Experience with fixed wing UAV NAVAID's measurements

Biography

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Education:

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Abstract

When the market started asking for drone based flight inspection systems, our expectation was that the easiest way to get approval for such platforms would be to equip them with conventional / proven FI sensors, antennas and positioning technology. The RPAS should be capable to fly conventional flight inspection patterns, to further ease the transition from commonly used flight inspection aircraft to RPAS with regards to local CAA approvals. This strategy ruled out the commonly used category drones of vertical takeoff and landing (VTOL / multirotor). This needed to be based on a fixed wing type, mostly due to the demand for payload size and weight.

This paper details experiences from several field tests on operational ILS and VOR stations with emphasis on the measurement results, RF conditions and comparison to conventional type flight inspection aircraft. It also details some operational- and regulatory aspects worth mentioning from the trials.

Introduction

We see a very clear trend that the interest from the market for RPAS based flight inspection solutions is increasing rapidly. Since 2019 there have been numerous RFI’s, some RFQ’s and even some public tenders already. There is an expectation from the market that the industry already now can provide tested and capable solutions for a price which is extremely competitive to the cost of conventional aircraft, both in acquisition and operational aspects.

As one of the major Flight Inspection Systems providers worldwide, Norwegian Special Mission (and others) was faced with the challenge of creating an RPAS company strategy and how to approach this new and exciting field. It is interesting to see that most other equipment providers seemed to aim for multirotor solutions where Norwegian Special Mission started with larger, fixed wing solutions.

This paper details the experiences we have so far with the fixed wing platform and why we selected this particular platform as our starting point for RPAS based flight inspection. More specifically, Norwegian Special Mission teamed with the Czech Republic company Primoco UAV SE back in 2019 for the development of an RPAS based flight inspection system. Their product, the Primoco One 150 UAV, is a fixed wing RPAS with a MTOW of 150 kg and thereby falls into the Specific category as per EU 945/2019 and 947/2019 directives as well as under STANAG 4703 as per EMAR 21 standard.

TECHNICAL SPECIFICATIONS	ONE 150
Wingspan:	4.85 m
Length:	3.65 m
Maximum take-off weight:	150 kg
Maximum Payload:	30 kg
Range from GCS (without Satcom and relay antennas)	200 km
Maximum distance:	2,000 km
Cruising speed:	100 – 150 km/h
Endurance:	15 hours
Maximum altitude:	3,300 metres (FL100)
Runway length:	500 metres
Navigation system:	GPS/Glonass/Galileo/Beidou / Innertial / Radio positioning
Air traffic control	Transponder S-Mode (ADSB In/Out)
Communication:	Radio Datalink 5 - 6 GHz or Satellite Communication
Equipment:	65 Various sensor (another slides)
Shipping format:	Container 290 x 125 x 100 cm

Figure 1: Specifications of the selected fixed wing RPAS.

Figure 2: The Primoco One 150 with GCS as setup on first ILS test.

Fixed wing vs. multirotor RPAS

General

RPAS – Remotely Piloted Aircraft Systems has existed for more than 120 years since Spanish engineer Quevedo made a simple radio-based control system intended to test airships with the intension of reducing risk for test pilots. However, it is in the last 20 years that the RPAS technology has really advanced, matured, and more importantly, become cost efficient for civilian use. Still, we see that many startups in the RPAS solution / products domain do not make it to the commercial market beyond a prototype stage. Hence, a big challenge for anyone looking for an RPAS based solution is selecting a platform that will be supported in the expected life cycle.

Speaking of life cycle, one may ask what is a reasonable “life expectation” for RPAS today? A well maintained conventional flight inspection aircraft (and system) could see as much as 30+ years in service. Among the RPAS platforms that NSM has cooperated with, no single individual has surpassed 1000 hours of airborne time, yet the Primoco One 150 UAV fixed wing actually come close and probably will cross the 1000 hour mark soon. In order to calculate the life cycle costs, this parameter is extremely important and yet very few can guarantee a typical figure.

One should not forget that also drones need maintenance and inspections. Engines, both piston type as well as electric, will have the need to be replaced at some point. Same goes for servos, batteries, gear, tires and probably airframe too.

In the following sub-chapters, we will talk a little about differences between fixed wing and multirotor RPAS, their strong and weak sides, as we at NSM made our initial RPAS development strategy. We should be clear that Norwegian Special Mission also has delivered solutions for multirotor and are currently working with multiple manufacturers of such platforms. The following explains why NSM started to work on fixed wing platforms as our initial RPAS type.

Endurance, payload and power

The range/endurance is probably the single most significant performance-related difference between fixed wing and multirotor RPAS. Where a fully electric multirotor drone typically has 15-30 mins with payload attached, a piston engine powered fixed wing usually has significantly more, often seen specs exceed 10+ hours of airborne time. The Primoco One 150 used in our trials has a fuel consumption of approx. 3 liters per hour (MOGAS) and is able to stay airborne up to 15 hours. With typical flight inspection pattern work, the effective range would exceed 1500 km (810 NM). Typical cruise speed is in the range 65-75 kts.

