DAY TWO

PROCEDURAL ASPECTS AND PROBLEMS

SPECIAL MILITARY CONSIDERATIONS

NEW TECHNICAL DEVELOPMENTS. FLIGHT INSPECTION SYSTEMS

STATIC FLIGHT INSPECTION DISPLAY

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FLIGHT INSPECTION OPPORTUNITIES IN A MILITARY MARKET
Potential for Improved/New Flight Inspection Methods

ABSTRACT

The flight inspection procedures for military communication, navigation and surveillance- (CNS) systems differ from country to country. In some states, soldiers inspect their own military systems with military aircraft. In other states, military systems are inspected by the same civil service providers responsible for the civil systems and some states have a combination of both. In Germany, the military CNS systems of the Bundeswehr are inspected by Flight Inspection International (FII), a civil service provider. The work of FII is supported by Bundeswehr personnel. The purpose of the following paper is to show the challenges and economic possibilities provided by the military market.

The paper starts with a brief description of those CNS systems of the Bundeswehr that are specific to the military and those that are identical to civil systems. This is followed by a presentation about the number of CNS systems that need to be inspected, the periodic flight inspection intervals and the number of flight inspections performed as well as the costs incurred by these inspections. Our current flight inspection procedures and possibilities for their optimization are then discussed on the basis of the flight inspection of precision approach radar units (PAR). This is followed by an overview of NATO's Precision Approach and Landing System (PALS). Selected technical data about the CNS systems used by the military is provided in the annex.

BACKGROUND

The military situation shall be presented on the basis of the military CNS systems in the Federal Republic of Germany. Admittedly, it is difficult to draw general conclusions about the military field because of different national regulations, but some universally valid statements about military flight inspection can certainly be made on the basis of the situation in Germany.

On principle, flight inspection is not only necessary for civil CNS systems but also for military ones (ICAO Annex 10). While the flight inspection of civil ATC systems focuses primarily on ILS and VOR/DME, a multitude of systems ranging from outdated analogue to state-of-the art digital technology is still in existence in military aviation. Normally, these systems must be inspected at specified intervals (depending on the type of equipment, these intervals range from 3 to 9 months in Germany). At present, the Bundeswehr is in a period of transition. In the medium term, at least part of the military ATC equipment will probably be replaced. Military ATC Services in Germany are currently performed with the following CNS systems, which have been in service for up to 30 years.

CNS SYSTEMS SPECIFIC TO MILITARY

Aerodrome Surveillance Radar (ASR)

Primary radar (ASR-910 by Raytheon; in service since 1979) serves to cover the area of responsibility of local military air traffic control (≤ 60 NM around military aerodromes). The 28 facilities in Germany are not interconnected but stand-alone units. In the medium term, the ASR-910 will be replaced by new and interconnected equipment. The technical data of the ASR-910 are provided in the annex.

Secondary Surveillance Radar (SSR)/ Identification Friend or Foe (IFF)

The SSR/IFF by Siemens (1990-D1) was developed in the 1970s. It contains digitalized circuits and is installed together with the primary ASR 910 (SSR/ IFF antenna mounted on top of the primary antenna and SSR/IFF rack inside ASR shelter). The military side plans to replace the SSR ground interrogators by Mode-S ground interrogators with IFF capability. See annex for technical data.

TACtical Air Navigation (TACAN)

The navigation information provided by TACAN corresponds to that of the VOR with DME. As opposed to the VOR/DME, TACAN also transmits the directional information in the DME frequency band. The bearing information is determined in the aircraft by a phase comparison. In the Bundeswehr, TACAN facilities are used for en-route navigation and for non-precision approaches (NPAs). Today's TACAN facilities were installed in the Bundeswehr from 1991 to 94. See annex for technical data.

Precision Approach Radar (PAR)

By means of PAR, the approach controller can assist the pilot during final approach (20 NM or 10 NM from touchdown). Deviations of aircraft from the glide path and the centre line are displayed to the approach controller, who can then pass the information on to the pilot by means of UHF/VHF radiotelephony. The PAR systems in Germany will probably be used until 2010. See annex for technical data.

At present, PAR is still the standard system for precision approaches in NATO member states. The installation of microwave landing systems (MLS) in Italy's TORNADO wings is currently in progress. The UK plans the replacement of ILS/PAR by MLS and ILS.

