Flight trials with the Mission Flight Aids of NH90 TTH

by
Dr. H.-D.V. Böhm, J. Frank and R. Ehrenwinkler

Eurocopter Deutschland GmbH
D-81663 München, Germany
e-mail: hans-dieter.boehm@eurocopter.com

Abstract:

The Tactical Transport Helicopter (TTH) is one of two NH90 versions which are being developed under a contract of the NATO agency, NAHEMA, representing France, Germany, Italy and the Netherlands. The NH90 helicopter has been under development since 1992 and made its maiden flight in Dec. 1995. In 2000 Portugal joined the program. In the year 2004 the first production helicopter will be delivered to NAHEMA.
A presentation of the mission flight trials and specific mission equipment will be given to show the status of this development. The mission system provides a high degree of flexibility due to architectural design and SW-layout and includes an Obstacle Warning System (OWS) as a retrofit. It may be adapted to different missions by easy changes of its configuration. Additionally the present development also makes provision for further extensions to more specialized missions which its vast cabin allows.

For the first time a transport helicopter is equipped with highly sophisticated mission flight aids which are part of the mission system. These mission flight aids provide the helicopter with an effective capability for day, night and adverse weather conditions. This is especially the case with the Vertical Situation Aids (VSA) which consist of a modern Forward Looking Infra-Red (FLIR), see Figs. 1 and 3, and a visor-projecting binocular Helmet Mounted Sight/Display (HMS/D), see Fig. 7, which includes Image Intensifier Tubes (IITs). These mission equipments are highly integrated to give the pilots an online FLIR or IIT presentation projected onto the HMS/D's visor overlaid by symbology. This allows for a "looking-ahead" capability.
This modern Pilot Vision Systems (PVS) has day and night flight capability with two different type of sensors: FLIR and IIT. The IITs are integrated into the binocular helmet and the FLIR is installed into the nose of the helicopter. The helmet Line of Sight (LOS) is measured by an electro-magnetic tracking system which provides an output to steer the FLIR-platform. Two binocular HMS/Ds, one for the pilot and one for the co-pilot, are used in the NH90 cockpit of the TTH. The results of the flight trials with the NH90-TTH will be presented at the end of this paper.

Introduction:

The NATO Helicopter (NH90) has been in the development phase since 1992. The four nations France, Germany, Italy and The Netherlands are working together in the quadri-lateral NH90 program. The maiden flight of PT1 took place on 18.12.1995. In 2000 Portugal joined the program. 72 Helicopters are on order for export to Finland, Norway and Sweden. Fig. 1 shows PT 4 during flight trails. The NH90 Tactical Transport Helicopter (TTH) version provides an effective Nap Of the Earth (NOE) day, night and adverse weather mission capability. The TTH-Mission gross weight is 8700 kg and the dash speed is >300 km/h.
The mission requirements for the NH90 TTH have been defined by NAHEMA and Industry. The helicopter NH90-TTH is capable of flying different missions during day and/or night. The NH90 TTH is designed primarily as a tactical transport helicopter for delivery of 14 combat ready troops and/or materials from a pick-up zone on friendly territory to a landing zone on friendly territory possibly close to the forward edge of the battle area, but in principle outside direct threat from the enemy.

With special equipment other missions can be performed such as:
- heliborne operations (transport of a LTV)
- SAR in peacetime
- electronic warfare
- airborne command / parachuting
- casualties rescue
- VIP transport

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Taking into account the new military tasks (such as UN operation in civil wars), additional mission requirements are arising. Therefore investigations are being made into future versions of the TTH i.e. to fulfil electronic warfare missions, mine detection and to have improved self defense capability. Different versions of transport capability are defined: 14 - 20 troops or >2500 kg of cargo or up to 12 stretchers or a light tactical vehicle with crew.

The crew workload is reduced by maximum integration of the flight control system. The NH90-TTH has both basic and mission avionics. The Mission Flight Aids (MFA), as part of the mission avionics, is an advanced system. The helicopter sensors measure the threat radiation, both passive and active. Therefore the level of protection is high even against Radar, Laser, EMI and NBC radiation threat..