A typical multirotor in this segment has an endurance of 30 mins with payload. This limits the useful area of operation down to near-field and slightly beyond the boundaries of the airport. With multiple battery packs and ability to “hot swap” those on the ground, one would be able to fly various patterns, but still limited to a range and profile which is very different from conventional flight inspection patterns / methods.

The choice between fixed wing or multirotor, from an endurance point of view, then comes down to the question of flying beyond the near field area or not.

As for payload capacity, fixed wing RPAS generally has an advantage. The Primoco One 150 UAV has 30 kg available for sensor/systems payload. An option to reduce the fuel tank capacity will enable even more payload. Multirotor and other VTOL RPAS will become very large in order to take a 30+ kg. payload, often exceeding the 150 kg MTOW and thereby fall into a category difficult to operate in civilian airspace.

Figure 3: The planning of payload installation.

Another aspect of payload is the available compartment for sensors – internally or externally on the RPAS. With fixed wing solutions, there is most often an internal payload compartment which has environmental protection. The multirotor RPAS often requires payload sensors to be mounted externally and thereby requires that the units are protected from water/dust etc. to achieve a reasonable IP rating.

The required payload capacity comes down to what type of sensors one intends to attach. Even with 30+ kg payload and a limited compartment space, it was impossible to find a solution that would house enough sensors to cover most or all of the navaids to be inspected. We found the need to separate into mission-specific payloads and created:

a) UNIFIS 1000-ILS: For ILS, VOR and DME inspections.
b) UNIFIS 1000-TCN: For TACAN inspections incl. DME part.
c) UNIFIS 1000-MBR: For multi frequency band radio (V/UHF) COM checks.
d) UNIFIS 1000-VGSI: For Visual Glide Slope Indicators (PAPI etc.).

Another important consideration is the power consumption of the payload. Battery powered RPAS can normally share their main power with payload/sensors, which will reduce the overall endurance/range. By carrying dedicated batteries for the payload, the weight will increase, which also affects endurance and range in the end.

A fixed wing RPAS with combustion engine normally includes a generator. In our case with the Primoco One 150, the generator can deliver up to 400W for payload/sensors.

RF characteristics and antenna pattern

Antenna gain pattern is a graphical representation of the radiation intensity of an antenna as a function of direction. It indicates how the antenna directs the transmitted or received energy in different angles. Antenna gain is a measure of how effectively the antenna converts the input power into radio waves in a given direction. It is usually expressed in decibels (dB) relative to a reference antenna, such as an isotropic radiator or a dipole antenna.

Factors affecting the gain pattern of antennas on aircraft

The perfect antenna for measuring field-strength would be an isotropic antenna with constant gain of 0 dB in all directions, but true isotropic antennas are only possible in theory. Omnidirectional antennas are often used on aircraft for communication and navigation purposes, as they provide a wide coverage area and do not require pointing or tracking. An ideal omnidirectional antenna would have a constant gain of 0 dB in the horizontal plane within a vertical sector.

However, when installed on aircraft, omnidirectional antennas may experience significant variations in their gain pattern due to several factors, such as:

- The presence of the aircraft body, wings, tail, and other structures, which may block, reflect, or scatter the radio waves, creating areas of high and low gain.
- The orientation and position of the antenna on the aircraft, which may affect the horizontal and vertical radiation patterns.
- The movement and attitude of the aircraft, which may change the angle of incidence and reflection of the radio waves, causing fluctuations in the gain.
- The polarization of the radio waves, which may mismatch with the polarization of the antenna, resulting in signal loss.
- The frequency of the radio waves, which may interact differently with the antenna and the aircraft materials, depending on their wavelength and propagation mode.

These factors may cause the omnidirectional antenna to have a distorted or irregular gain pattern, which may affect the quality and reliability of the communication or navigation signals. Therefore, it is essential to test and measure the antenna performance on the aircraft and to account for the possible variations in the gain pattern when designing and installing the antenna.

An example of this is the actual measured NAV antenna gain pattern - when installed on a typical / conventional flight inspection aircraft - which by the antenna datasheet is described as an omnidirectional antenna with gain 0 +/- 2dB.

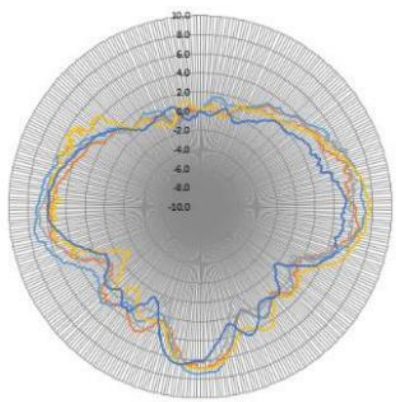

Figure 4 Example of actual NAV antenna gain pattern

The actual gain pattern measured shows variations much larger than 2dB both with respect to azimuth angle, elevation angle and frequency. Since ICAO 8071 Vol I specifies that power density / field strength shall be measured with an uncertainty less than +/- 3dB, these variations in the actual antenna gain pattern must be taken into account by the flight inspection system.