IDENTICAL CIVIL/MILITARY CNS SYSTEMS

Instrument Landing System (ILS)

At seven military aerodromes, the Bundeswehr operates ILS facilities identical to civil systems. The replacement of the SEL 3000 facilities, which have been in service now for more than 20 years, is imminent. See annex for technical data.

UHF Direction Finder

In the Bundeswehr, the UHF direction finder is used above all by approach and aerodrome control units for supporting the rapid identification of aircraft. During ASR flight inspections, the UHF direction finders are also checked. At present, plans for the replacement of these systems, which are more than 30 years old, do not exist.

Non-Directional Beacon (NDB)

In the Bundeswehr, NDB facilities identical to the civil systems are used above all for the transport helicopters of the Army and the Navy. The Bundeswehr plans to utilize the available NDB systems until 2013.

VOLUME OF FLIGHT INSPECTION

Number of ATC facilities to be inspected

83 military CNS systems are to be inspected at regular intervals. The total number of all the military CNS systems of the German armed forces that require flight inspection is 123.

Facility	Number
ASR/SSR	28
TACAN (stationary)	19

TACAN (mobile)	4
PAR-80	28
ILS	7
UHF DF	19
NDB	17

Flight inspection intervals

What follows is an overview of the flight inspection intervals currently in force. For practical purposes, these intervals must not be exceeded by more than 25%. If the intervals have been exceeded by more than 25%, the approach minima are to be changed to those of the approach procedure giving the next lowest minima (e.g. from precision approach to NPA).

Annex	Flight inspection interval
ASR/SSR	9 months
TACAN	9 months
PAR-80	4 months
ILS	3 months
UHF DF	on request
NDB	on request

Flight inspections

For the flight inspection of German military CNS systems in 1999, approximately 170 inspections and 900 flying hours were required.

These figures comprise initial, special and routine inspections by calibration aircraft with active calibration equipment (ILS, TACAN and NDB, if required) and calibration aircraft without special calibration equipment (target representation for ASR, PAR and UHF-DF, if required).

In 1999, the cost incurred by the flight inspection of military CNS systems in Germany was approximately DM 6 million (including cost for the Bundeswehr's own flight inspection personnel).

SPECIAL MILITARY CONSIDERATIONS

Today's flight inspections of PAR 80 systems

To ensure the Cat-I capability of Germany's military aerodromes, 28 Precision-Approach-Radar-80 systems (PAR 80) are used in addition to 7 ILS facilities. A flight inspection of these PAR-80 systems is currently performed every 4 months. Deviations of ±0.2 degrees from the nominal value (azimuth and elevation) are admissible.

To check the accuracy of the runway centreline and glide path representation, calibration aircraft (Learjets) are used for target display. The calibration aircraft is vectored by a military approach controller and kept in the graticule of a theodolite by an observer on the runway (near touchdown). The nominal value (including tolerances) and the flight path tracked by the theodolite observer are represented on a paper strip. According to the information provided by the military approach controller, the theodolite observer marks on the paper strip the distance from touchdown and the points at which the calibration aircraft is exactly on the extended runway centreline and/or the glide path of the PAR-80 indicator. The flight inspection is supervised and controlled by an external military flight inspection officer in the approach control room.

This type of flight inspection requires good weather conditions (necessary oblique visibility ≥ 5NM) and considerable manpower (costly). Besides, it depends on the persons performing the inspection (human factor).

It is conceivable that

1. the pilot's corrections are inadequate, resulting in insufficient on-glide-path, on-centreline information,
2. the approach controller may not be able to vector the calibration aircraft exactly in the middle of the cursor,
3. the on-glide-path, on-centreline markings are made too late/early by the theodolite observer,
4. the calibration aircraft is not kept exactly in the graticule by the theodolite observer.

In the final analysis, the results of today's flight inspections do not only depend on the technical condition of the PAR-80 but also on the ability of the persons performing the inspection (approach controller, theodolite observer, pilot and flight inspection officer).

POTENTIAL FOR IMPROVED / NEW FLIGHT INSPECTION METHODS

LASER tracker

As opposed to the theodolite, the laser tracker can be installed beside the runway. By using an aircraft with a flight inspection system and a laser tracker on the ground, the runway would no longer be blocked during the inspection (off-set capability) and weather minima could be lower (necessary optical oblique visibility ≥ 3 NM)

Trials have shown that the more significant advantage (calibration flights in poorer weather conditions) is not really decisive as pilots need orientation with ground features (buildings/ landmarks) in order to stay on the final approach path to an acceptable degree of accuracy.

