Experiences in Performing Flight Inspection with Rotary Wing Aircraft

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BIOGRAPHIES

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ABSTRACT

Flights following instrument flight rules with rotary wing aircraft are growing in aviation. These flights could be private flights with helicopter, which raises in popularity these days, but more important are flights concerning search and rescue, ambulance and other emergency situations. In addition, the commercial market for rotary wing flights to platforms, dedicated hotels, hospitals or different fixed heliports is increasing.
Due to these GPS based procedures for landing and enroute navigation for helicopter are expanding tremendously. Flight validation and flight inspection of these new procedures for rotary aircraft is compulsory. First attempts of performing flight inspection of these procedures with fixed wing aircraft ended up in problems through steep and narrow approaches on hospitals in populated areas. Out of such adventures a new kind of flight inspection executed by helicopter was born. Completely new challenges needed to be resolved and new techniques were required to be developed.
This paper summarizes experiences, practices and requirements regarding flight inspection with rotary wing aircraft. It evaluates the hard- and software necessities to perform procedure validation and highlights the challenges and pitfalls with such flight inspection helicopter. Examples of existing flight inspection helicopter are presented and explained. The corresponding results of these procedure validation flights are examined in detail and evaluated in comparison to normal flight inspection constraints.

INTRODUCTION

Since helicopter operation in aviation is increasing in situations like ambulance, search & rescue or private use, RNAV procedures for helicopter are getting more and more important. These procedures must be validated same as procedures for fixed wing aircraft, while a validation by fixed wing aircraft is difficult or even impossible. There are many differences in operation, like steep angles, speed, maneuverability and flyability, which make it clear, that many helicopter procedures must be evaluated by helicopter.
Therefore, the main focus for a helicopter flight inspection system is the RNAV procedure validation, which defines the basic equipment for such a system:

- GNSS receiver
- Attitude sensor, e.g. IMU
- Real time computer
- Operator computer
- Software

As additional equipment, a FIS Communication radio is possible, used to check coverage to ground operators like ATC.

While the focus of every helicopter flight inspection system is the procedure evaluation, the requirements of customers may differ, so that different kinds of helicopter flight inspection system configurations are possible.

PORTABLE INSTALLATION

A portable installation maybe required, if the type of helicopter is not finally defined or does not exist.
This could be the case, if e.g. helicopter will be hired for flight inspection or in a bigger fleet no dedicated helicopter exist for flight inspection.
The main requirements for a portable installation are

- The flight inspection system is completely independent from helicopter interfaces
- The type of helicopter is not fixed
- Made for GPS based procedures

An example for a portable installation is the helicopter flight inspection system AD-HeliFIS-0300.
The main items are

- Completely independent from any aircraft interface
- Easy to install GNSS antenna
- Based on portable Aerodata RNAV-FIS
- Portable box with RTS and GNSS receiver with IMU
- Operator laptop
- Portable Cockpit Information Display (option)
- Integrated battery pack
- Software fully compatible to fixed wing FIS software

One of the challenges for a portable system was the installation of the FIS GNSS antenna. Since the antenna must be removable, the installation at the helicopter window was selected.

Figure 1: GNSS antenna in portable installation

For an easy installation, an antenna with RAM ??? system is used. It is easy to connect and remove to and from the window. It is a ruggedized active antenna, capable of GPS L1/L2 and GLONASS L1/L2 and hermetically sealed. The window position needs a good view to the sky and must be aligned to the IMU of the HeliFIS.
A metal-based coating for sun/UV protection or heating wires on window may lead to limited GPS reception. This should be considered on selection of the window position.

The Realtime Interface Unit contains the main elements of the HeliFIS.

It is a ruggedized aluminum box with a shock-mount chassis plate, consisting of

- RTS computer
- GNSS receiver with IMU (Inertial Measurement Unit)
- Power supply (Battery)
- Interface panel

Figure 2: Realtime Interface Unit

It is independent from any aircraft interface like avionics or power. The RTS computer is a modern Aerodata AD-RTS-0100, the GNSS receiver is a Novatel GNSS receiver with integrated Inertial Measurement Unit (IMU). For safety reasons lead-acid batteries are used as power source, instead of Lithium batteries.
The installed battery pack gives an operational time of up to four hours.