There are two main subsystems on the Mission-Bus: Mission Flight Aids (MFA) and Electronic Warfare System (EWS).

The MFA includes a piloting-FLIR with a steerable platform, two binocular Helmet Mounted Sight & Display (HMS/D) (equipped with Image Intensifier Tubes (IIT) as sensors), an Obstacle Warning System (OWS) as a retrofit, a Weather Radar and a Digital Map System.
The Vertical Situation Aids (VSA), which is part of MFA, consists of the FLIR, HMS/D and OWS. At the moment OWS selection is decided for the German TTH with a derivative of EADS-Dornier Hellas; and for the Italian TTH with the Marconi LOAM.

Fig. 1: NH90 TTH Prototype 4 during Flight Trials Campaign in Manching, Germany. In the nose section is installed the FLIR (small) above the Weather Radar

The **FLIR** (with a 30° x 40° piloting Thermal Imager (TI)) is installed in the nose of the helicopter (HC). It includes a steerable platform, positioned by the LOS angular data, which is measured by the HMS. The Pilot Vision System (PVS = FLIR and two HMS/D) comprises two binocular HMS/Ds; one each for the pilot and co-pilot.

The binocular **HMS/D** consists of a new light weight helmet shell equipped with an individual form fit liner, intercom and an Optical Module (OM) (which includes two Cathode Ray Tubes (CRTs), two Image Intensifier Tubes (IIT) and optics). For displaying the information a visor projection system is provided. The visual information projected includes flight symbology. High accuracy is required for the Helmet Mounted Sight (HMS) within a large Head Motion Box (HMB). The HMS steers the nose mounted FLIR platform. The platform with the FLIR and the HMS/D are working closely together as a PVS.

The **OWS** is required for the detection of different obstacles during NOE missions. The OWS is specified as a fixed forward sensor using eye-safe Laser technology with intelligent signal processing for cable and other obstacle separation, as well as different modes of obstacle presentation. Its FoV is equivalent to that of the FLIR. A 99.5% probability of detection (PoD) is required.

Eurocopter (EC) has, over a long time, gained much experience with MFA on platforms such as the BO105, PAH1, BK117-AVT, Dauphin, Ecureuil, Gazelle, Super-Puma and TIGER. Eurocopter Deutschland (ECD) is responsible in the NH90 TTH program for the selection, procurement, development (in co-operation with the suppliers), installation, testing and to qualification of the MFA. The flight qualification of the MFA is performed at several Flight Centers.

The operational requirements

The NH90 TTH shall have the capability to fly during day, night and in all weather conditions. These conditions are specified as:

- At night: with at least Night-Level 4 > 0.7 mLux (and sometimes Night-Level 5, as defined in FINABEL 1-R-9, 1978)
- All weather conditions: maximum extinction coefficient of 1.0 km^{-1}

Depending on the mission task, the weather conditions or the enemy threat situation, the crew will select a certain flight altitude for each mission segment.

To minimise the detectability and thus the safety of the flight, the natural cover of the topography is used. The NOE track leads close to and between obstacles such as hills, trees, and power poles and wires. As a consequence, the Pilot has to look continuously for a compromise between the three parameters: of ground speed, flight altitude and distance to obstacles.

On its own, the FLIR sensor on the platform has some limitations during a 24 hour mission. The absolute temperature characteristic or the emissivity of natural materials will vary over a 24 hour period (ref. 2 - 5). For example, a thermal zero contrast (wash-out effect) during rainfall, or a so called “cross over effect” is observed, especially at dawn and during twilight. In these conditions the foreground is not detectable against the background, such that, for example, pylons could become very dangerous for the HC crew.

Therefore, the combination of the two visual aids, IITs and FLIR, (which are based on different physical principles), is better suited to fulfil the increased requirements of adverse weather conditions during day and night. These two visual aids can be combined in the binocular HMS/D with binocular vision (two CRTs and two IITs on the helmet). The crew can switch between the IIT image and the TI image minimal delay. Additionally, flight symbology can be superimposed on the images.