PAR-80 flight inspection in the future? (Direct link between computers)

The military precision approach radar used in Germany has been modified several times in the course of the years. The original Gilfillan AN/FPN-33 was upgraded to the AN/FPN-36 and, ultimately, to today's PAR 80. In the process, some of the electronic circuits of the PAR-80 were digitalized. Supplying the analogue display units with spare parts is becoming increasingly difficult, which is why the radar display shall be represented on a computer monitor. The required interface between the radar unit and the computer monitor could also be used for flight inspection purposes (analogue-to-digital conversion of signals).

By means of today's flight inspection systems using DGPS technology, the position of a calibration aircraft can be represented to an accuracy of one decimeter. It is therefore conceivable that the digitalized target signal of the calibration aircraft obtained via an interface from the PAR is fed into a computer where it can be compared directly with the position that is being down linked by the calibration aircraft. From our current perspective, this would provide the following advantages:

1. The performance of flight inspections would be largely independent of weather conditions. The only minima that would be significant would be those of the aerodrome approach minima.
2. The result of the flight inspection would no longer depend on the persons performing the inspection.
3. The procurement of suitable recording devices would make the result of the flight inspection transparent to everybody.

THE PRECISION APPROACH AND LANDING SYSTEM (PALS) OF NATO

NATO transport, liaison and combat aircraft must be able to land under Cat-I conditions at all NATO airbases within NATO territory. NATO's Approach and Landing Systems Working Group (ALS WG) has been tasked to draw up a Standardization Agreement (STANAG) for the Precision Approach and Landing System (PALS).

Since NATO member states have not been able to agree on a uniform system for final approach control at military aerodromes and the new system should also have growth potential for DGPS, different ground components may be introduced by the individual states. The Precision Approach and Landing System (PALS) comprises:

1. an Instrument Landing System (ILS)
2. a Microwave Landing System (MLS) and
3. a GNSS-based Landing System (GLS)

Consequently, the equipment to be installed in NATO aircraft must be capable of interacting with all three systems (multi-mode receiver) to enable precision approaches to aerodromes equipped with one of the above ground components.

Once the STANAGs 4533 and 4565 has come into force, the individual states will plan the re-equipment of their military aircraft in accordance with their financial resources and the age and the planned remaining useful life of the aircraft.

CONCLUSIONS

Until the complete replacement of today's generation of old military technical ATS facilities, which are equipped for the most part with analogue circuitry, continuing the flight inspection of military facilities at regular intervals will be indispensable, at least during peacetime operations.

Due to the large number of military technical ATS facilities and today's relatively short inspection intervals, improved and/or new flight inspection methods will also be interesting from an economic perspective.

REFERENCES

1.- ICAO Annex 10, «Aeronautical Telecommunications Vol I Radio Navigation Aids»

2.- NATO Standardisation Agreement (STANAG) No. 3374 «FLIGHT INSPECTION OF THE NATO RADIO/ RADAR NAVIGATION AND APPROACH AIDS -AetP-1 (B)»

3.- NATO Standardisation Agreement (STANAG) No. 4533 «PRECISION APPROACH AND LANDING SYSTEM (PALS) STRATEGY»

4.- NATO Standardisation Agreement (STANAG) No. 4565 « PALS AIRBORNE MULTI MODE RECEIVER»

ANNEX

Selected technical data:

ASR

Aerodrome Surveillance Radar (ASR-910)

Detection and display of aircraft

TX-frequency	2,7 - 2,9 GHz
TX-peak power	> 500 kW
TX-average power	> 525 W
Range	60 NM
Antenna speed	13,5 ± 1,5 Upm
RX-sensitivity	> - 110 dBm
Range resolution	> 500 ft
Angle resolution	> 1,55°
Manufacturer	Raytheon Company, Boston, MS, USA

SSR

Secondary Surveillance Radar (SSR)/ Identification Friend or Foe (IFF)

SSR/IFF-Interrogator 1990 D1 / D9

Identification of aircraft and height information

TX-frequency	1030 MHz
TX-peak power	70/400/800/1600 W
RX-frequency	1090 MHz
RX-sensitivity	> - 84 dBm
Range	120 NM
Manufacturer	Siemens, Germany

TACAN (fixed)

TACtical Air Navigation (TACAN FTA-43)

