FLIGHT LABORATORIES AND FLIGHT DATA RECORDERS

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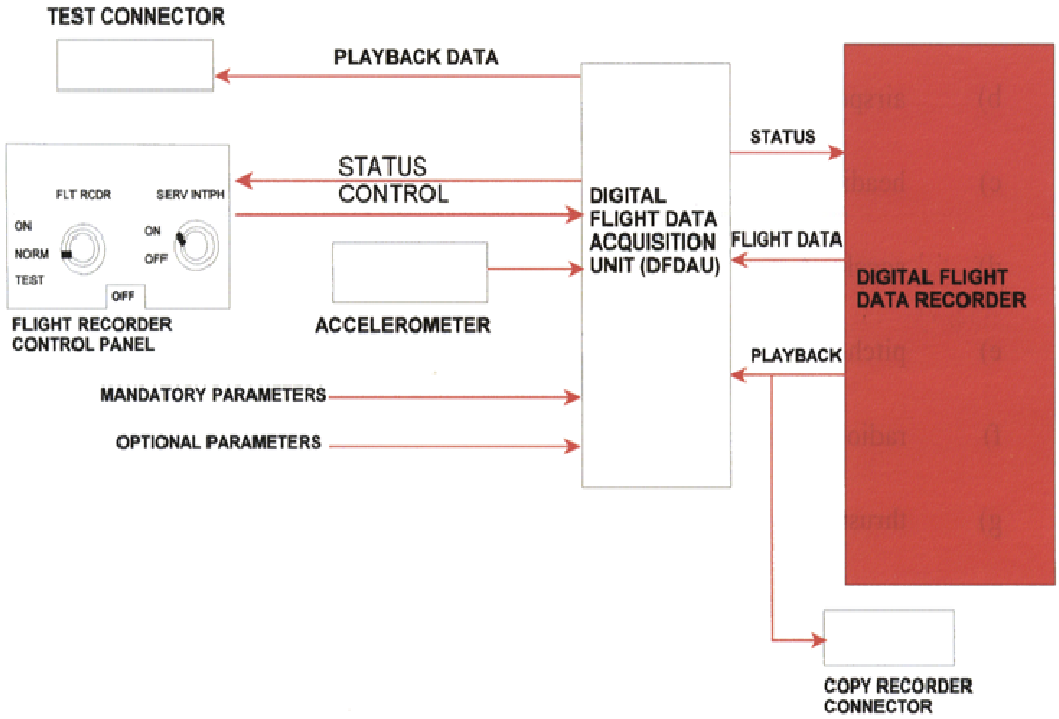
Summary: The aim of this paper is to familiarize the reader with the specifications of Flight Data Recorders used in aviation and used for the flight laboratory of University of Žilina, which is the part of project named:"Centre of Excellence for Air Transport" ITMS 26220120065.

Key words: flight data recorder, aviation, flight laboratory, aircraft

INTRODUCTION

Concerning the aviation development is required to equip the aircrafts with recorders of certain data, important for eventual identification of the aircraft and for crash causes clarification. The older data recorders were analogy types with direct record on the barograph or photograph paper. They were featured with poorer accuracy and short record time. Nowadays aircrafts registered from 1st April 2000 are required to be equipped with digital flight data recorder.



Source: www.boeing.com/boeingmanual

Fig. 1 - Block scheme of Flight Data Recorder FDR

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1. GENERAL REQUIREMENTS FOR FLIGHT DATA RECORDERS

Recorder is supposed to record data during the flight without interruption. The case of flight recorder is required to:

- be coated with bright orange or white colour,
- be treated with reflex material for high visibility,
- be securely connected with automatically activated signalisation for localisation under water

Recorder is required to be installed so that:

- the probability of data damage is minimised,
- is powered by electricity from the most reliable electrical bus,
- is equipped with voice or visual features for verification of the correct operation during pre-flight check.

Flight data recorders are classified as I, II, IIA. Types according to the number of registered parameters and according to the ability to store information.

Type I – this kind of flight data recorder is supposed to be able to record minimum of 32 parameters in particular aircraft.