After installation of antenna and Realtime Interface Unit, the initial settings must be configured. Heading direction for the alignment of the heading sensor is marked on top of the box. The antenna position in relation to the IMU sensor must be measured and entered to the program in order to perform lever arm corrections. In case the same helicopter will be used again, this data must be setup only once.

The flight inspection software is similar to standard AFIS software. This make it easy to learn and maintain.

Recommended for a portable installation is the portable Cockpit Information Display. It is a 7" or 10 " ruggedized tablet computer with touchscreen control and shows a moving map for the pilot with all necessary information about the current and planned flight profiles.

Figure 3: Toughbook as Moving Map

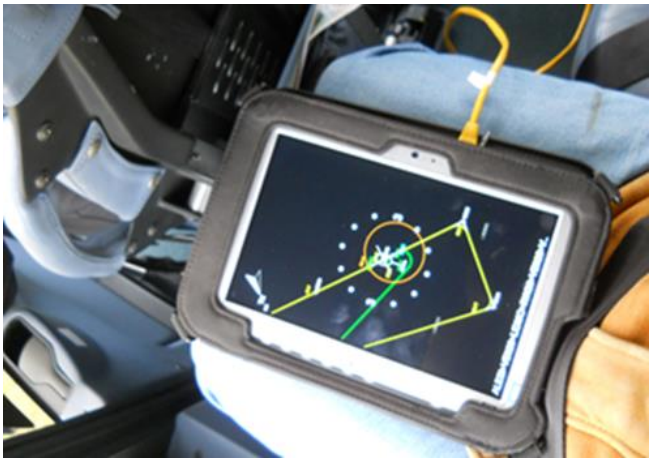

Figure 4: Toughbook used in cockpit

To check the reception of the removable GNSS, antenna check flights in different helicopter types were performed. One flight was done in a Gyrocopter Cladius, another flight in a Eurocopter EC 120B Colibri.