At night or during reduced visibility (adverse weather), especially when flying NOE, the safety of the aircraft has to be maximized with regard to obstacles. To achieve this, the crew is supported by the use of the VSA. The VSA helps the pilot to see obstacles also during night and bad weather conditions with the aid of IITs and FLIR. Additionally the OWS provides warnings in case of obstacle threat for the helicopter.

System Architecture

The NH90 TTH Avionics System is subdivided into two parts: the Core System and the Mission System. Both of them are based on dual redundant STANAG 3838 digital data-buses. These two independent buses are called “Core Bus” and “Mission Bus”.

The TTH Core System is composed of the following subsystems:
- Aircraft Management Subsystem
- Control and Display Subsystem
- Communication and Identification Subsystem
- Navigation Subsystem

The TTH Mission System provides the following functions:
- Mission Flight Aids
- Electronic Warfare
- Additional Communication
- Tactical Control
- Up/Down Loading of Tactical/Mission Data
- Mission System Management

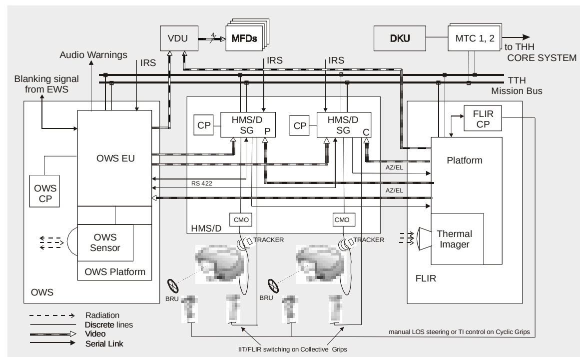


Fig. 2: TTH mission system architecture for FLIR, HMS/D and OWS

The Mission System Management is performed by two redundant Mission Tactical Computers (MTC 1 and 2). These MTCs include the bus controllers for the Mission Bus and are the links to the Core Bus. The Mission System will be operated by the pilots through the Control and Display Units (CDU’s), the Multi Function Displays (MFDs), (which are part of the Core System) and by the dedicated control panels of the subsystems.
The functions of the Mission Flight Aids are performed by the Horizontal Situation Aids (HSA), which consist of the Weather Radar (WXR) and the Digital Map Generator (DMG), and the Vertical Situation Aids (VSA, Fig. 2), which consist of the Helmet Mounted Sight and Display (HMS/D), the FLIR and the Obstacle Warning System (OWS). Each of the five subsystems of the MFA are directly connected to the Mission Bus. The control and mode-switching of the subsystems is done either via the control panels or via the DKUs.

To ensure no degradation of the thermal image, a careful design of the complete video path from the entrance lens of the thermal imager to the observer's eye has to be done. Each block is characterized by its Modulation Transfer Function (MTF), (The capability to process and transfer signals depending on spatial frequencies). The MTF analysis method allows simple multiplication of all single MTFs to obtain the complete resulting MTF of the entire path. Cabling and SG/mixer MTF are specified and assumed to be negligible. The system MTF represents the resulting end-to-end MTF.

