IMPLEMENTATION OF GPS, FLIR AND RWR IN THE RNLN LYNX HELICOPTER

A.L. Vergroesen
Royal Netherlands Navy (RNLN)
The Hague, The Netherlands

Abstract

In early 1994 RNLN decided to have a Global Positioning System (GPS), a Forward Looking InfraRed (FLIR) and a Radar Warning Receiver (RWR) installed in their Lynx helicopters and in the Lynx simulator. The aim of this update programme is to have 22 updated Lynx helicopters and well trained operators by the end of 1998 within the budget and within the operational requirements.

Although very recently expanded with the introduction of Chaff/flare, this paper is focussed on the design and prototype (D&P) phase of GPS, FLIR and RWR. This phase will be finished by September this year and the update of all remaining aircraft will follow immediately. The simulator is being updated at this moment and will be ready for training by the end of this year.

This paper briefly describes the main technical issues and some operational aspects of this update programme. Highlights are the cockpit reshuffle, the installation of the FLIR monitor and the positioning of the RWR antennas.

Supported by a long series of tests the overall performance of the RNLN Lynx increases significantly as a result of the update.

Introduction

The main objective of the Royal Netherlands Navy (RNLN) is the effective use of fighting power at sea against threats. For this purpose RNLN operates, among many other means, 16 frigates. Most of these frigates carry the Westland Lynx helicopter as an important weapon system for Anti Submarine Warfare (ASW) and Anti Surface Warface (ASuW).

A total of 22 Lynx helicopters is currently in use with the RNLN. The helicopters not actually on board ships are being used at Naval Air Station de Kooy (located in Den Helder, northern part of Holland) for training, Search And Rescue (SAR), transport and military support missions. All together the RNLN Lynx may be used in 8 basic roles.

The Gulf war and a rapidly changing world have led to the RNLN decision to install GPS, FLIR and RWR in such a way that all RNLN Lynx heli-copters may operate in every desired role. Financial constraints, however, meant that if not for all 22 heli-copters equipment could be procured within the budget, at least "provi-sions for" should be available.

This paper contains four sections. The first section is a programme overview. The second and third section decribe the equipment installation and testing. The way ahead and conclusions can be found in the fourth section. The paper provides a general overview of the programme with emphasis on technical matters.

Programme overview (see figure 1)

The early beginning of this update programme was somewhere in the late eighties when the RNLN requirement for RWR was effected. In the early nineties the FLIR and GPS requirements were added. Staying within budget these systems also had to be implemented on the simulator.

The complexity of each requirement led to the conviction that it would be wise to carry out the requirements as one programme. It took a lot of effort and time to fit the GPS, FLIR and RWR staff requirements for both real aircraft and simulator in the budget without relinquishing requirements. As a result it lasted until early 1995 before contracts were signed.

At that time the implementation of Chaff/flare was not an issue for several reasons. By the end of 1995, howevr, RNLN decided Chaff/flare to form part of the update. The design and prototype phase was in such a stage that embodiment of this requirement could be carried out without much trouble.

Year quarter	1995 1 2 3 4	1996 1 2 3 4	1997 1 2 3 4	1998 1 2 3 4
design and prototype phase	<——————	——————>		
production phase		<——————	——————————	——————>
simulator update	<——————	——————>		

Figure 1: A programme overview

The whole programme is now expected to last until the end of 1998. By that time all 22 RNLN Lynx helicopters must be capable of flying in every operator desired role. The simulator update will be finished ahead of the real aircraft thus enabling the operators to gain a lot of experience on the updated Lynx **before** flying it.

The design and prototype phase as well as the production phase for all other helicopters is being carried out by Fokker Services. At this moment the design phase is nearly finished and the production phase will follow shortly.

The simulator update, performed by CAE Electronics Ltd., started a few months after the real aircraft design. The on-site installation has just been finished. A lot of pressure was put on this update to ensure maximum benefit from the updated simulator. On the other hand the offset of several months was neccessary allowing for the real aircraft design to be proven.

Systems

General. The D&P phase for this update programme actually consists of the implementation of GPS, FLIR, RWR and a Fourth Crew Member's Seat. This seat, however, is not a system or a sensor and will be disregarded. As stated in the previous section it was not until May this year before the Chaff/flare requirement also became apparant.

Since the design part of this equipment was going on while this paper was written, I will focus on GPS, FLIR and RWR.

The most obvious changes to the RNLN Lynx can be found in the cockpit (see figure 2) and on the aircraft outside structure (see figure 3). These figures present the new situation.