Bearing and distance information

TX-frequency	962 - 1024 MHz 1051 - 1213 MHz
TX-peak power	3 kW
RX-frequency	1025 - 1150 MHz
RX-sensitivity	> - 92 dBm
Range:	200 NM
Bearing accuracy	± 1,5° until 130 NM ± 2,5° beyond 130 NM
Range accuracy	± 0,12 NM + 0,05% of distance until 65 NM ± 0,17 NM + 0,05%

	of distance beyond 65 NM
Manufacturer	Standard Elektrik Lorenz AG, Germany

TACAN (mobil)

TACtical Air Navigation (TACAN AN/TRN-26)

Bearing and distance information

TX-frequency	962 - 1024 MHz 1051 - 1213 MHz
TX-peak power	400 W
RX-frequency	1025 - 1150 MHz
RX-sensitivity	- 90 dBm
Range	> 35 NM
Manufacturer	Montek, LTV, USA

PAR

Precision Approach Radar (PAR-80)

Guidance of aircraft for final approach

TX-frequency	9,0 - 9,2 GHz
TX-peak power	150 - 180 kW
RX-sensitivity	> - 100 dBm
Range	10/20 NM
Azimuth scan	- 15,5° - + 15,5 °
Elevation scan	- 1,7° - + 6,7°
Manufacturer	ITT-Gilfillan, Los Angeles, CA, USA

ABBREVIATION LIST

ASR	Aerodrome Surveillance Radar
ATC	Air Traffic Control
ATS	Air Traffic Service
CNS	Communication, Navigation and Surveillance
DGPS	Differential Global Positioning System
FII	Flight Inspection International
GLS	GNSS-based Landing System
GPS	Global Positioning System
IFF	Identification Friend or Foe
ILS	Instrument Landing System
MLS	Microwave Landing Systems
NATO	North Atlantic Treaty Organization
NDB	Non-Directional Beacon
NPA	non-precision approach
PALS	Precision Approach and Landing System
PALS	Precision Approach and Landing System (NATO)
PAR	Precision Approach Radar
SSR	Secondary Surveillance Radar
STANAG	Standardization Agreement (NATO)
TACAN	TACtical Air Navigation
UHF DF	UHF Direction Finder

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REAL TIME «ON-BOARD TO GROUND» CURVES TRANSMISSION

ABSTRACT

For several years, the main objective in flight inspection was to improve the implementation, availability and accuracy of the trajectography system. SFIM industries solved this problem with the CARNAC 21(*) flight inspection system more than 4 years ago and, as a result, ASECNA has asked SFIM industries to develop a new functional feature to improve the partnership in flight inspection with airport maintenance teams: The real time «on-board to ground» curves transmission.

Real-time transmission to ground of all acquired and calculated curves and parameters will enable the navigation aid maintenance to monitor all measurement operations carried out by the flight inspection system.

This function does not only considerably improve the dialogue between the airport maintenance and the flight inspectors, it also reduces the time required by the maintenance team for beacon tuning.

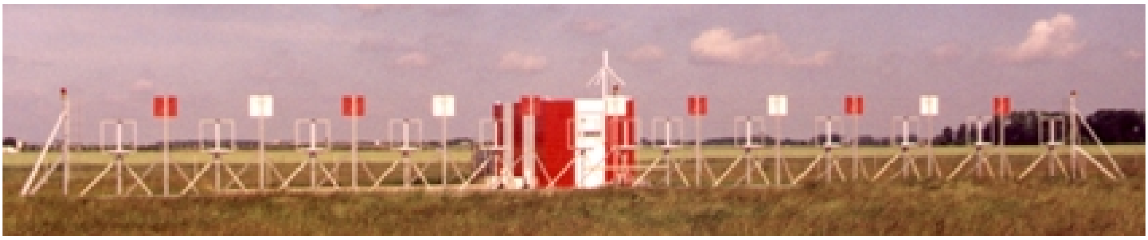
Furthermore, the ground engineer permanently receives information on the aircraft position, avionics instruments, and various representations of the runway during flight inspection depending on the beacon to check and the selected sub-function.

Lastly, continuous and real-time complete display of curves and parameters does not call for any action by the maintenance team and, consequently, no training is required.

This paper describes the objectives, the concept, and the technical characteristics of this new functional feature.

(*)«**CARNAC**» is an acronym for: **C**alibration des **A**ides **R**adio à la **N**avigation, à l'**A**tterrissage et aux **C**ommunications. (Calibration of Radio Aids for Navigation, Landing and Communications).