Sensor of the Mission Flight Aids FLIR

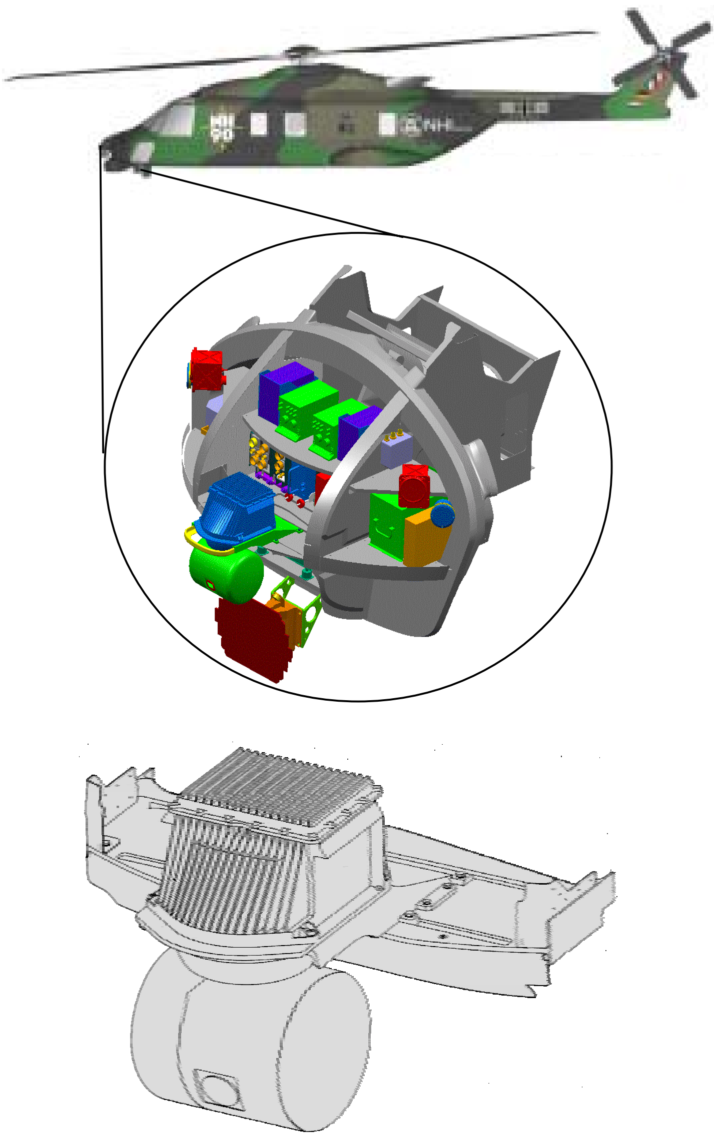


Fig. 3: NH90 TTH nose section and FLIR support

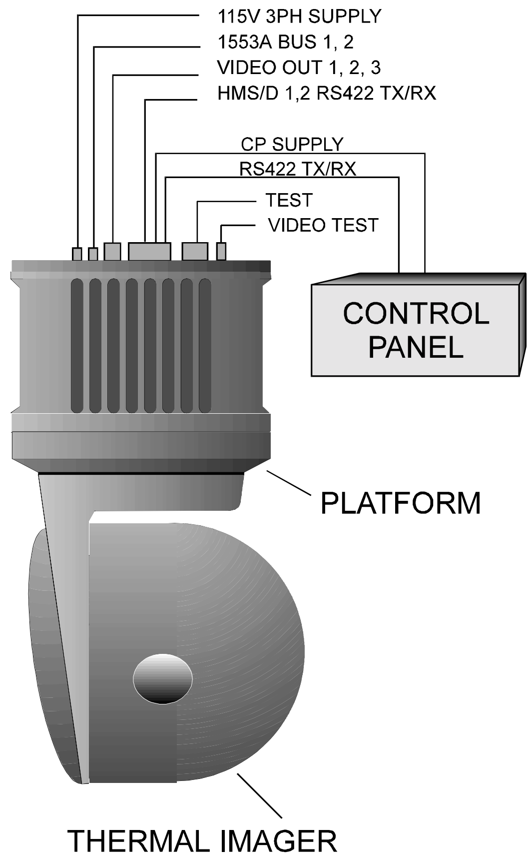


Fig. 4: NH90-TTH-FLIR Platform with Thermal Imager from Galileo Avionica / Hensoldt / AIM

<u>General description</u>

The FLIR Sensor (Forward Looking Infra Red) is an electro-optical sensor installed at the nose of the HC. It is a part of the MFA and comprises 3 LRUs: Thermal Imager (TI), Platform (PL) and Control Panel (CP). It is provided by Galileo Avionica in co-operation with Hensoldt and AIM (Fig. 4 and Fig. 5).

<u>Detector</u>

The heart of the TI is the IR CCD detector with a row of 288 by 4 detectors. The Mercury Cadmium Telluride (MCT)-detector device is sensitive in the 8 to 12 µm band and has been developed in France and Germany. The IR scene is scanned with one sweep of a horizontal scan mirror. 288 lines correspond to one field of the STANAG 3350B Video Standard. A second sweep with one line vertical offset completes the entire video frame.