Type II and IIA - this kind of flight data recorder is supposed to be able to record minimum of 15 parameters in particular aircraft.

Components of FDR:

- recording system:
    - Digital Flight Data Recorder – DFDR
    - Flight Data Interface Unite – FDIU
    - Linear Accelerator – LA

- overhead panel control unit- similarly allows cockpit voice recording - CVR (Cockpit Voice Recorder). This panel also contains GND CTL switch button with positions ON or AUTO:
    - position ON: CVR and DFDR are switched up
    - position AUTO: CVR and DFDR are switched up in situations:
        - constantly when electrical source on
        - on the ground with one engine in operation
        - during the flight (when engines not in operation too)
- operating unit on the middle panel. EVENT button allows adjusting of several parameters.

2. INFORMATION AND REQUIREMENTS SPECIFIED BY EU OPS

Mandatory information specified by EU OPS requirements are altitude, indicated airspeed, aircraft heading, accelerometer (acceleration), tumbling and incline position,

traction or engine performance, air temperature, configuration and setting of devices for buoyancy or revolt increase, using of autopilot system, striking angle.

Optional information are main steering position and balancing position, altitude determined by altimeter, navigation information presented to the crew, cockpit warning, position of landing gear.

Requirements of EU OPS regulations for FDR:

- activity during 10 hours in the aircrafts with weight up to 5700kg and including the aircrafts registered after 1st April 1998,
- activity during 25 hours in the aircrafts:
  - heavier than 5700 kg,
  - with more than 9 seats.

Mandatory information has to be recorded in all types of aircrafts with weight up to 27000 kg including. Optional information has to be recorded in all types of aircrafts heavier than 27000 kg. Aircrafts registered from 1st April 2000 are required to be equipped with digital flight data recorder.

Further requirements for FDR:

- FDR is supposed to be able operate automatically if the aircraft is movement worthy using own power and vice versa to be able automatically to stop activity,
- FDR has to be operable during increased humidity,
- Aircraft with weight up to 5700 kg could be equipped with the FDR in combination with cockpit voice recorder.

Nowadays the Aircraft Integrated Data Systems – AIDS are used. It simplifies the record and analysis process of flight data through DMU (Data Management Unit). Thanks this system the flight information could be transmitted in certain intervals to the operator via ACARS - Airborne Communication and Reporting System.

3. LOGGER

Diametrically different requirements are set for flight data recorder (Loggers) for gliders. Logger is in fact certified flight recorder equipped with GPS. The main role of the unit is recording of flight data such are position GPS, GPS altitude, pressure altitude and voice values of the engine. This data are periodically recorded for further flight analysis. Flight recorder has to fill all the requirements of International Gliding Commission (IGC) and International Flight Federation (FAI - Féderation Aéronautique Internationale) and consequently could be used for competition flights. The output from the recorder also could be used for application concerning gliding badge and for recognition of world record. Flight data recorder has to be equipped with electronic stamp that will ensure that every flight record will contain digital signature. As soon as the electronic stamp is damaged, flight recorder records flight but without digital signature so that it isn't usable for sport purposes.

Flight recorder doesn't require any programming or initialisation for start its function. If the antenna and power supply are connected with the recorder, it will start recording flight immediately as the speed higher than 12 kts is recognized, or if the increase of altitude is observed. After flight it is possible to download the data to the computer for analysis.

Flight data recorder contains GPS receiver with antenna, pressure sensor that measures absolute altitude according to the standard atmosphere and sensor that measures noisiness of engine. The sensor measuring the engine noisiness is used to prevent cheating at the competitions concerning the pilots flying gliders equipped with engine. Without this sensor pilots could start engine during unfavourable weather conditions, gain the altitude and continue in the flight. Flight recorder would record the same data as would during classic circling in rising air. Indication of the noisiness sensor is achieved by microphone and special filter. While gliders without engine produce specific aerodynamic voice during flight, gliders equipped by engines produces excursion when the engine is on. The noise values are then presented during flight analysis.