Figure 1: LOCALISER



During the flight inspection of ILS and VOR radio navigation aids, some inspections run with beacon tuning require continuous dialogue between the ground maintenance team and the flight inspector. As this dialogue between the on-board and the ground team is limited to a simple conversation with a VHF transmitter, it becomes more and more necessary to improve this aspect of flight inspection both in terms of quality and quantity to answer the most important leitmotiv of the 21 century: **save time while increasing the quality of the service.**

The « on-board to ground curves transmission » function is dedicated to these objectives.

CARNAC 21 growth capability allows all the acquired on-board data to be continuously transmitted in real time during the flight inspection, without affecting any of the current performances of the system (fully automatic FIS, very precise D-GPS trajectography up to Cat III, results and reports immediately available...).

- First of all, data are acquired by the acquisition unit (FDAU) which has already been used for commercial flights by more than one hundred airlines.

- A UHF data link transmits these data to the ground station.

- The ground computer which uses the same algorithms as the on board flight inspection system then processes these data in order to plot the same curves appearing on the plane's screen onto the ground display in real time.

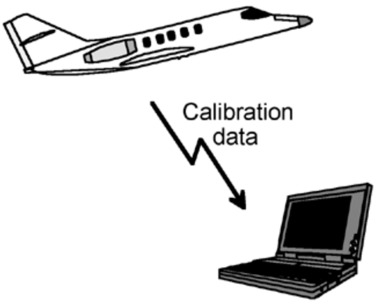


Figure 2: Concept - real time «on-board to ground» curves transmission

- Furthermore, the flight inspector continuously controls the ground computer so that he can define and control all the parameters which characterise the curves (type, scale, ...). This additional possibility allows the flight inspector to optimise the quality of the information in accordance with the needs and the technical environment of the mission.

- Of course, the aircraft trajectography information (instruments, mapping...) is also available on a second window, should the ground engineer wish to consult it.

- Therefore, this new equipment enables the ground engineer to check the effects of the tuning carried out on the beacon, to continuously know the aircraft's position and to **considerably improve dialogue with the flight inspector.**

Lastly, the set up is so easy (antenna connection, power on, only one function key needed to toggle between Mapping display and curves) that **the maintenance team needs no special training.**

During the mission's set-up phase, the flight inspector selects all the parameters which are used by the « on-board to ground curves transmission » function. This configuration is defined by selecting in scroll boxes. Of course, all the parameters can be modified quickly during the flight inspection.

The system is installed in the ground shelter of the beacon to be calibrated by simply connecting the power supply and the UHF antenna.

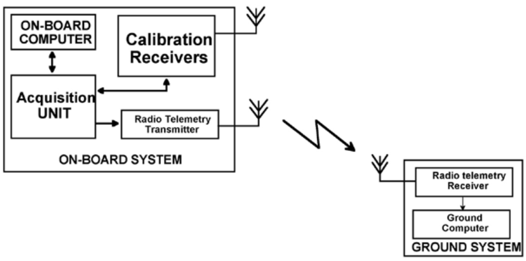


Figure 3: General block diagram

The ground engineer starts up the equipment by using the power on switch, and then uses only a simple key to toggle between the real time curves plotting and the aircraft path.
As the data transmission is in real time, the beacon tuning modify instantaneously the curves and the parameters selected by the flight inspector and displayed on the ground system.

Thanks to a permanent access possibility to the configuration menu of the « on-board to ground curves transmission » function, the flight inspector can modify the parameters and the curves which are displayed on the ground system in accordance to the needs of the mission.

The ground engineer who tunes the beacon has one window which shows:

- Either real time curves plotting of the tuned parameters

- Or aircraft moving on a map with instruments

This equipment runs automatically, because it is controlled by the aircraft flight inspection system. The ground engineer need only select the window: either the one with the curves or the one with the mapping and instruments.