Thermal Imager, Platform and Control Panel

The Thermal Imager (TI) is a new development and represents today's state of the art technology. The TI contains all detector- and video-electronics.
The platform (PL) supports the TI and allows the elevation movement. The lower part of the platform is turnable and allows the azimuth movement. The upper part of the platform holds gimbal-, interface- and power electronics and provides interface connectors to the avionics system.
The Control Panel (CP) is connected to the PL via an RS 422 serial link to control all operational functions as shown in Fig.4. As with all other control panels in the NH90 TTH the panel illumination is NVG compatible according to MIL-L-85762A.

Key parameters of the FLIR Sensor are:

Main Operational Functions/Data
• High performance Detector Module with Cooler and Proximity electronics with long life and low noise linear cooler • High performance analogue and digital signal processing for excellent Signal to Noise ratio and low fixed pattern noise • Analogue video signals to HMS/Ds and MFDs • LOS controlled by the Helmet tracker, “hands-on stick” manual or automatic steering with look into turn capability or fix forward (FF) position • Advanced Automatic Gain and Level function with “hands on stick” manual correction • Polarity selection allows “hot is white” or “cold is white” • Automatic de-icing

The table above shows the top level parameters. Highlights of the TTH FLIR are:

- ⇨ Very low weight and volume - compared to other Piloting FLIRs in the same performance class
- ⇨ No active stabilization necessary for this FoV
- ⇨ Automatic gain and level with line-by-line evaluation
- ⇨ Flexible serial links to MIL BUS, to HMS and to Control Panel with the possibility for easy modifications
- ⇨ Advanced software design
- ⇨ Look into turn function (see below)

Look into turn function

In case of HMS failure or other reasons the crew can select the AUTO mode (automatic look-into-turn steering). In this mode the FLIR evaluates actual NAV data from the HC and calculates a smooth movement of the FLIR LOS with the following features:

AZ steering + EL steering of Look into turn function
AZ • Depending to the radius of the flown curve the LOS will be moved towards its center. Limit is half the horizontal FoV (20°) to avoid pilots disorientation.
EL • The horizon is kept in the upper 1/5 of the image; this is independent of banking and pitch angle of the HC, but limited to the end stops of the FLIR and aids the pilots spatial orientation.

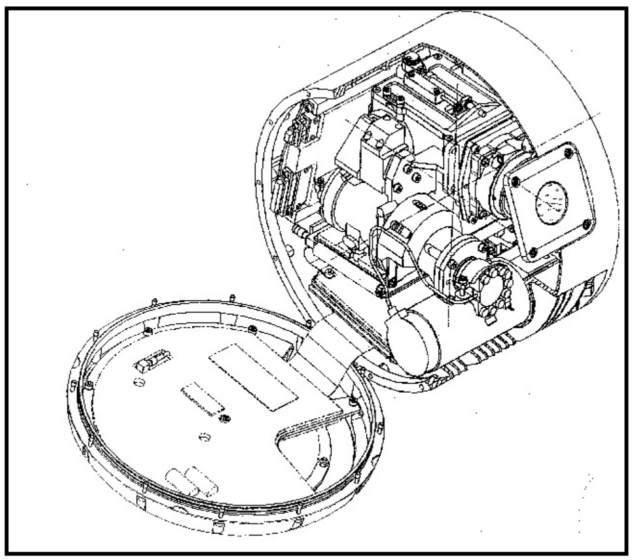


Fig. 5: Opened Thermal Imager with IRCCDs (288 x 4) and with linear cooler

Fig. 6: FLIR Control Panel (CP)

Binocular HMS/D with IITs

Fig. 7: NH90-TTH-HMS/D from Thales Avionics / Diehl Avionics

General Description

The binocular HMS/D is developed by Thales Avionics in co-operation with Diehl Avionics. It will provide the pilot and copilot with visual aids for missions during day and night and/or adverse visibility conditions. The HMS/D is part of the MFA subsystem. There are two sets of HMS/D equipment for each TTH-helicopter:

- one HMS/D equipment set for the pilot (HMS/D-P)
- one HMS/D equipment set for the copilot (HMS/D-C)

The two HMS/D equipment sets will be independent from each other.

