Remote Controlled Flight Inspection System

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ABSTRACT

Modern Flight Inspection Systems can be operated fully automatically, requiring only little inputs from a flight inspector under routine conditions. The systems themselves need no adjustments or checks under normal conditions in flight.

A full set of calibration tasks can be predefined in a flight list, and each run needs only to be started and stopped.

The flight inspector monitors the run and if the facility is in its limits, no further action has to be carried out on board. Prints can be stored on a digital storage media.

Such a system can be operated from a location other than the flight inspectors work table in the cabin.

After the runs have been completed, the results (in graphical and/or numerical form) have to be evaluated by a flight inspector and a judgment about signal quality has to be performed.

If no problems occurs with the facility, there is no need to have the flight inspector on board of the FIS aircraft. This will be a typical application of a routine calibration on a known-to-be stable ground facility.

This remote functionality can save working hours of a flight inspector, especially if long ferries and short calibration times occur. Ideally, he can calibrate several facililties in parallel from his office.

Prerequisites are a fully automatic Flight Inspection System, stable data and voice links to/from the aircraft and a good knowledge of flight inspection procedures from the pilots.

Reliable and affordable data and voice links are becoming more and more available, so this may be an approach to minimize personnel costs in the future.

This remote controlled operation mode will not be applicable for unknown, new or critical ground facilities. In this case an experienced flight inspector still has to be in the aircraft, responding immediately to any problems with the signals from ground.

A Hardware concept as well as operational aspects are discussed in this presentation.

PRESENT SITUATION

Workshare in the aircraft

Typical workshare in a FIS aircraft in calibration runs:

a) LH Pilot is flying the aircraft
b) RH pilot /1st officer is radio operator and supports the pilot by preparing the ongoing and next run for the pilot
c) FIS Operator in the cabin: Setup of flight profiles on the console, start/stop of runs, data evaluation and handling of print-outs. He evaluates online the quality of the signals received from the ground station under calibration. He or the pilot handles the list of profiles to calibrate and communicates with the ground technicians.

Current workload

In a fully automatic operation of the FIS, the average workload under normal conditions in standard flight profiles is assumed to be

a) LH Pilot:	100 %
b) RH Pilot /1st officer	40 %
c) FIS Operator	50 % (short peaks up to 100 %)

Is it possible to keep the flight inspector on the ground ?

DESIGN DESCRIPTION

Prerequisites

The following prerequisites will be assumed:

Airborne aspects:

- The airborne system is fully automatic and has a high reliability
- The database in operation is well known and has been used before showing correct results
- A comfortable flight guidance information from the FIS is given to the cockpit. (This is not part of this presentation).

Ground aspects:

- Continous ground monitoring of the system under calibration shows stable results
- No problems have been reported from the operation of the ground facility since the last calibration
- The ground facility is known to be stable and has always been well within limits

Operational aspects:

- The calibration runs are exactly the same like the last routine inspection
- A flight inspector is available while the inspection flight is conducted . He is equipped with voice and data communication systems established between his location and the aircraft

Basic Idea

The basic idea is to prepare the calibration runs before flying in the office and to start and stop each profile in the air by the copilot. Evaluation of recorded results are done later or on-line under the responsibility of the flight inspector. In this stage it is not planned to evaluate the data automatically and report the result to the cockpit crew without the judgement of a flight inspector.

Presentation in the cockpit

A flight list has to be prepared before the flight and agreed by the flight inspector and the pilots as under classical FIS operation tasks.

This list will be loaded into the Flight inspection system. It will be permanently available to the cockpit crew.

- This list with the pre-programmed flights will be presented on an existing cockpit screen, i.e. the MFD or CDU/FMS
- Hotkeys to select a profile are installed in the cockpit enabling profile selection, Start / Stop and Abort functions.
- Status information about system status is presented in the cockpit

Flightlist on cockpit display

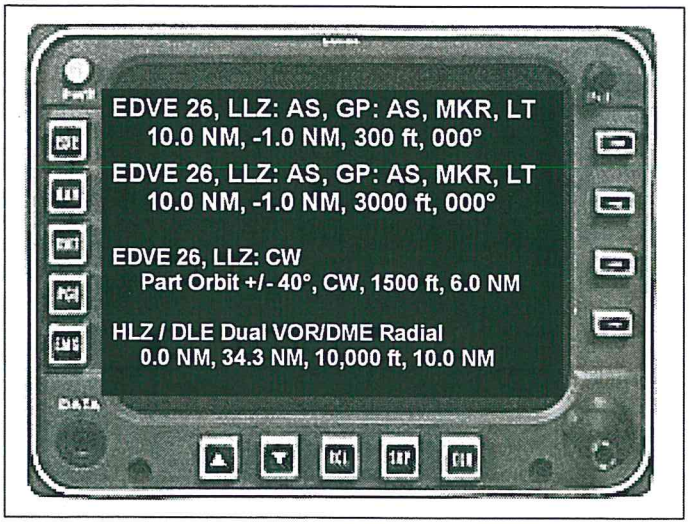


Figure 1: Flightlist Presentation on MFD

Colors:

