14ème/14th SIIV IFIS
Toulouse-France 12-16 Juin/June 2006

Remote Flight Inspection of Enroute Facilities

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ABSTRACT

Remote Flight Inspection allows for a flight inspection of VOR/DME/VORTAC Enroute Beacons to be performed without the need for ground technical personnel to be positioned on site, the aircraft to land and the deployment of equipment.
All transmitter adjustments, standby transmitter change over and monitor resets are performed using a digital communication link from a remote location, some distance away from the beacon under inspection. The Flight Inspection System (FIS) uses GPS technology as a reference system for accurate measurements. The net result is that multiple facilities may be flight inspected during a single mission flight at a lower cost and with minimal technical personnel.
This is only achieved with the use of modern technology, good co-ordination and excellent communications.
The South African Civil Aviation Authority has recently performed a number of Flight Inspection test trials to find an optimum procedure in which to execute Remote Enroute Flight Inspections. Final implementation date is planned for July 2006.
The following paper will discuss the test trials performed, technical problems encountered and how solutions were implemented.

INTRODUCTION

In the Republic of South Africa from 1958 to 2001, all VOR, DME and TACAN beacons required the CAA (Civil Aviation Authority) to positioned the traditional theodolite very close to the facility during a flight inspection check. At least three people were deployed to the site i.e. Theodolite Operator, Ground Technician and Flight Inspector. In addition if it were an en-route facility, distances of up to 800 Km had to be traveled by road thus requiring at least one day to complete a single VOR calibration check.
In 2000, both the CAA and the ATNS (Air Traffic and Navigational Services) Company embarked on a complete modernization program for the replacement of all navigational equipment including replacement of flight inspection equipment.
One specific requirement was to investigate the feasibility of performing an enroute VOR/DME flight inspection check remotely.

METHOD

The method decided was that the flight inspection aircraft equipped with the new Sagem CARNAC 21 FIS (Flight Inspection System) would use the GPS as the reference position system whilst the VOR technician remains at the allocated control center using a digital interface to make all the necessary VOR adjustments for routine checks.
For enroute facilities, stand-alone GPS positioning was found to be accurate enough to be used as a FIS reference position system. The accuracy in the horizontal plane was found to within 10 meters, adequate for VOR/DME flight inspection. The FIS continuously indicates GPS accuracy and insufficient accuracy warnings to the Flight Inspector. Should the GPS accuracy diminish during the orbit check, the Pilot simply extends the aircraft orbit radius until the correct prerequisite accuracy is acquired. There is no longer a need to set up any auxiliary ground equipment or personnel at the facility under inspection.
The VOR/DME replacement program technical specifications required that all new VOR/DME must have a digital interface to allow for all necessary transmitter adjustments including transmitter standby changeover and monitoring. After initial installation and commissioning no further adjustments were to be made manually. The VOR/DME technician is then able to make all the necessary flight inspection adjustments remotely over a digital communication line using a laptop computer from his/her stationed control center.
With an established digital communication to the VOR/DME and a VHF voice communication link between the aircraft and control center, flight inspection of an enroute facility is possible using the CARNAC 21 Flight Inspection System. The flight inspection aircraft simply flies to the VOR, competes the flight inspection check without landing and continues to complete the rest of the mission. There is no need for any personnel and equipment to be deployed on site.
Using this method, the CAA is able to comply with all the ICAO recommended requirements for a routine VOR/DME.

VOR/DME EQUIPMENT

The Thales VOR/DME 400 series was chosen with an extra 8-point external ground monitoring facility to ensure integrity of all Conventional VOR's. The reason for the extra monitoring system is that a ground-check can be performed remotely. A monitor antenna is placed every 45º around the VOR counterpoise. Only one monitor controls the VOR and the other seven provide warning indications. The monitor displays the following VOR parameters: Azimuth (bearing), RF Level, 30Hz FM Modulation (FM Index), 30 Hz AM Modulation and 9960 Modulation.
Doppler VOR's do not need an extra monitor system as ground checks can be perform internally by antenna switching.
The following options were investigated for the digital communication link to interface the VOR/DME to the control center:
1.**Telephone landlines** - using a dial up modem and RS 232 communication proved successful but slow, expensive and sometimes unreliable in remote areas.
2. **Cellular communication** – using the GSM modem and GPRS communication was faster, more reliable but not all facilities are serviced because of their remote location.
3. **Satellite communication** – a new development using V-SAT (MRSAT) and LINEX MCS software. This advancement will be network based using the ATNS LAN network. It allows all the VOR/DME to be monitored throughout South Africa at the different control centers but will be password controlled to specific users for maintenance and flight inspection purposes.