When applying the same antenna on an RPAS that is not made of metal, the ground plane effect may be different from that of a conventional aircraft. The ground plane is the conductive surface that reflects the radio waves and affects the antenna radiation pattern. A non-metallic RPAS may have a smaller or less effective ground plane, which may alter the gain pattern of the omnidirectional antenna. On the other hand, a non-metallic RPAS may also have more flexibility in choosing other types of antennas that may offer better performance, such as directional or circularly polarized antennas. These antennas may not be suitable for conventional aircraft due to certification or installation constraints, but they may be more feasible for drones that have less stringent requirements and lower airspeed. Therefore, it is important to consider the different antenna options and their trade-offs when designing and installing the antenna on an RPAS. A more consistent omnidirectional antenna gain pattern will improve signal sensitivity because antennas are passive and can only adjust / spread gain and not increase the real signal which will also make the measurement system less dependent on direction with less compensation required.

Operational aspects

Perhaps some time into the future, every navaid may have it's small RPAS that will self-launch to make inspection measurements. Until then, we will have to travel to the site, setup our ground station and deploy our RPAS. This is where the smaller multirotor platforms have an advantage over a larger fixed wing RPAS. A typical multirotor system can be transported by a normal car, assembled by one person and requires no runway to take off and land. The Primoco fixed wing platform, as an example, requires a transport van, two people to assemble and 500 meters runway length.

Primoco UAV SE´s Light Unmanned Certificate LUC, as per EU directive 945/2019 and 947/2019 was approved to operate in Czech Republic, Slovakia, Denmark, Germany, Spain and many other countries. The RPAS is allowed to perform any activity within the assigned aggregated risk factor class SAIL II with ARC-b air risk as residual (i.e. in non-segregated airspace), which practically means the RPAS can operate over sparsely populated areas (up to 300 persons per square kilometre). In 2022 the company gained the LUC (Light UAS Operator Certificate) and is entitled to self-regulate the UAS operation with further extension in 2024. The LUC allows to the company to self-regulate its operation much like in any manned-aviation company.

We are now experiencing improvements in the process to achieve flight permits from our very first trials in Czech Republic and Iceland in 2021. The fixed wing RPAS is equipped with ADS-B in/out. Furthermore, the RPAS now has a ballistic emergency parachute which can be deployed in the event of severe bird-strike or other loss-of-control occurrences. This chute significantly reduces the potential impact energy and was an important factor to achieve SAIL II. The RPAS can even be reused after a parachute landing.

Figure 5: Ballistic parachute.

The fixed wing platforms will typically require more airspace than multirotor RPAS. We have even seen RFQ's where it was required to attach safety wire to the RPAS (mooring- or tether system). In this case, the RPAS can only move vertically, but still be used for PAPI / GP measurements. With the fixed wing Primoco UAV, our trials have been conducted in both segregated and non-segregated airspace. Based on a SORA/SAIL process, the 150 kg Primoco UAV was able to fly ILS trials at Egilsstadir Airport in Iceland in a non-segregated airspace already back in 2021.

Our experience with fixed wing RPAS is that from arriving on site, with a crew of 2-3 people, one can be operational within approx. 30 minutes. The integrated ground control station (GCS) in the transport van creates a very suitable working environment for pilot and flight inspector. The GCS has 4 large screens where at least one screen can be dedicated to the FIS unless operated from a laptop. Furthermore, the van has a comfortable air condition system. All these factors contribute to a very good workstation for the mission.

A suitable workstation is important as the RPAS cruises significantly slower than a conventional aircraft. Where an aircraft most often can increase speed for ferry flight and reposition quickly for another approach, the RPAS will steadily fly in- and outbound at it's usual 65+ kts. "One nautical mile per minute" or so, very predictable. It takes more flight-time to cover the same ILS pattern work, no surprise, and this is where a comfortable workstation is important.

The choice of RPAS platform for initial development

Having briefly looked at some typical performance numbers above for fixed wing vs. multirotor, let's now look at why we at Norwegian Special Mission initially decided to base our RPAS Flight Inspection System, UNIFIS 1000, on a fixed wing platform.

The single most important question for us was: <u>Which type of solution will provide the easiest path to achieve local CAA approval of an RPAS based inspection system?</u>

We strongly believe that if the RPAS based solution meets the following criteria, it will be the very best starting point for a local approval:

1. **AVIONICS**: The system should be able to carry proven, conventional sensors for measurements on ILS, VOR, DME, TACAN etc.
2. **POSITIONING**: The system should be able to use proven positioning solutions for flight inspection with the same level of accuracy as used for conventional solutions.
3. **FLIGHT PROFILES**: The system should be able to fly identical flight profiles as the established methods for conventional flight inspection aircraft.
4. **DATA I/O**: The system should sample data from multiple sensors with time-tagging mechanisms to ensure data accuracy and integrity.
5. **USER EXPERIENCE**: The system should provide near real-time user experience for the flight inspector from virtually any location (ground control station or some distant headquarters). Furthermore, the user experience should be identical to sitting inside the aircraft with ability to interface the system for new/repeated profiles, tuning of sensors etc. In other words, precisely how you would operate a FIS in an aircraft.