Profile selected:	**green**
Profile available:	**yellow**
Profile done:	**blue**

Hotkeys and status information display

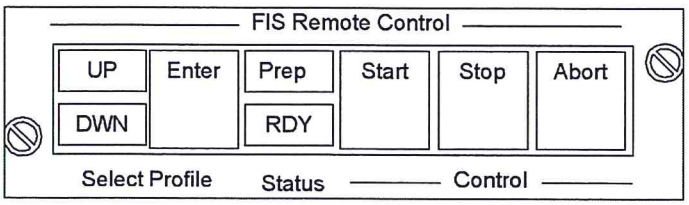


Figure 2: Control Panel for Flightlist Presentation

Comparison to FIS display

The information in the cockpit is a subset of the detailed display in the FIS main screen.

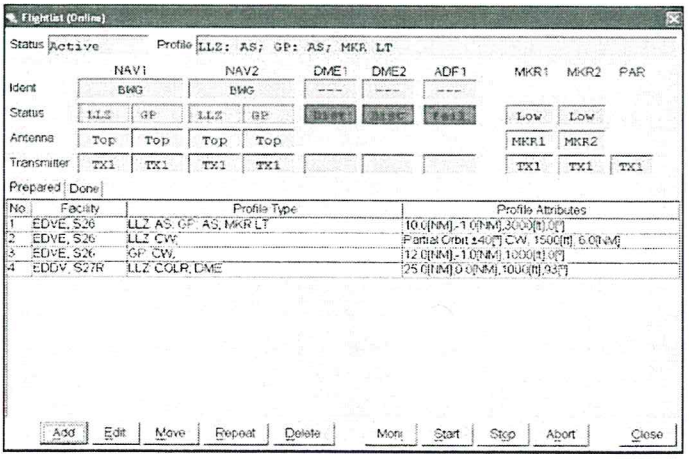


Figure 3: Flightlist and status Presentation on FIS Display

Presentation on ground

The presentation on ground is independent from the location of the flight inspector.

He has voice and data links to the aircraft and has the latest version of the flight list available.

He can get hardcopies of the graphic plots from the FIS in nearly real-time after each run or after the mission is completed.

The presentation is the same as in the aircraft.

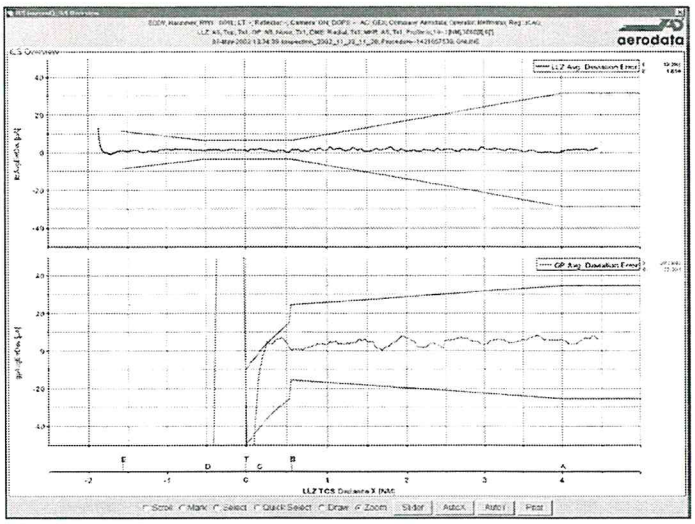
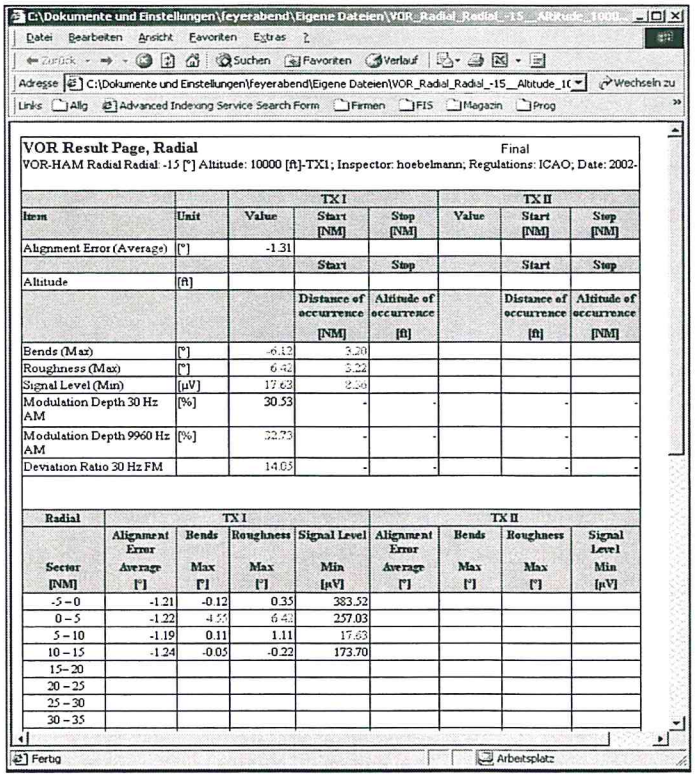