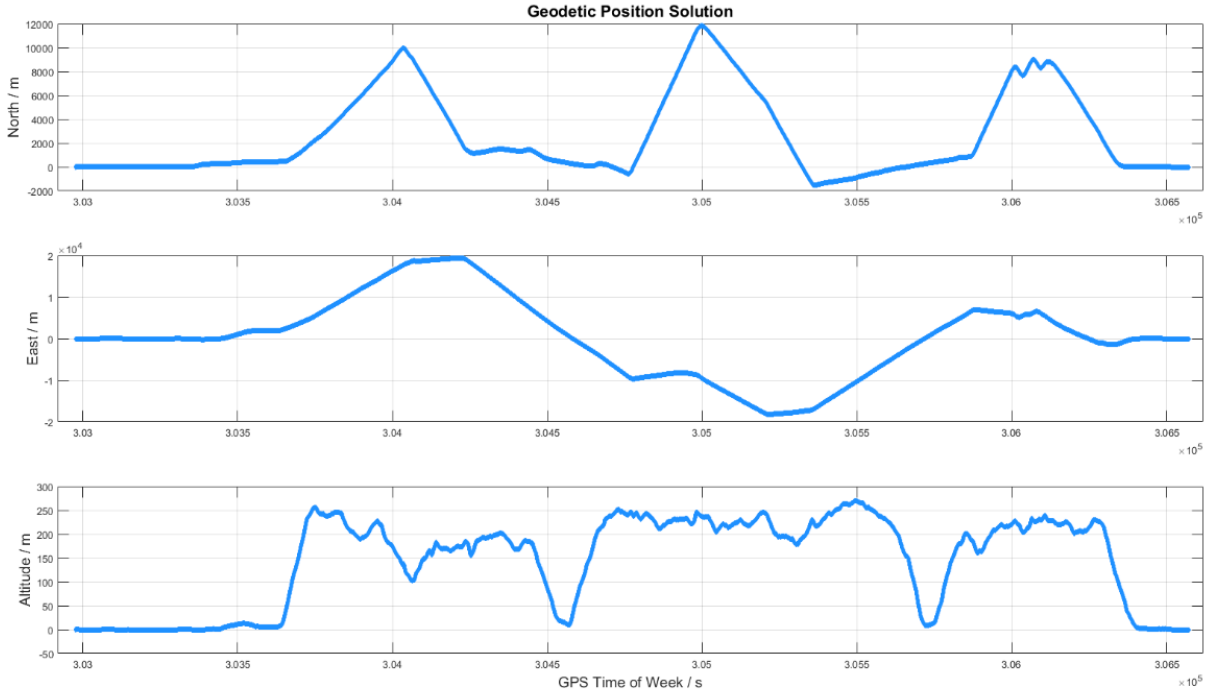

Figure 5: Geodetic Position Solution

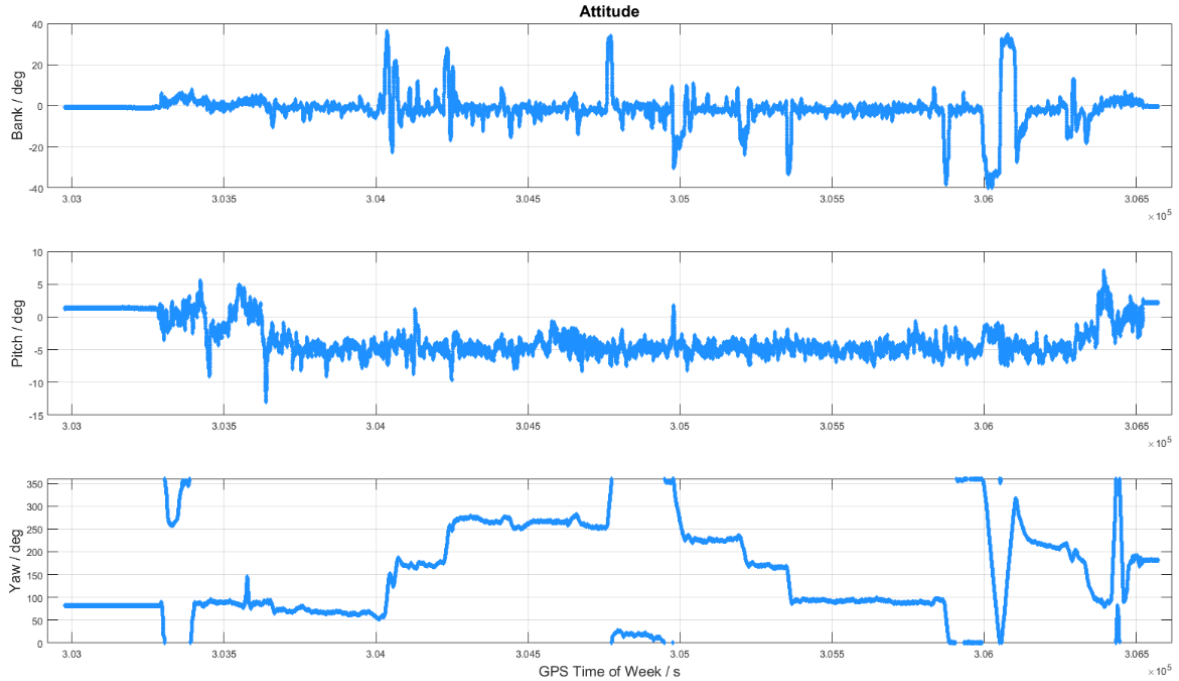

Figure 6: Altitude

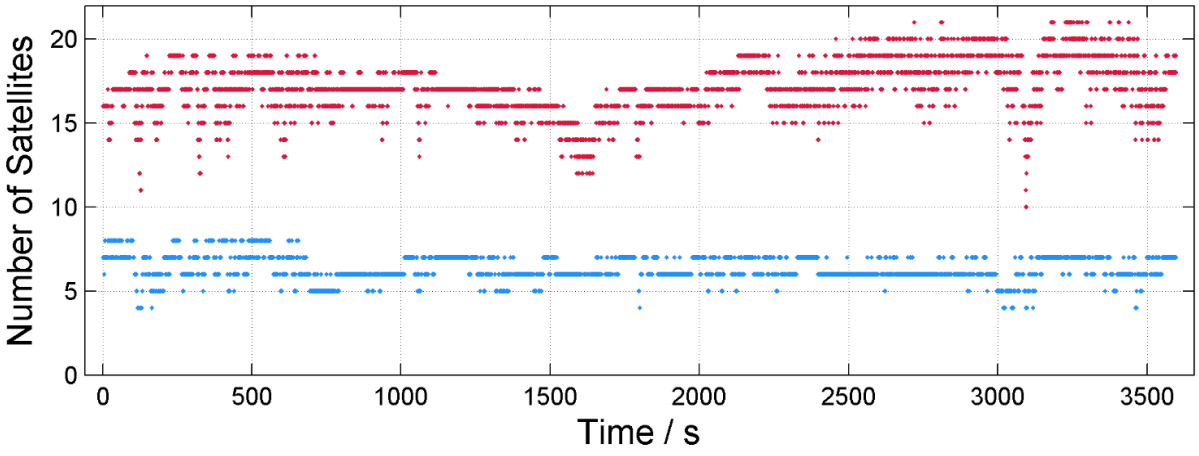

Figure 7: Number of Satellites