With all the above items fulfilled, we would have an RPAS solution that would come closest to a conventional flight inspection aircraft, with one major exception: the crew would be located on the ground / remotely. We strongly believe that when approaching your local CAA to seek approval for the use of RPAS for flight inspection, it will be easier to achieve such approval if the difference to established / conventional methods are as small as possible.

The only platform that could fulfill all the above goals was a fixed wing RPAS with MTOW of 150 kg. All other options fell short on multiple parameters. Norwegian Special Mission therefore decided to initially start our development of RPAS based UNIFIS 1000 with a fixed wing solution. The cooperation between Primoco UAV SE and Norwegian Special Mission was then established which has brough us to a proof-of-concept and a solution which is practically ready for delivery.

Experience with fixed wing RPAS for flight inspection

Selecting technical solutions for testing

As explained below, Norwegian Special Mission decided to start test activities on ILS initially. The UNIFIS 3000 flight inspection system has used various receivers / analyzers over the years, ranging from air transport category receivers by Honeywell and Collins to various NAV analyzers from Rohde & Schwarz. It was already known at the time that Rohde & Schwarz was developing a NAV analyzer for RPAS use, which would be based on the EVSF1000 model. This model was already in use by several UNIFIS 3000 systems and at the time we had logged sufficient flight time to prove its accuracy and integrity. With support from Rohde & Schwarz Norway, the choice was to utilize the R&S EVSF1000 NAV Analyzer for our trials with fixed wing RPAS. This is a high sensitivity, dual channel signal processing for simultaneous LOC and GP measurements. The fact that one can measure both LOC/GP at the same time somewhat compensates for the reduced cruise speed of RPAS compared to conventional aircraft.

For positioning system, the UNIFIS family has always relied on Trimble GNSS technology and the choice fell on the BX992-INS unit which came readily with housing suitable for installation in the payload compartment. By using dual antennas sufficiently apart, the heading parameter was also available. This reduced the need for developing advanced interface to the RPAS systems initially.

ICAO DOC 8071 Vol I contains a table for minimum positioning subsystem accuracies for linear truth systems (Table I-4-11) for flight inspection of ILS. A reference system used for flight inspection of a CAT III Localizer will need an accuracy of at least 0.33m @ ILS point D. For CAT II/III glideslope the accuracy requirement is 0.083m @ILS point T. These strict accuracy requirements cannot be met with standard DGPS augmented or SBAS augmented GNSS solutions without the use of carrier phase augmentations systems like RTK or Trimble Centerpoint RTX. The BX992 GNSS receiver is capable to receive Trimble Centerpoint RTX with the appropriate subscriptions enabled. We therefore decided to base the test solution on RTX rather than RTK, in order to keep the test configuration as simple as possible.

Shakedown flight

As this early development took place during covid, our engineers were not able to travel to Primoco's location in Prague. The first prototype was entirely built by remote support and equipment shipped from Norwegian Special Mission to Primoco. Given all the uncertainties, it would seem like a good idea to perform a simple shakedown flight just to verify operational status and connectivity.

Such flights were performed, during covid, with engineers from Norwegian Special Mission controlling the UNIFIS 1000 remotely from Norway while Primoco was operating the RPAS from their test site in Pisek, Czech Republic. That, in itself, was a good test of connectivity and ability to control the FIS from a remote location.

The biggest takeaway from this very first flight was the lack of antenna sensitivity. We measured very weak signals where we should have had reasonable signal strength well within the VOR operational service volume. As it turned out, conventional aircraft NAV antennas require a better ground-plane than what was achieved with the fiberglass/composite fuselage of the Primoco One 150. This was mitigated by adding a thin copper film to the side of the fuselage, bonded to the antennas. This improved sensitivity to a level where we measured expected signal strength values. This is the reason for the copper film visible on all photos of this prototype. The production variant will have the ground-plane molded into the fuselage at the time of production. The shakedown flights proved very useful before heading out to a fully equipped airport.

Figure 6: Primoco engineers installing the prototype UNIFIS 1000-ILS.

Performance testing on operational ILS

The fact that RPAS can successfully perform PAPI measurements was established a long time ago. The real question was if we could achieve good measurements on ILS, which is the type of inspection that represent perhaps most of our activity and certainly the most safety critical. Secondly, this is the measurement which requires the highest accuracy. We therefore decided to start our proof-of-concept by testing the performance of ILS measurements. The following points were critical to achieve a good test scenario:

- Unlimited access to a fully operational ILS with localizer and glidepath.
- Flight authorization to duplicate the same flight profiles as flown by a conventional flight inspection aircraft on the particular ILS facility.
- Inspection results for comparison between RPAS and conventional FIS.
- Airport access to all equipment such as ground station etc.
- Sufficient time to correct any findings (technical) and to repeat all flight profile 3-4 times for repeatability analysis.
- Weather conditions suitable for RPAS operation.