Figure 4: Typical graphical presentation on board and in the office



VOR Result Page, Radial — Final

VOR-HAM Radial Radial -15 [°] Altitude: 10000 [ft]-TX1; Inspector: hoebelmann; Regulations: ICAO; Date: 2002-

Item	Unit	TX I Value	TX I Start [NM]	TX I Stop [NM]	TX II Value	TX II Start [NM]	TX II Stop [NM]
Alignment Error (Average)	[°]	-1.31					
			Start	Stop		Start	Stop
Altitude	[ft]						
			Distance of occurrence [NM]	Altitude of occurrence [ft]		Distance of occurrence [ft]	Altitude of occurrence [NM]
Bends (Max)	[°]	-6.12	3.20				
Roughness (Max)	[°]	6.42	3.52				
Signal Level (Min)	[µV]	17.63	2.56				
Modulation Depth 30 Hz AM	[%]	30.53	-	-		-	-
Modulation Depth 9960 Hz AM	[%]	32.73	-	-		-	-
Deviation Ratio 30 Hz FM		14.05	-	-		-	-

Radial Sector [NM]	TX I Alignment Error Average [°]	TX I Bends Max [°]	TX I Roughness Max [°]	TX I Signal Level Min [µV]	TX II Alignment Error Average [°]	TX II Bends Max [°]	TX II Roughness Max [°]	TX II Signal Level Min [µV]
-5 – 0	-1.21	-0.12	0.35	383.52				
0 – 5	-1.22	-4.55	6.42	257.03				
5 – 10	-1.19	0.11	1.11	17.63				
10 – 15	-1.24	-0.05	-0.22	173.70				
15 – 20								
20 – 25								
25 – 30								
30 – 35								

Figure 5: Typical result page presentation on the FIS and in the office

Hardware requirements on ground

If the flight inspector is located in his office, he can use his telephone and his office computer. Both are hooked on radio links to the aircraft.

If he is located next to the ground station under calibration within radio distance to the aircraft, he may use portable systems.

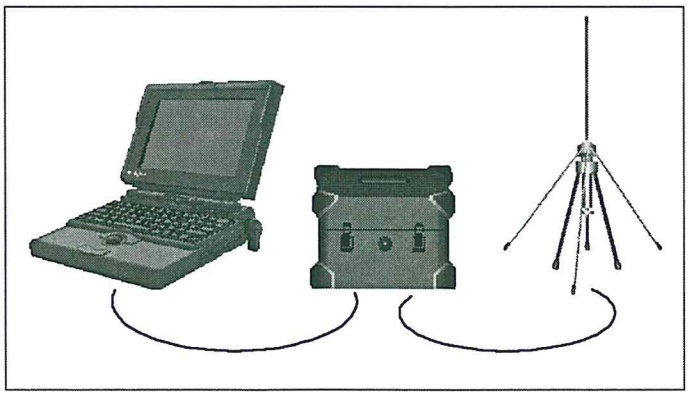


Figure 6: Example of a portable Ground Equipment to monitor FIS data

A ground position reference system should be available, which needs no manual supervision. This could be realized by remote controlled P-DGPS reference stations.

Voice link:

The voice link from/to ground and aircraft, if the flight inspector is in his office is based on SATCOM.

If he is on ground close to the aircraft, VHF COM is an option.

Expected phone time: 5 min per flight calibration hour. Actual prices for one minute SATCOM phone call is about 1 US$ (Iridium).

Data link:

The data link from aircraft to ground, if the flight inspector is in his office, is based on SATCOM / Internet.

If he is close by the aircraft, UHF Telemetry may be an option.

Expected data volume: per graphic page: < 15 kByte. About 10 pages per hour are printed in normal calibration flights.

Voice and datalinks are availbale now with acceptable costs and reliability.

WHAT ARE THE BENEFITS?

Most of the calibration work in ILS and VOR/DME Enroute is routine work where no problems are expected with signals from the ground.

The flight inspector, although being not on board, has full control of the calibration runs, because he defines the flight list and evaluates the results.

The flight inspector needs to be present only while the aircraft is carrying out a calibration run. He has no ferry or ground waiting times. He can monitor more then one calibration task at a time.

The aircraft is still equipped with a full operator workstation and can be used with or without flight inspector.

LIMITS

This remote controlled operation mode will not be applicable for unknown, new or critical ground facilities. Here an experienced flight inspector still has to be in the aircraft, responding immediately to any problems with the signals from ground.

CONCLUSION

Flight Inspection Systems become more and more automatic, requiring less attention to the hardware in normal operation. Ground reference systems for the FIS need no manual supervision any more. The flight program is predefined before the flight. The next logical step is to let the system operate without permanent control, only taking results after the runs. Therefore there is no need to have the flight inspector on board in such cases.