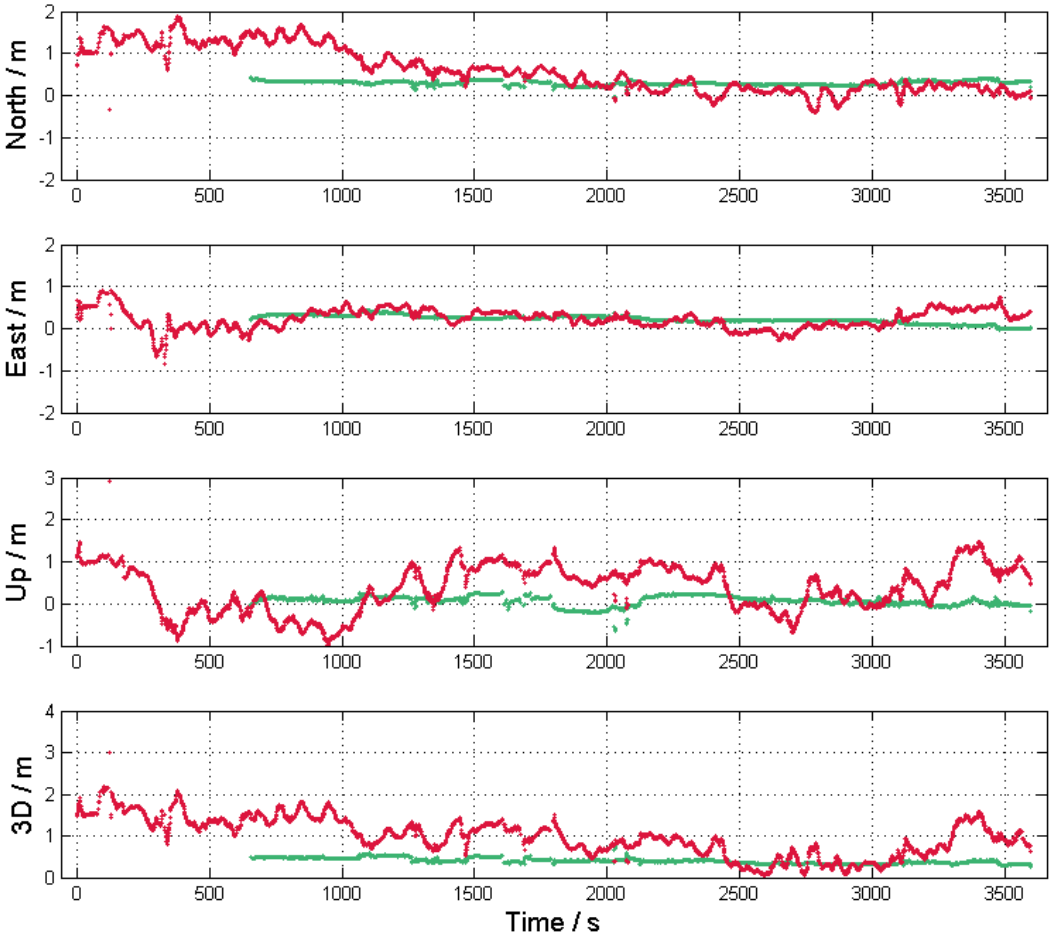

Figure 8: Position Error

During both flights, a good GNSS reception was available. The 3D position according position post processing was around 1.5m.