Locating potential test sites was a challenge, considering all items above. We did find the “perfect spot” eventually, even though it was far away. Through our excellent relationship with ISAVIA in Iceland, we were given the opportunity to fly more or less unlimited at the airport of Egilsstadir (BIEG), located on the east coast of Iceland.

The Icelandic CAA processed our flight permit application based on the SORA process principles. As it turns out, other RPAS test campaigns (airborne surveillance) had also been conducted earlier at the same facility. This time however, it was given without segregating the airspace, which in itself was a huge leap forward.

Furthermore, the ISAVIA flight inspection aircraft, a King Air 200, has a UNIFIS 3000 system installed. This FIS even has similar type NAV analyzers as we planned to use in the RPAS solution. ISAVIA generously shared inspection results for our comparison analysis.

In other words, the BIEG airport checked all our test site requirements, perhaps with the exception of suitable weather conditions… We did get close to 20 kts winds on the last day of testing, but fairly parallel to the runway, which was good.

After this initial test in Iceland, we have continued our test campaigns at an ILS equipped airport in Czech Republic.

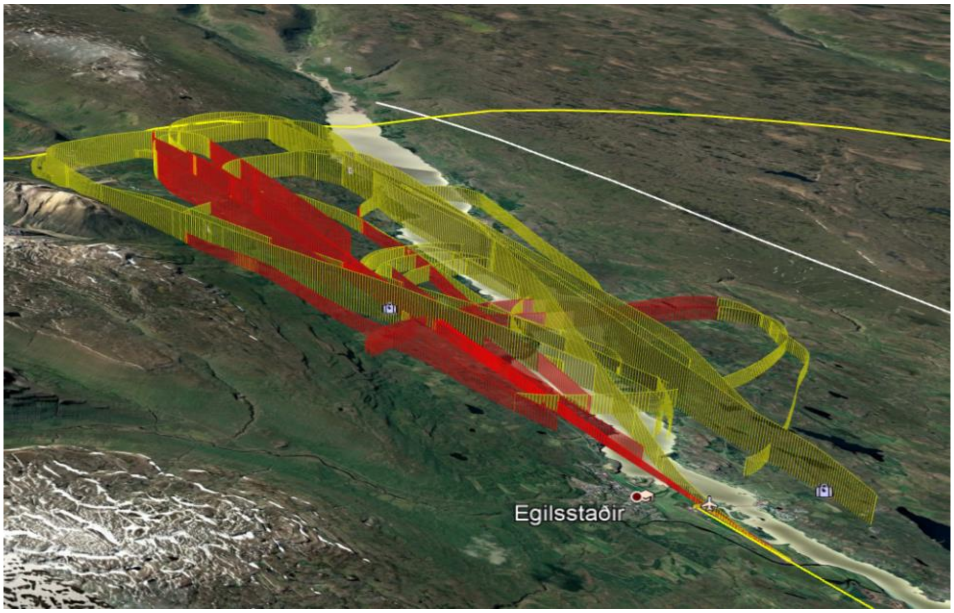

Figure 7: Sample ILS inspection flight paths flown at BIEG, reaching approx. 14 NM out.

Figure 8: Icelandic weather conditions added an extra element in the testing, here close to 20 kts wind.

Main takeaways from our ILS test campaigns

RPAS ability to fly FI patterns in non-segregated airspace

Having pre-programmed the RPAS flight paths, broken into ILS inspection profiles, it came as no surprise that the RPAS flew the ILS pattern work with ease. Since we flew the Iceland tests in non-segregated airspace, the procedure sequence was somehow affected by inbound / outbound traffic, all easily manageable by the flight control software.

The RPAS flies the pre-programmed patterns with a high degree of accuracy, even in various wind conditions. As the figure below shows, the RPAS is typically within +/- 3 µA of the centerline. At least for these tests, the RPAS must follow GPS guidance with points created by the UNIFIS 1000 and manually entered into the flight planning software. It is not capable to follow the ILS itself. In future it would be good to create an automated interface from the UNIFIS 1000 to the flight control software and/or flight planning software.

No doubt that the RPAS can fly ILS pattern work with ease, including arcs/crossovers, offset, level and straight in approaches. When operating in non-segregated airspace, one should also keep in mind to pre-program holding patterns as these were frequently used due to other traffic.

One important test-parameter was to verify that the UNIFIS 1000 data time-tagging was optimal. For LOC, the easiest way to verify this is to check if the deviation line crosses at the same spot when flown both clockwise and counter clockwise. For glidepath one needs to verify that the level flight aligns with measurements made on approach and offset approach procedures. We found that the data time-tagging mechanism was fully acceptable.