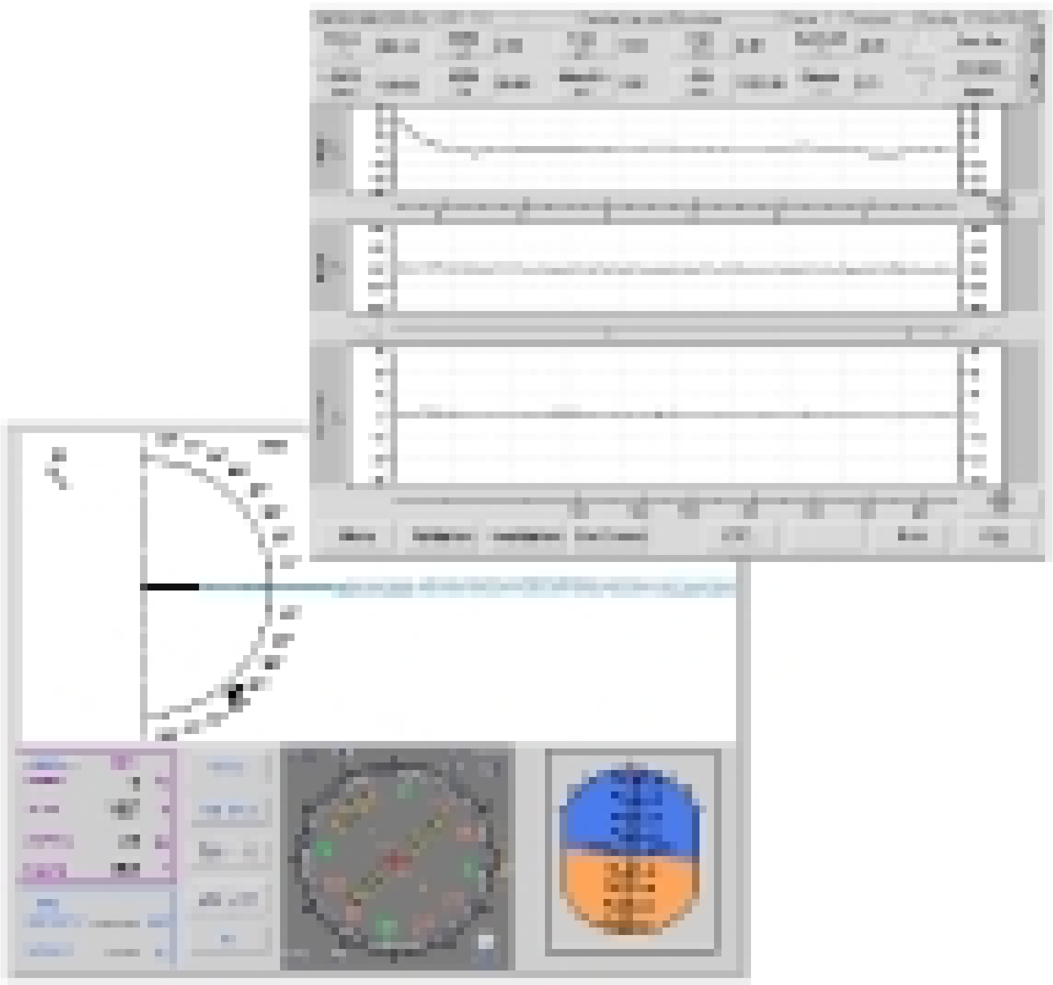


Figure 4: Ground operator display

This equipment is used during ILS and VOR flight inspections when ground beacon tuning is necessary.

After the power has been switched on, the system starts automatically at the beginning of the mission. For each new run, the curve plotting starts and stops automatically.

In the aircraft, the flight inspector can, at any time, consult his display to see the curves being transmitted to the ground system and modify the parameters and scales in real time.

TECHNICAL CHARACTERISTICS

The aircraft flight inspection system sends data to the ground equipment with a data link.

Figure 5: Ground container

The ground equipment is fitted into a suitable container including:

- A portable computer with an LCD display
- A 9600 baud data-link receiver
- A UHF antenna.

General specifications

Power requirements: 110/220 V AC
80 W

- Dimensions (Width, height, depth):
  470 x 260 x 320 mm
  185" x 102" x 126"

- Weight:
  Container : 10 Kg (22 lbs)
  Antenna with tripod: 8 Kg (18 lbs)

Environmental characteristics

- Temperature: 0°C/+ 40°C operating
  (- 20°C/ + 70°C storage)

- Altitude: 20 000 ft operating
  (40 000 ft storage)

- Humidity: 95 % RH at 40°C

Performances

- VOR / ILS software with two windows:
  - Curves and parameters
  - Map with instruments
- 1 Hz data update
- Range up to 8 Nm.

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FLIGHT INSPECTION DATA DOWNLINK.
11th IFIS

ABSTRACT

The engineering and commissioning of radio navigational aids such as ILS is a team effort between the flight inspector and the ground equipment engineer, a task complicated by the physical separation of the two participants.

The Flight Inspector has all of the performance data of the aid available to him in real time; he must then communicate this to the ground engineer to enable adjustments to be made to optimise the system.