TEMPORARY INSTALLATION IN DEDICATED HELICOPTER

A temporary installation in a dedicated helicopter may be required, if the helicopter to use for flight inspection is always the same, but shall be used only temporary for inspections. An example for this kind of HeliFIS is the AD-AFIS-0220H.
It is designed for an Agusta AW109SP da Vinci helicopter of the Swiss Air Ambulance REGA, an ambulance helicopter, which is used for emergency medical assistance. It contains a stretcher for the injured person and a monitor for medical control.
If the helicopter shall be used as flight inspection helicopter, stretcher and monitor is replaced by the HeliFIS. This is an easy procedure which the pilot can do even alone.

Since the helicopter is clearly dedicated, it was possible to do fixed installations for flight inspection use.

The FIS GNSS antenna is installed on top of the tail of the helicopter by a Service Bulletin from Agusta Westland.

Figure 9: FIS GNSS Antenna, Side View

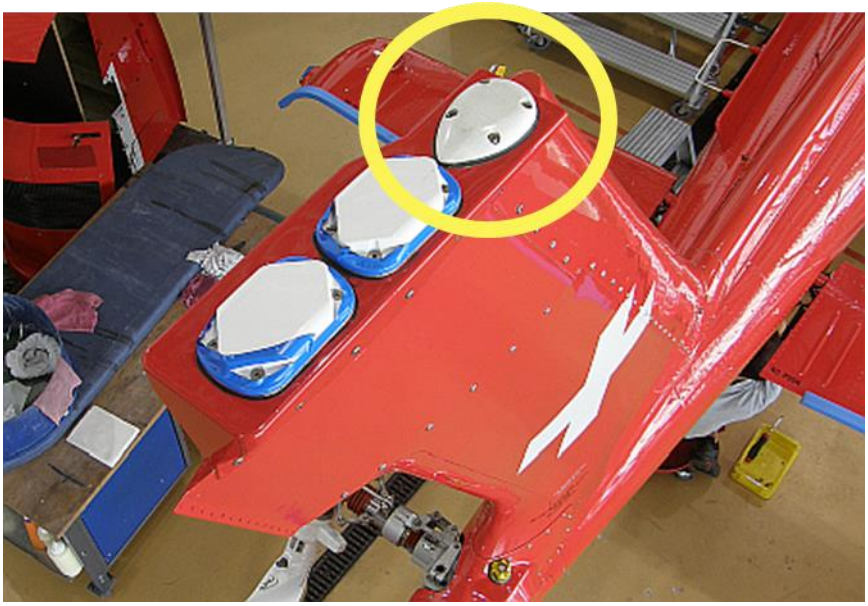

Figure 10: FIS GNSS Antenna, Top View

As VHF/UHF antenna, an already installed antenna is connected to the HeliFIS. The FIS cabinet is using the AD-AFIS-0220 components for fixed wing aircraft and is designed for RNAV/SBAS procedures and VHF/UHF RX ATC coverage checks. Therefore the same AFIS software can be used, which makes training and certification very easy.

Figure 11: FIS Cabinet

Figure 12: Installation of FIS Cabinet

Since all antenna and power connections are permanently installed, it is very easy to install and remove the HeliFIS for operation.

FIXED INSTALLATION

For more frequent use of the helicopter for procedure validation, a fixed installation is recommended. It gives the operator all capabilities and comfort of a fixed wing flight inspection system and provides best performance. Even when it is a fixed installation, it is of course possible to remove the HeliFIS to get a transport configuration for the helicopter by just spending little more effort to the installation procedure.

Example for a fixed installation is the AD-HeliFIS-0200., e,g, installed in a Bell 429.
Designed for

- Flight Validation of Instrument Flight Procedures
- RNAV / RNP / LPV
- GNSS/SBAS evaluation
- NDB calibration

The following flight inspection antennas are installed at the helicopter.

- Fixed installation of FIS GNSS antenna on tail (A)
- Fixed installation of FIS ADF antenna on rear side (B)
- Fixed installation of FIS UHF telemetry (GPSREF) (C)

Figure 13: FIS Antenna Installations

The AD-HeliFIS-0200 Console consist of an Operator Workstation and an Equipment cabinet.