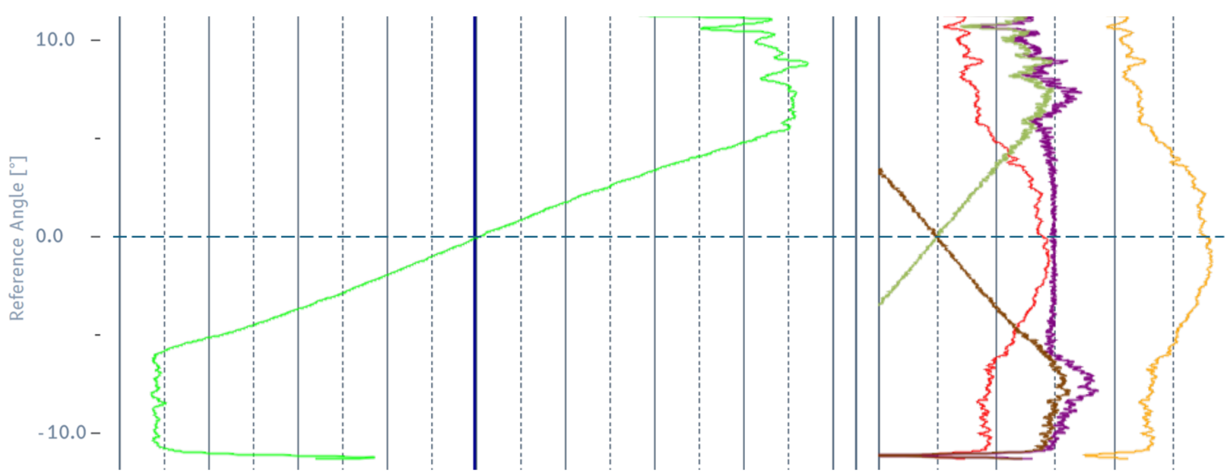

Figure 9: LOC crossover/arc to test data sample timing in the system.