Inside the aircraft several solutions had to be developed allowing FLIR control for both the tactical coordinator (TACCO) and the sensor operator (SENSO).

GPS. The GPS installation proved to be simple. The system only consists of a receiver, an antenna and a few cables, one of them being an interface (link) to the FLIR. The receiver had to find a place in the cockpit, well within reach for TACCO and very close to the Navigation Computer (using doppler information), allowing for easy cross checking.

The experience with another GPS system (installed during the Gulf war) was the basis for locating this antenna at the same position: on top of the tail boom and just in front of the tail fold hinges (see figure 3).

The actual GPS installation showed indeed no surprises. The interface with FLIR worked well. The receiver temperature stayed within limits as did the operational performance.

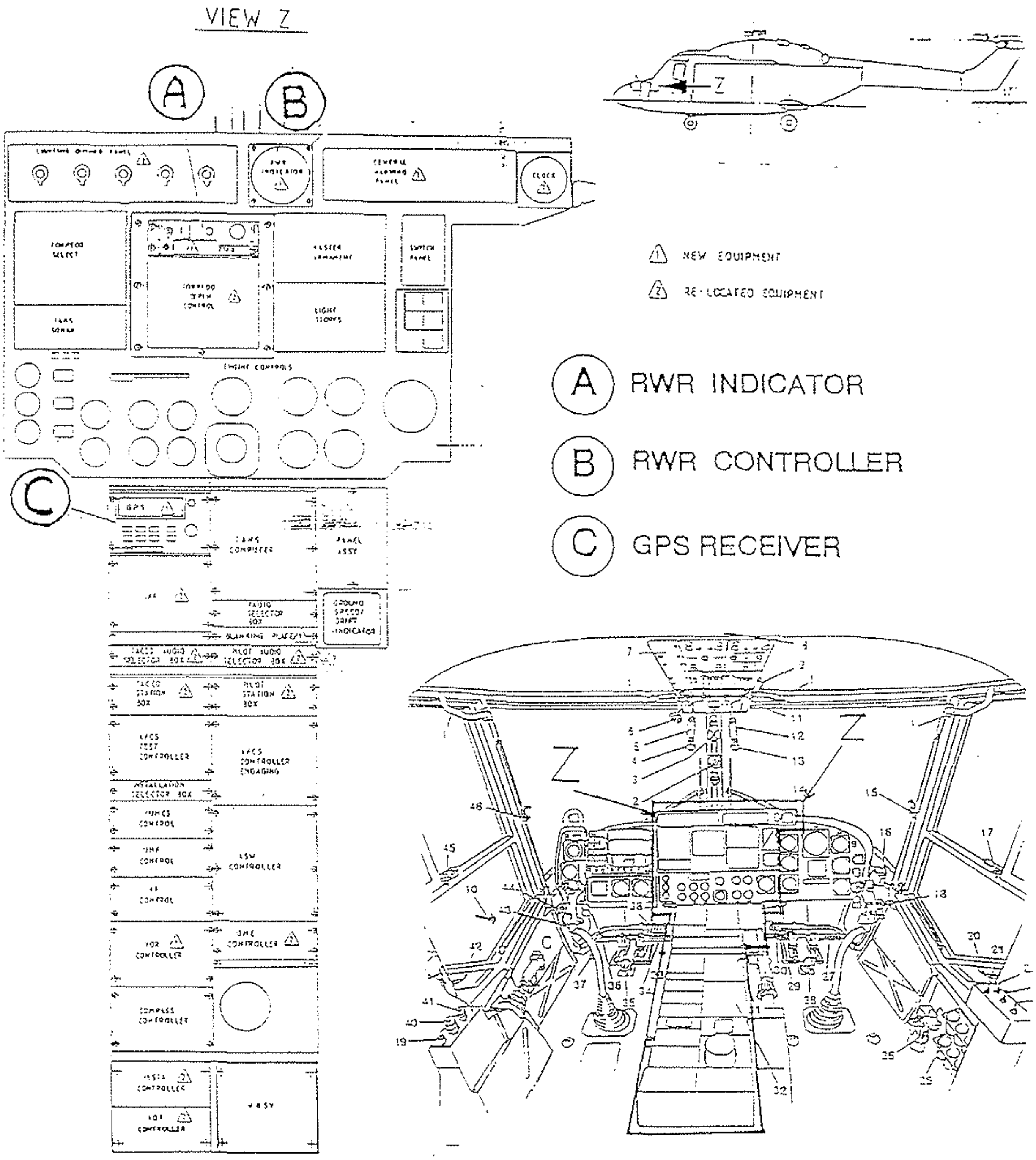

Figure 2: RNLN Lynx cockpit configuration (View Z is the new situation)

