. As the name implies, the signal transmitted does not include inherent directional information. The basic airborne equipment used for flight testing NDB facilities is a standard aircraft automatic direction finding (ADF) receiver calibrated to read field strength and bearing to the NDB. A voltage proportional to the received signal strength usually can be obtained from the receiver, or field strength readings may be taken from a separate field strength measuring equipment carried in the aircraft. Since the ADF indicates the angle between the aircraft and the ground beacon, any yawing motion of the aircraft will produce a swing in the ADF needle indication. Care should therefore be taken during a flight check to keep the aircraft heading as steady as possible. In this way, the yawing motion of the aircraft is removed from the record. The figure below show outputs from NDB flight testing of ZLA.

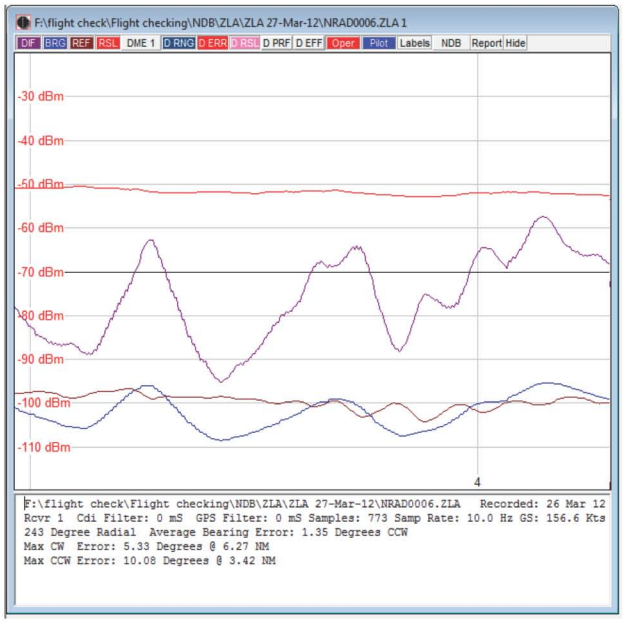

Figure 4- Win FIS-NDB [2]

VOR

VHF Omni Directional Radio Range (VOR) is a type of short-range radio navigation system for aircraft, enabling aircraft with a receiving unit to determine their position and stay on course by receiving radio signals transmitted by a network of fixed ground radio beacons. It uses frequencies in the very high frequency (VHF) band from 108 to 117.95 MHz.

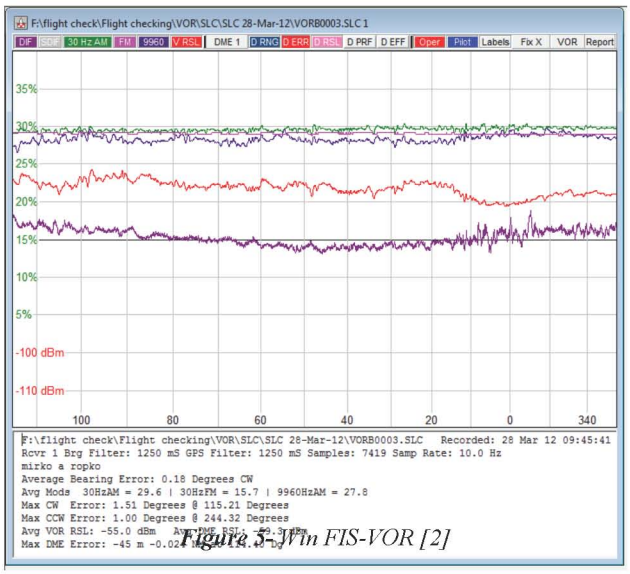

Figure 5- Win FIS-VOR [2]

The VOR parameters must be measurable to the accuracy shown in the figure 5. The ripple (scalloping) is a fast periodic radial change of values on either side.

PAPI

Flight angle measurement of individual signals is performed by horizontal flights in the height of 300 meters above the threshold (THR) in the direction of approach from a distance of 10 km, so that the aircraft was at a distance of 8km from THR seated in horizontal flight with PAPI indication RRRR. Left pilot watches indication of PAPI and telling moments of each colour change signals the operator console or the brand itself generates at the moment of gradation. Figure 5 shows PAPI angles and their values for LZZI airport.

Sample	V Angle	H Angle
1	3.72	-0.34
2	3.98	-0.45
3	4.35	-0.64
4	4.65	-0.71

Sample Count: 4 Samples Averaged: 4
Average Angle: 4.18 (4:10:48) Std Deviation: 0.35
Max: 4.65 (4:39:00) @ 4 Min: 3.72 (3:43:12) @ 1
Recorded: 19 Apr 12 13:41:52
NOTE0003.PAPI 06
GPS Tracked Vasi/Papi Inspection
Meranie PAPI 06 LZZI
Inspection of LZZI PAPI 06
Task ID: LZZI 19-Apr-12

Sample	V Angle	H Angle
1	3.72 (3:43:12)	-0.34
2	3.98 (3:58:48)	-0.45
3	4.35 (4:21:00)	-0.64
4	4.65 (4:39:00)	-0.71

Figure 6 - Win FIS-PAPI [2]

During the procedure, it is necessary to generate tags only one crew member and once for each transition. On-board measuring equipment shall be evaluated at the time of generating brand instant elevation angle of the aircraft to touchdown and automatically determines the average angle between the angles.

Conclusion

Flight checking is the evaluation process, using properly equipped aircraft, regarding continuity, integrity and accuracy of significant parameters from radio navigation aids and procedures, aiming their calibration with international standards. This paper shows examples of flight inspection ensured by Air transport department in collaboration with the Air Training and Education Centre of the University of Žilina.

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