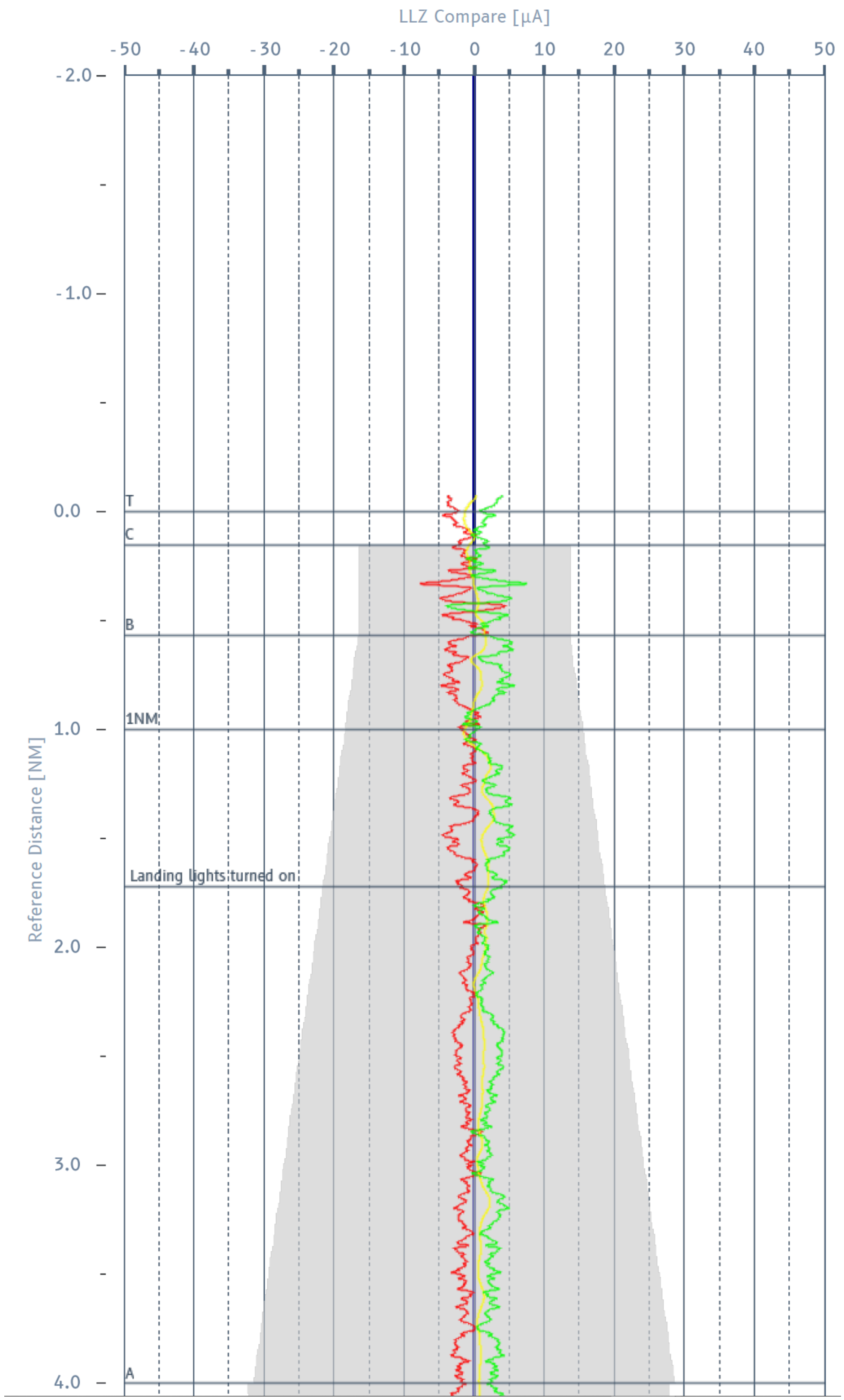

Figure 10: Yellow line is RPAS flight path showing +/- 3 µA ability to maintain centerline in windy conditions.

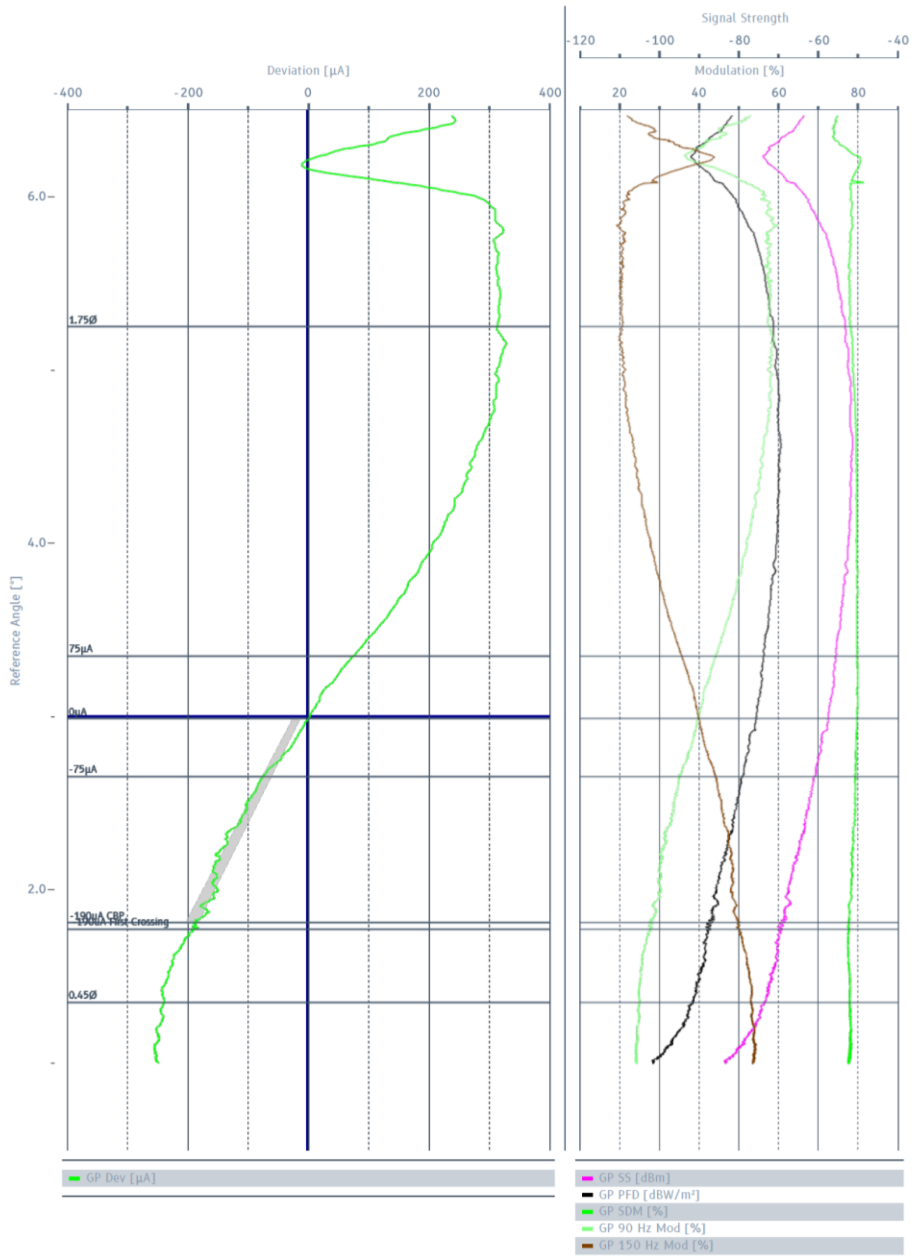

Figure 11: Sample from glide path level flight.

Antenna challenges

With the conventional NAV antenna used in the initial trials, we experienced poor performance on arc/orbital patterns. As explained earlier in this paper, the lack of a large ground plane such as the rudder on a conventional aircraft may create an unwanted effect. The antenna pointing away from the ground navaid will receive some signal and thereby partially cancel out the signal in the looped antenna (coupler).