FLIR. The Forward Looking InfraRed (FLIR) system comprises five units: a Hand Control Unit (**HCU**), a Central Electronics Unit (**CEU**), a **Turret**, a **monitor** and a **video recorder**. A special **pod** was designed to accomodate both CEU and Turret (see figure 4) for the FLIR system. Furthermore a solution for FLIR presentation in the cockpit was found and is called **FLIR/radar interface**. The GPS position is obtained via the **GPS/FLIR interface**. A more detailed describtion of these units can be found in the next few paragraphes.

The one-hand controlled **HCU** provides all operator control functions. The HCU can be mounted such that both TACCO and SENSO can take the HCU and control the system. For this purpose the HCU has an extension cord. The SENSO sitting in the cabin behind the TACCO has his own FLIR monitor. Flying in sonar configuration this monitor will be mounted on the sonar rack next to the sonar indicator thus providing the SENSO with both underwater and surface view.

In non sonar roles the sonar rack is not fitted and the monitor will be mounted on an existing frame near the cabin roof.

As indicated before both the **Turret** and the **CEU** were put together in a pod, an outside rectangular box fitted to the port side of the aircraft. The turret being the infrared eye of the system is positioned such that a 360° view is available.

Originally the RNLN aimed at fixing the **monitor** for the SENSO to the cabin roof such that the monitor would always be in the same position irrespective the role. This position was, however, such that the monitor was vibrating too much and this position had to be abandoned.

This was particularly unfortunate because of the fact that the only solution for one fixed monitor position for every role is mounting the monitor at that specific cabin roof area.

The next step was to allow for a maximum of two monitor positions. Depending on whether the sonar rack was to be installed or not the monitor had to be fitted to this rack or somewhere else.

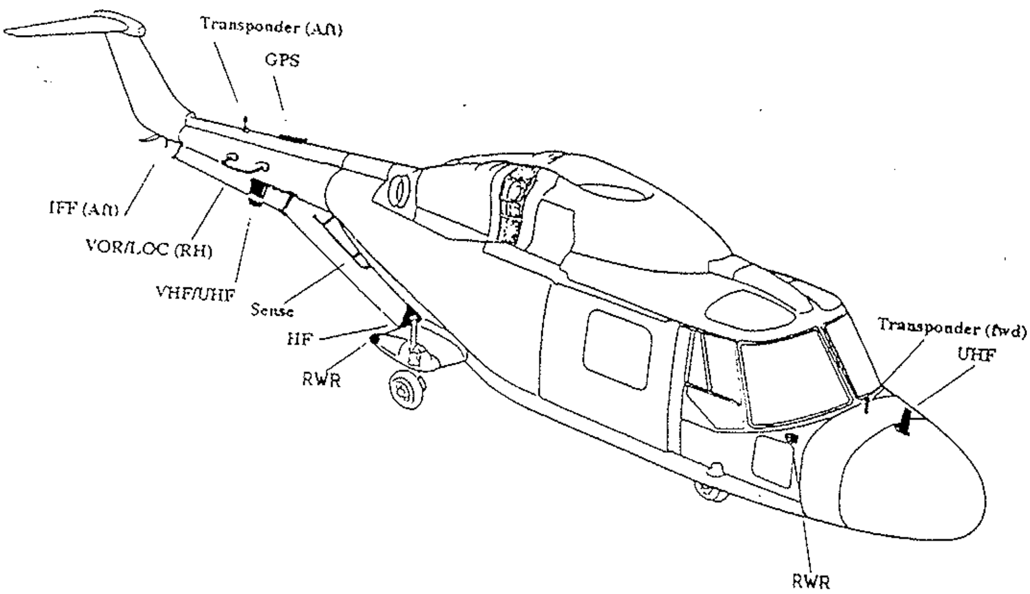

Figure 3: RNLN Lynx new antenna layout

Without interfering with an emergency hand lever for one of the hydraulic systems a new bracket was developed allowing for both quick release of the monitor and attachment to the control frame in close vicinity to the cabin roof (see also figure 4).

The second position (sonar rack) for the FLIR monitor provides the SENSO with simultaneous infrared and, when performing sonar operations, underwater view. In this case the FLIR is mounted on the right side next to the sonar indicator at the same distance to his eyes.