Sponsored by a major customer, FPL has worked with Aerodata to develop a system to present flight inspection data directly to the ground equipment engineer in near real time. This allows the ground engineer to see the results of his adjustments immediately, improving both the effectiveness of the engineer, and the quality of the navigation aid. In addition, this system helps minimise the flight inspection flying, and consequent delays to scheduled air traffic.

This paper details the development of that system, looks at applications, benefits and possible future enhancements.

BACKGROUND

Discussions with customers led FPL to investigate the possibility of providing flight inspection data to ILS ground engineers in near real time. It was intended to demonstrate the system at the 11th IFIS, but for commercial rather than technical reasons, the project has been delayed.

CONCEPT

The flight inspector has a multitude of information available to him during the course of the flight inspection. To enable the engineers on the ground to adjust the system for optimum performance, the flight inspector must relay this data. In the case of absolute figures i.e. sdm and RF coverage, then RT communication is sufficient. For optimisation of aerial phasing or path structure, it is difficult to communicate an onscreen graphic verbally over an RT link. For this reason, FPL proposed to send data over a telemetry link in near real time, such that the ground engineer could observe the graphical plots, enabling him to make adjustments and see the effects immediately.

TECHNICAL DESCRIPTION

Initial system design is for ILS data, but the design allows for future expansion to incorporate other radio navigation aids.

Data from the flight inspection system is encoded, and transmitted by a simplex UHF telemetry link.

The ground system consists of a radio-modem, and a laptop PC.

Diagram 1

Overview of the Data Downlink System showing major components.

The design considerations made included the following main points:

- The system should be fully portable, and require no input except power.
- The ground PC should operate a standard Microsoft Windows operating system.
- The ground system should require little training in operation.
- The ground system should require no user action after initialisation, but be capable of customisation.
- All hardware should be ‘off the shelf’.

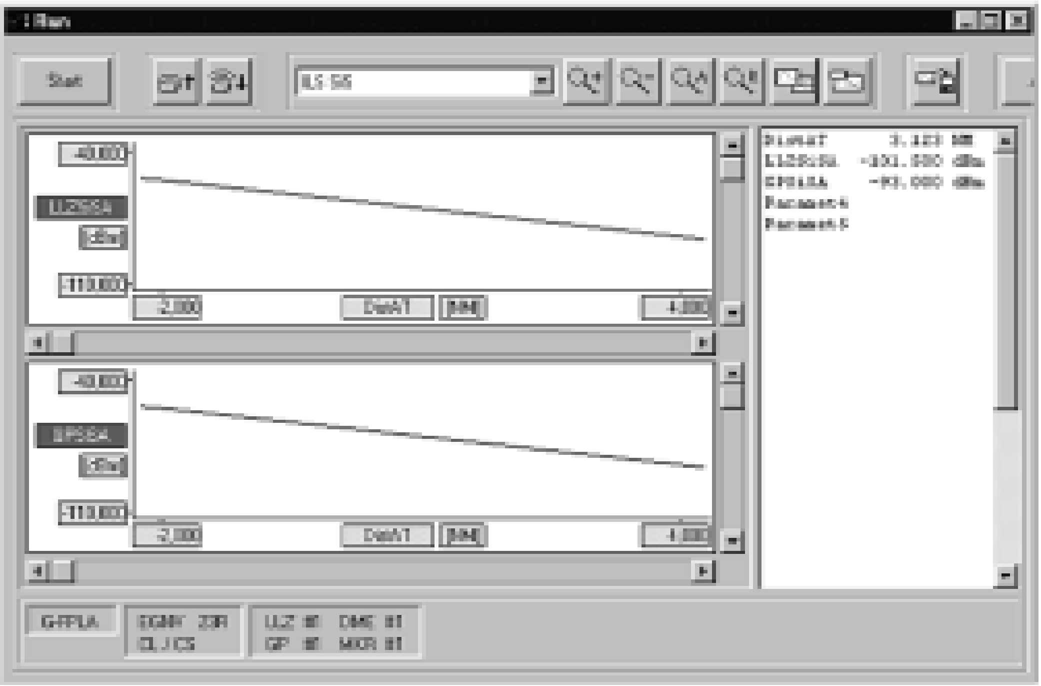
* Hard copies of the screen should be available.

- There should be a facility to save data to disk for later analysis.