However, this effect is only seen on arc/orbital patterns. For the other ILS profiles, the conventional antenna provides good signal reception and performance comparable to that of an aircraft. For this reason, we are still finalizing the antenna solution for ILS and VOR measurements.

EMC challenges

Most RPAS are built to standards very different from conventional aircraft production standards. This is seen for practically all RPAS manufacturers NSM has experience with. Most systems we have tested, fixed wing or multirotor, has a noise level that may affect measurements of weak signals towards the lower limits of coverage. Further analysis revealed that for the fixed wing RPAS, this noise was introduced by insufficient shielding on the main wiring harness inside the RPAS. The problem was eliminated by applying FIS/aircraft standards and methods in producing the RPAS main wiring harness. We are now able to measure weak signals towards the limit of the NAV analyzer.

Our experience is that mitigating EMC in the fixed wing RPAS is stable and much easier to mitigate than for the highly dynamic noise created in a multirotor RPAS. Multirotor RPAS will vary its RPM's totally out of control to the operator and create a difficult EMC environment.

Workload and overall experience

Much like any normal flight inspection mission, if the mission has a solid game-plan, the outcome is a smooth ride with a comfortable workload. In our trials so far, the cooperation between pilot, inspector and air traffic control (ATC) has proven to be very easy.

ILS profiles were briefed to all parties. The pilot and inspector had the means to pre-program the mission plan and ATC was briefed on the profiles as well. Briefing ATC on already established conventional ILS patterns was much easier than explaining a whole new method of near-field patterns.

During the flights, the comfort of sitting in the ground control van was an excellent experience. There is no turbulence, easier communication to the pilot by sitting side-by-side and even though the missions are longer (slower cruise speed), the fatigue factor was not nearly as high as onboard the aircraft (in my opinion). In fact, there was a moment that I thought to myself that this could potentially be a “one-man show” with the complete training as pilot and inspector. That might be pushing it, I know.

With a high-speed datalink, in our case 15 Mbps / 200 km range, the data transmission is hardly noticeable. Measurement data is sampled and timetagged onboard the RPAS, so a slight delay in datalink transmission will not affect the measured results in any way. It is clearly an advantage to operate as a crew in the ground control vehicle, however with experience I believe that operations where only pilot is on site and inspector is remotely located will be fully possible. As mentioned, this was the case early in our test program where NSM engineers operated the system from Oslo/Norway and the RPAS flew in Pisek/Czech Republic.

Figure 12: Integrated Ground Control Station (GCS) in the transport vehicle.

Figure 13: Transport vehicle able to carry 2x Primoco One 150 UAV.

Conclusion

NSM has developed the UNIFIS 1000 for RPAS, initially for fixed wing 150 kg category platforms since approx. 2019. Trials have revealed some challenges with antenna technology and EMC. However, solutions are implemented and still being optimized.

We believe that a fixed wing platform capable of carrying conventional flight inspection equipment, as well as the ability to fly the same patterns as manned FI aircraft, will represent the RPAS solution that is closest related to conventional methods used today. Any RPAS-FI solution which meets these properties should thereby represent the easiest path to receive approval by the local CAA as a new inspection method. The use of proven solutions and the approval-aspect are the main reasons we decided to initially work on a fixed wing platform.

Multirotor platforms have advantages on many other areas: pricing is more favorable, weight class and flight permits more streamlined, less airspace needed etc. Some profiles such as PAPI and ILS ground checks would be easier to perform with smaller multirotor than a fixed wing RPAS. Pre-commissioning checks etc. makes a lot of sense. However, these smaller multirotor platforms still represent a significantly different method to what we have been doing for many decades in flight inspection. Measurements made near the airport may not reveal signal quality issues further out towards the outer part of the ILS service volume.

We strongly believe that the time has come for FI service providers and others to explore how RPAS based systems can support traditional flight inspection methods. Experience needs to be built over time and gradually. Some companies claim to have solutions which is mature and ready to take over all inspections as a full alternative to conventional systems. We believe this will take time and that the very best approach is to start with fixed wing systems with technical solutions that is proven on conventional FIS. Even as a supplement to traditional aircraft inspections, there is a great potential for cost savings.

In the sales process of these RPAS based solutions, we experience that the RPAS and FIS is accepted quickly. The time-consuming part of the sales process is for the customer to seek operational airspace access from the local regulators. This process takes time and requires full insight into the RPAS flight-, design and safety documentation.

And one thing remains certain: The aviation community (and regulators in particular) are extremely conservative towards new methods. That’s why we still fly ILS approaches!

Acknowledgements

The development of a fixed wing RPAS based FIS has been made possible by teams and individuals coming together to cooperate for a common goal. We would like to thank the skilled engineers at Primoco UAV SE for their enthusiasm and willingness to travel far with their equipment. Furthermore, initial trials at Iceland was only made possible by the support from ISAVIA and Iceland CAA. Also, many thanks to the great staff at Egilsstadir Airport for their cooperation while performing the tests. Thanks also to Rohde & Schwarz Norway and to Norgeodesi (Trimble dealers, Norway) for their contributions.