The **FLIR/Radar interface** was something specially designed for the RNLN application: presentation of the FLIR images on the radar indicator in front of the TACCO.

The interface forms part of the radar indicator and by turning one of the radar control knobs the TACCO may choose between radar and FLIR. Naturally crew management is important when at the same time both radar, FLIR and sonar are being used. These three sensors have to be operated by only two operators which again emphasizes the importance of the simulator update.

Finally, a requirement for the presentation of GPS position information was laid down. By means of a **GPS/FLIR interface** the GPS position is fed digitally to the FLIR ensuring that the GPS-position is continuously presented in the right hand lower corner of the FLIR picture.

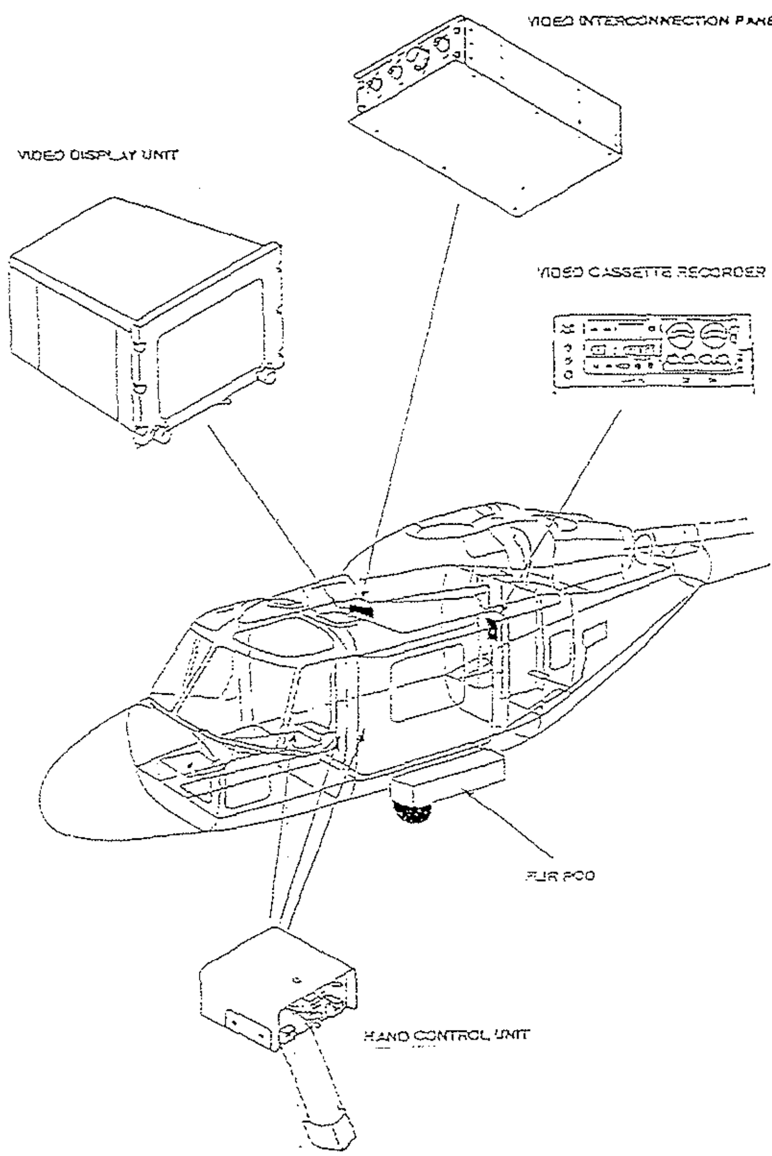

Figure 4: RNLN Lynx FLIR system

RWR. This system comprises six basic components: four **antennas**, two Crystal Video Receivers (**CVR**), an Instanteneous Frequency Measurement Receiver (**IFM**), a Signal Processing Unit (**SPU**), an **indicator** and a **controller** (see figure 2, 3 and 5). As expected, the installation of this system proved to be much more complicated. As with the FLIR system each unit is described in more detail in the following paragraphes.

Putting four small **antennas** on the edges of the aircraft with a tolerance of only 1° calls for very accurate installation procedures and equipment. The 1° requirement was met by using an optical Leica 3D measurement system.

Another important issue, always calling for compromise, is location of the antennas (see figure 3).

It was not easy to stay within all requirements with respect to coverage, cable routing, cable length and some structural requirements.