Figure 14: AD-HeliFIS-0200 Console

Figure 15: Installed Console in Bell 429

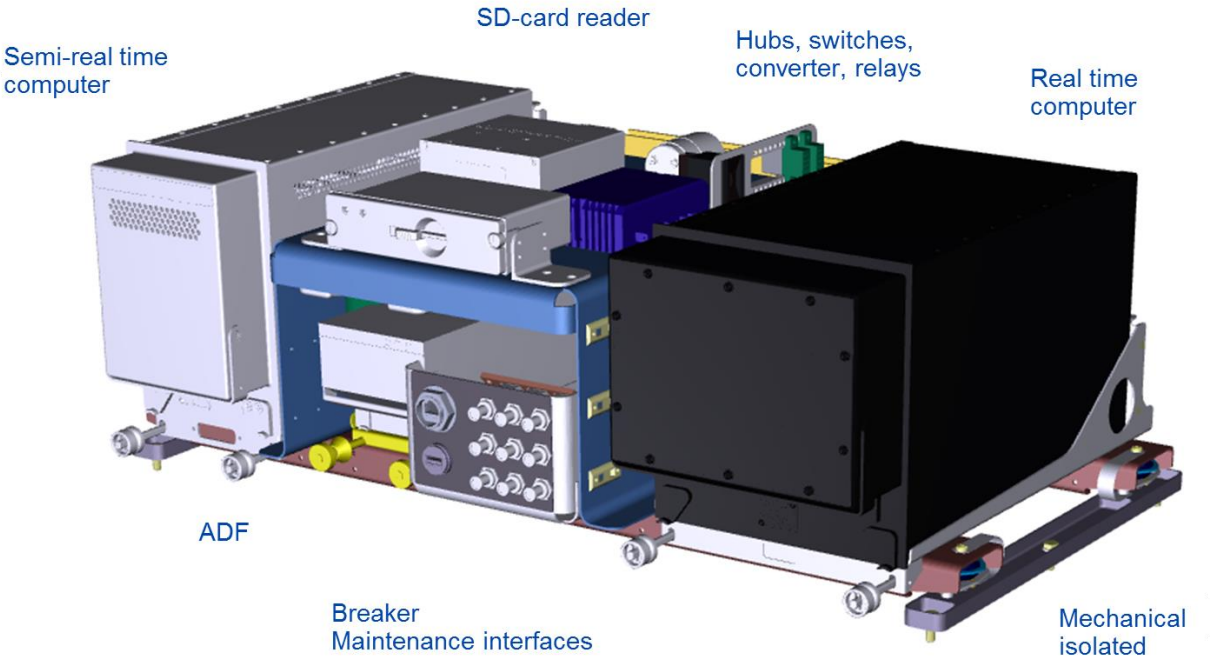

Figure 16: Equipment Cabinet

The equipment cabinet contains semi-real time computer and real time computer as used in fixed wing systems. The software is similar as in fixed wing aircraft installations and is very easy to learn for the operator. It is configured for the flight validation of Instrument Flight Procedures, RNAV/RNP/LPV, and GNSS/SBAS evaluation. With the ADF receiver, also NDB calibration is possible, in respect to limitations due to reflections by the rotor blades.

During training flights in Kediri, Indonesia, the system performance was shown to the operators. The comfortable installation of the flight inspections system and the smooth operation of the Bell 429 helicopter made the procedure validation flights easy and enjoyable.