To achieve the above criteria, the following solution was researched. The telemetry link is unidirectional using UHF radio modems. This does not allow the use of handshaking but CRC protection is used to flag ‘bad’ data. The data rate is 4800 baud. This allows the transmission of 9 parameters at 2Hz, and 2 parameters at 5Hz, which, together with the control data occupy 75% of the available bandwidth, allowing inclusion of additional parameters as required.

A header block is transmitted at regular intervals interlaced with the data blocks, and is used to configure the ground system without operator intervention.

The ground system acts as a dumb terminal. This is hosted on a laptop PC running MS Windows NT4 or 98. Once the program is initialised, it waits to receive data from the flight inspection aircraft. Once data is received, the first header block to be decoded will set the configuration of the ground system, to include software version number, Facility ID, Profile, Time and default graphic display. Data is only transmitted during the manoeuvre, and for a short period after, this is automatically detected by the ground system.



<u>Diagram 2</u>
Data Downlink PC Display

For ILS, the following parameters are transmitted during manoeuvre:

- Aircraft Range
- Aircraft Height
- Aircraft Bearing
- Localiser Deviation
- Localiser RSL
- Localiser sdm
- Glidepath Deviation
- Glidepath RSL
- Glidepath sdm

These are transmitted at a rate of 2Hz, additionally the following parameters are transmitted at a rate of 5Hz;

- Localiser Error (structure)
- Glidepath error (structure)

All parameters are displayed in an Alphanumeric window, with any two parameters being selectable for display as graphics.
At the end of an approach manoeuvre, the recalculated ILS structure is transmitted at an equivalent data rate of 10Hz, together with ICAO tolerance lines.

All of this data is stored to the PC hard disk for later analysis. The data will remain on screen until such a time as the flight inspector initiates another manoeuvre.

With this information on the PC screen, the ground systems engineer is able to see the results of adjustments immediately, and so better optimise the facility.

The ground engineer can obtain a hard copy printout of the screen to any suitable printer, thus enabling him/her to keep a record of the information presented for later use or comparison.

The system has thus met the design criteria from the customer's point of view. An additional facility designed from inception is the ability to add a modem and GSM telephone to the ground system. This gives the ability to display the information in real time on a suitably equipped PC and Modem anywhere in the world. This opens up many exciting possibilities.

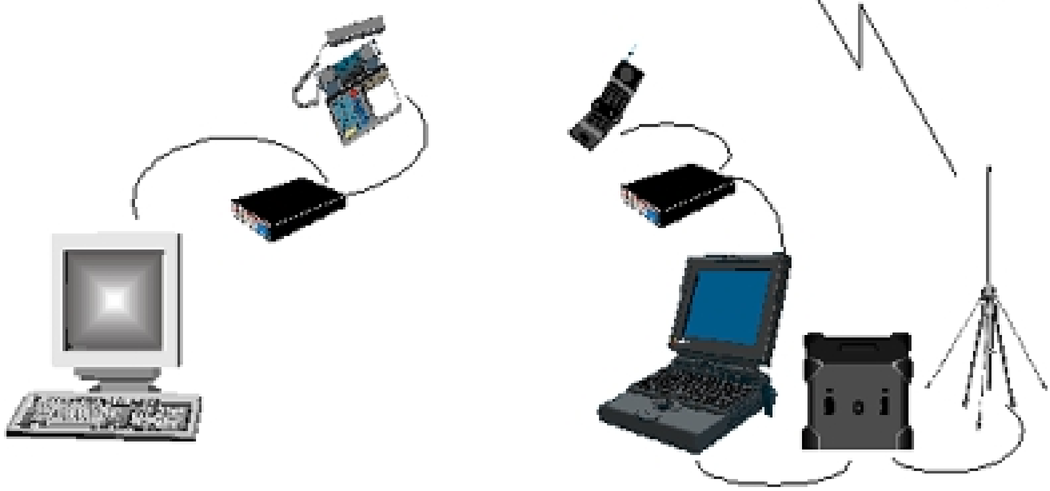


Diagram 3
Forwarding of downlink data to remote PC

Future enhancements being considered are:

Addition of MLS functionality.
Addition of VOR/DME functionality.
Additional parameters.
Data Compression.
Storage of user defined graphics.

CONCLUSIONS

FPL believes that this is a way forward, utilising technology that is now available to us in order to benefit both the customer and the end user. The customer benefits by having the necessary information available to him to set up the facility for optimum performance, and the end user benefits by receiving a better navigation service.

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