The cable routing requirement for instance prevented the RNLN from choosing the aircraft nose for the forward antennas. A compromise was found by putting the antennas on special brackets underneath the cockpit windows. The same requirements prevented the rear antennas from being positioned at the rear fuselage. The only position expected to fulfil all requirements was the trailing edge of the sponson. Although more exposed in this position the very robust antennas are designed not to suffer from damage caused by shipborne operations and the coverage at this position may be even better.

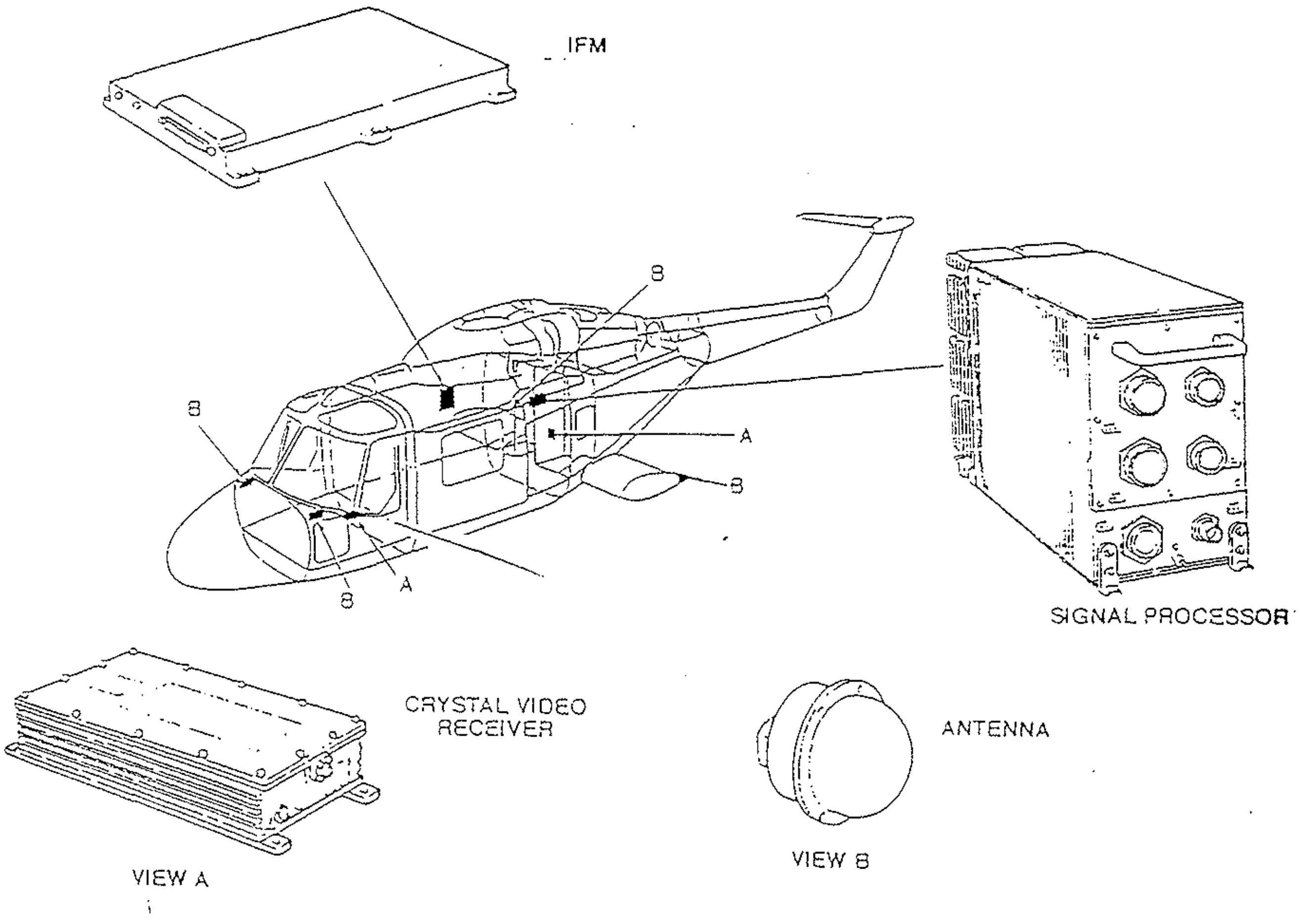

Figure 5: RNLN Lynx RWR system

The position of the other RWR equipment was even more complicated. Tight cable length limits, an over-crowded cockpit and role change requirements forced RNLN to accept compromise. Cockpit logic and RWR performance were agreed to be priority requirements. This resulted in a lower than desired role change flexibility due to the CVR installation and some extra programme costs for the indicator installation (see figure 2 for cockpit items and figure 5 for other RWR equipment positions).