Pilot is able to set the value from 1 sec to 60 sec concerning the record intervals. This value affects time capacity of the memory and it is advised by flight record manuals to set record interval in 4-10 sec. Logger allows pilot to adjust particular route he plan to fly before flight (from take-off point, start of the track, turning points, end of the track and landing point).

This procedure can be seen mainly at the competitions where the tracks are announced to the pilots in the morning for the upcoming day and consequently the tracks are set into their recorders. Tracks could be also set in computer and then downloaded into the recorder. The start of the track needn't to be the airport location where gliders takes off but could be positioned several metres further. Some recorders contain the function that acoustically alerts the pilot about crossing the start tape, where his competition flight starts. Start tape as well as the final tape could be adjusted (their location and size).

There are more logger producers at the market nowadays. It's possible to choose various types of loggers and all depends on the pilot and his requirements. Basic and the simplest flight recorders present small box (6,5x5x3 cm) with two diodes indicating the operation of the equipment and with one control button (Figure 2). This kind of flight recorder fills its basic function - configuration of the track before the flight, data saving during the flight in set interval and its consequential download to the computer for flight evaluation. There is an effort from producers to build the smallest and the lightest device because pilot doesn't use it during the flight at all.

Flight recorder could be connected with the PDA computer that serves to pilots for navigation. When connected to the computer offers flight data and also acts like GPS reciever.

Source: : http://www.imi-gliding.com/cz/erixx-flight-recorder-2.html

Fig. 2 - Basic flight recorder

In case the pilot needs more functions then offers flight recorder, he could use basic navigation equipment. For instrumentation – flight recorder Colibri (10 x 5,2 x 3,2 cm) offers keyboard and display for data presentation. Except of flight recording is equipped by functions such as wind calculation. Wind calculation is based on measurement of descending when circling in rising air and information about wind are presented after finishing of two complex circles. The flight recorder could be switched into the mode to present given task and offer navigation info for reaching another point according to the set track. Logger Colibri obtain airports database too. It is also possible to edit information about airports in the computer and consequently download it back to the recorder. After crossing the tape, logger navigates the pilot towards the airport. In case of early landing logger allows choosing of the closest airport and re-calculates the distance and the heading. As the recorder doesn't present navigation data on the display, it's possible to choose the scale for distance, altitude, speed and vertical speed among metric and non-metric ones.

Newer version of flight recorder has extra function – integrated collision avoidance system – Flarm. This product offers to the pilot two systems in one. The benefit is the mutual built GPS receiver, while antenna is installed on the device itself. Device contains also connector for connection of external Flarm display. It's also possible to connect flight recorder with integrated Flarm to navigate computer or PDA computer with the programme SeeYouMobile. Thanks such connection pilot obtains complex advanced flight and navigation system.

Source: http://lxnavigation.si/avionics/flight-recorders/23-colibri.html)

Fig. 3 - Flight recorder Colibri with extra functions

The flight recorder is the must for the pilot who would like to participate on gliding competitions and from that point of view it belongs to the compulsory gear of glide. It's also necessary to prove flight by flight recorder for appreciating of the badge and records. Previously used barographs are not recognized anymore.

Source:http://ziarko.type.pl/22_Sailplane/Avionic_General_DG800B-BIG.jpg

Fig. 4 - Contemporary dashboard

Figure 4 presents glider dashboard with contemporary equipment and computers. In the upper left corner there can be seen the collision avoiding system Flarm, right below it there is electronic variometer, slightly to the right there can be seen flight computer and on the right side there is navigation computer PDA. The transponder is installed on the lower right side and across the dashboard there is variometer with MacCready ring.

Mentioned dashboard could appeal overcrowded but it's just concern the routine. The mostly used devices during the flight are situated in one level at the first line. Pilot's sight just skims sporadically through the lower devices.

CONCLUSION

Described recorders could be very useful for installation in flight laboratory, which would allow analysing other values and increase the range of scientific research. The choice of the particular type of the recorder is necessary to synchronize with technical specifications concerning the continual providing of the chosen values but with the dimensional, weight and compatibility limits too.

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(6) *http://www.imi-gliding.com*.

(7) *http://lxnavigation.si.*