Besides the Thales 400 series the following VOR/DME equipment with software upgrades have the capability to comply:
1. SEL 4000 Series VOR/DVOR
2. Alcatel 400 Series VOR/DVOR
3. FACE 15/45 DME
4. FACE TACAN – limited capability
5. Thales TACAN – new development

AIRCRAFT COMMUNICATIONS

One the biggest problems encountered was a voice communication link between the Flight Inspector in the aircraft and the VOR/DME technician at the control center. A number of options were experimented included cellular communication but the most reliable was found to be VHF communication.
Permission was obtained from the relevant authorities for the use of cellular phones in flight. No interference with the aircraft systems was detected but special precautions remain in place whenever cellular phones are used. Unfortunately not all VOR/DME facilities have cellular coverage and an alterative solution had to be found?
South Africa has 100% VHF coverage with a complete standby system. Most VOR/DME sites have a VHF forward relay facility positioned in the near vicinity. The redundant standby system has the capability to select a different VHF frequency channel to the allocated VHF Area Frequency. At the control center, the technician selects the dedicated flight inspection frequency on the standby VHF system to ensure communication to the aircraft.

VHF voice communication is the preferred mode of communication but its use requires extra planning. Cellular communication is used as a backup system and should that fail the allocated area VHF frequency can be used to communicate with control center.

SPECIAL PROCEDURES

A number of new procedures were introduced to accommodate the new method of calibrating enroute beacons remotely. These procedures are strictly adhered to as not to compromise the integrity of the mission and to reduce overall risk.

1. Data recording of all VOR/DME transmitter and monitor parameters before and after the flight inspection check. All flight inspection data obtained from the FIS is downloaded and logged on to CD format. Date and time is used as a reference. All recorded information must be electronically archived for a minimum of 3 years.
2. Careful planning and co-ordination between Flight Inspector, Air Traffic Control and VOR technician.
3. The digital communication link to the VOR/DME is to be check and tested before the flight may proceed.
4. The VHF communication link is to be checked and tested before the flight may proceed.
5. No changes to the routine VOR procedures except that the orbit profile may be extended due to GPS accuracy and altitude restrictions.
6. Special in-house precautions to be implemented when using cellular phones in aircraft.

TEST TRIALS

The first test trial in 2004 was performed out of necessity, as the VOR technician was unable to make a scheduled time rendezvous for the Alexander Bay VOR (ABV) flight inspection due to a traffic incident. Cape Town, some 600 Km away, was the nearest control center.

Arrangements were hastily made to perform the flight Inspection remotely. A dial up modem was used as the digital interface between Cape Town and the ABV VOR. Cellular transmission was used as the voice communicator. The mission was successful but showed the need to replace the dial up modem, as it was slow and unreliable due to the poor quality of the telephone lines in rural areas.

Further test trials with the South African Air Force (SAAF) proved that the cellular GSM GPRS modem as more efficient.

In Bloemfontein 2005, the VHF voice communication was tested for the first time and proved successful from the outset. We no longer had to deal with bad reception and the competing cabin noise associated with cellular communication.

The test trials proved that remote flight inspections of VOR/DME are effective and feasible without any safety implications. With time, the process will become more streamlined as more technicians are trained and confidence levels increase.

ADVANTAGES

Many advantages can be achieved using the remote calibration method:

1. Multiple VOR/DME flight inspections may be performed on a single flight mission using only 1 VOR/DME technician. On an airway route up to 3 VOR/DME's may be calibrated in succession.
2. Greater flexibility in scheduling flight missions. If unexpected weather or ATC restrictions do not allow for the inspection of a specific VOR/DME, will not result in the cancellation of flying activities for the day. An alternative VOR/DME may be the flight inspected with minimal disruption.
3. Less personnel as only 1 VOR/DME technician is needed in the control center.
4. Time wastage kept to a minimal as there is no longer the need to travel. The added risk of having an accident on the road is negated.
5. Economically savings of up to 25 percent can be achieved due to less flight time of aircraft, traveling cost to site and reduction of personnel.
6. On completion of a mission, all reports and paperwork can be dispatched immediately to the various sections.

IMPLEMENTATION DATES

Full implementation of the remote calibration method for civilian beacons is July 2007, once all the new VOR/DME are commissioned and found to be compliant. The remote calibration method is not used for commissioning purposes because ground equipment has to be deployed, as stand-alone GPS is not used for certain checks.

In 2008 military beacons will become compliant, as it is envisage that the present VORTAC network, which allows only for TACAN standby transmitter changeovers, is to be replaced and made compatible with the civilian navigation network.

Towards the end of 2007 this method may be extended to both terminal VOR/DME and ILS. The ILS system would need an additional interface to accommodate the digital link from the control center. This will allow for greater flexibility when multiple systems are flight inspected at a single airport.