Furthermore, it was unsure what the influence of other equipment, transmitting in the frequency band where the RWR is "listening", was going to be. By investigating prior to the programme start it was concluded that, for the RNLN Lynx, only the radar mounted in the aircraft nose could be a problem. Therefore the RNLN developed a Blanking Pulse Unit (BPU) to prevent the RWR from "listening" while the radar is transmitting. Ground and flight trials proved this theory to be true. Neither the Doppler navigation system nor the Radar Altimeter were picked up by the RWR.

Finally, we didn't know what the real life performance of this system was going to be. The performance of this programmable system strongly depends on both the data fed into the system and the familiarization level of the operators. For these reasons RNLN will be performing more trials over the next months. More about this subject is described in the next chapter.

TESTING

General. As expected a long series of trials had to be performed in order to demonstrate the proper performance of all systems. In line with the previous installation, testing the GPS was the easiest job. FLIR trials were more difficult and took a lot more time. RWR testing, even more demanding, was still going on as this paper was written. In fact, only a small part of the RWR testing sequence has been performed so far, as will be explained.

GPS. Being a rather simple system, not many requirements were laid down to demonstrate the performance. Accuracy and other systems' influences were of course the main issues to be tested. No anomalies were found.

FLIR. Testing the FLIR took considerably more time than testing the GPS. This was mainly due to the fact that all modes of the system had to be tested. Since the system is a stand alone system a significant loss of performance in the Lynx as opposed to laboratory environment was not expected. This statement proved to be true with one exception: at certain speeds the aircraft vibration is too high when the FLIR is installed. At this moment a lot of effort is put in solving this problem.

RWR. Not counting the system self test (built in test) the testing sequence for this system comprises four basic steps. As a first step the 3D coverage of the antennas has to be known. The coverage, being an installation requirement, unfortunately can never be exactly predicted. In order to have maximum chance of success RNLN contracted the National Aerospace Laboratory (NLR) for this job and the coverage proved to be very satisfactory.

The second step was to determine the overall sensitivity of the system. In other words: at what distance can a particular signal of known strength be detected? Again a 3D determination is neccessary. For this job NLR was contracted as well. Flying several fixed patterns at a fixed, exactly known distance, the 3D sensitivity picture was established. An accurate position recording for this purpose was realized by means of differential GPS (DGPS).

The third step can be described as 'real life processor testing'. All kinds of different but well known signals must be transmitted in order to determine or verify the system response. RNLN is currently at this stage of testing.

The fourth and final step is testing in an operational environment. This step may take years and in fact this step is never really finished, because the operational environment keeps changing so continuous feedback will be needed to update the RWR software.

THE WAY AHEAD AND CONCLUSIONS

The way ahead. As already stated in the first section (programme overview) the Chaff/flare equipment was being installed on the prototype aircraft while this paper was written. This means that in the near future a lot of effort will be put in the testing and acceptance of this system.

Furthermore, the go ahead for the production phase of the programme was given in July this year which means that the second aircraft to be modified should be at Fokker Services somewhere in the beginning of September this year. Taking a learning curve into account a third aircraft may go somewhere in november or december later this year. All aircraft should be updated by the end of 1998 and by that time, with a lot of simulator help, all operators must be well acquinted with the updated Lynx.

It is not expected that any other major modifications on the RNLN Lynx sensors will be carried out during the next few years. The RNLN modification policy for this particular aircraft is such that all new developments are becoming less attractive now that the delivery of the successor of the RNLN Lynx, the NH-90, is in sight. This medium weight helicopter has to enter service in the first decennium of the next century and will also be stationed on board the RNLN ships.

Conclusions. Despite being very crowded before the update, the RNLN Lynx cockpit contains the neccessary equipment of three new sensors and furthermore the cockpit is now on a higher level of ergonomics.

The simulator update allows operators to get used to the new systems and to train with them in an operational environment thus preventing an overload situation in the real aircraft. Therefore the relatively expensive update of this simulator is a very important part of the update programme and was worth every guilder that was put into it.

As an overall conclusion it can be stated that, by means of a combined effort between the industry, research laboratories and RNLN, this update with all its budgetary restrictions is still being carried out with very acceptable results.