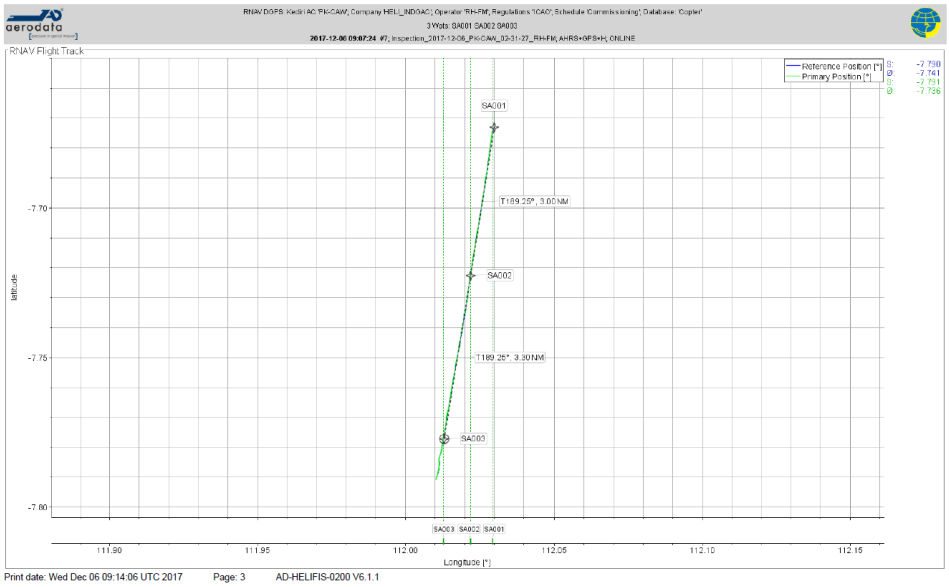

Figure 17: Training Procedure

The results of the flight inspection system are comparable with a fixed wing system. The horizontal accuracy of the primary GPS position was around 15m, which is acceptable for validation flights.

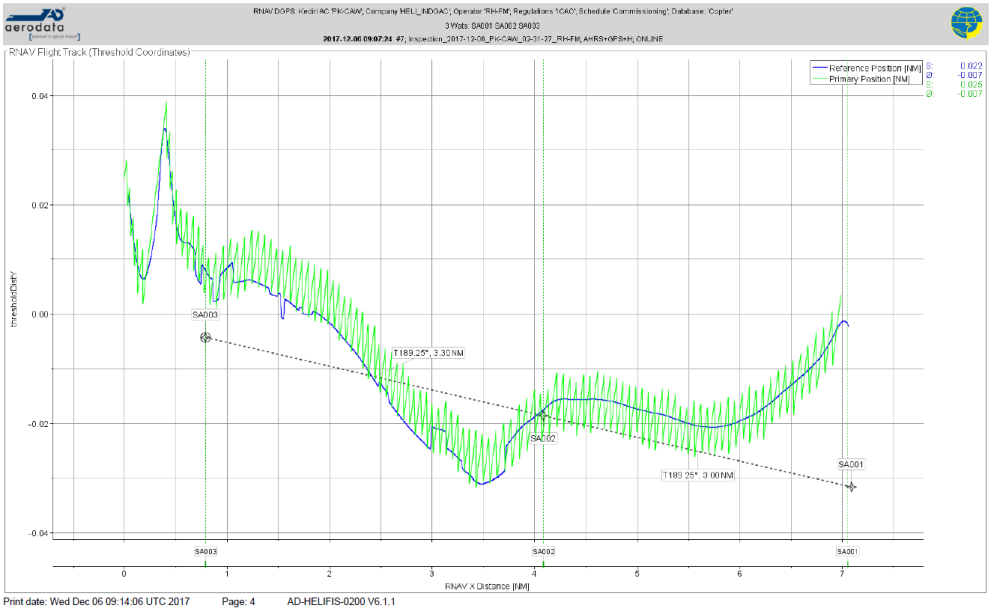

Figure 18: RNAV Flight Track Plot

Figure 18 shows the position as output by the primary FMS and the true or reference position. Steps in the blue reference curve are due to GNSS constellation changes.

EXPERIENCES WITH HELIFIS INSTALLATIONS

The installation of flight inspection systems into helicopter is, compared with fixed wing installations, a quite young part of flight inspection modification. Important aspects regarding limitations and difficulties had to be considered. Weight, safety aspects, certification, accuracy are just some keywords for a few of them.

The evaluation of suitable equipment for portable systems was a new challenge in several aspects

- GNSS antenna
- Position reference accuracy
- Inertial reference system without connection to the Helicopter
- Batteries

The location and installation of flight inspection antennas and sensors had to be checked according influence to primary equipment and by the rotor blades.

Helicopter are a different challenge to vibrating and buffeting than aircrafts.

A design of an ergonomic workstation inside the cabin was made for each type of system, since the space inside the cabin is more limited than in an aircraft.

For all systems, AeroFIS standard software was used to minimize the effort for training or certification.

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