Main Operational Function/Data
• Functions of the basic helmet: head protection and intercom • HMD functions: FLIR or IIT image and symbology presentation, vision under low light level conditions • HMS function: measurement of the pilot's or copilot's head position, computation and output of LOS pointing direction and head roll angle • Flight-Symbology generation in each HMS/D-electronics including Roll-compensation

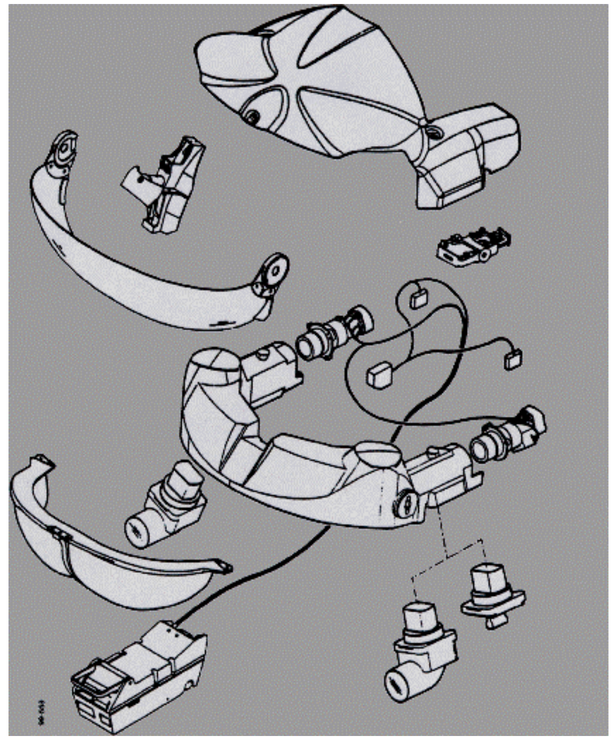
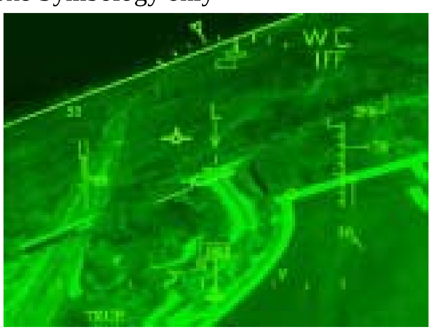


Fig. 8: Elements of HMS/D-DM, above, and changeable night vision tubes with day prism, below

The HMD is a binocular display system and is integrated into both the pilot's and copilot's helmets It enables the presentation of an image, generated by two Cathode Ray Tubes (CRTs) and an image generated by two IITs at night. The CRTs presents the FLIR image and/or symbology. The symbology will be superimposed onto the FLIR image (during day or night) or display symbology only (during day). To display the FLIR video the display will have the capability to operate in raster mode. To display symbology the display will have the capability to operate in stroke/cursive mode. To display FLIR video with symbology overlay the display will have the capability to operate in combined raster/stroke (or hybrid) mode with independent brightness control. Display of OWS information will also be considered. It will be possible to superimpose symbology also to the IIT imagery.

The FLIR or IIT imagery with (or without) symbology alone will be presented as an exact overlay against the outside world using visor projection technique with the visor being semi-transparent.
The position and orientation of the helmet will be measured continuously using the HMS-function to determine the pointing of the pilot’s and copilot’s LOS. LOS data will be used for slaving the FLIR platform. The measured head roll angle will be used for FLIR-image de-rotation.

a.) Stroke Symbology only



b.) Stroke Symbology superimposed over FLIR image

c.) IIT Image visible on Clear Visor

Fig. 9: Display of Flight Symbology, FLIR image and IIT image

Before starting a TTH mission the crew has to boresight the HMS. This means the alignment of the HMS with the reference axis of the HC co-ordinate system with regard to AZ, EL and ROLL. One Boresight Reticle Unit (BRU) will be installed for each crew member in the cockpit. The boresight symbology in the HMD is fixed to the HMD-Reticle.

Fig. 10: Boresight Reticle Unit (BRU)

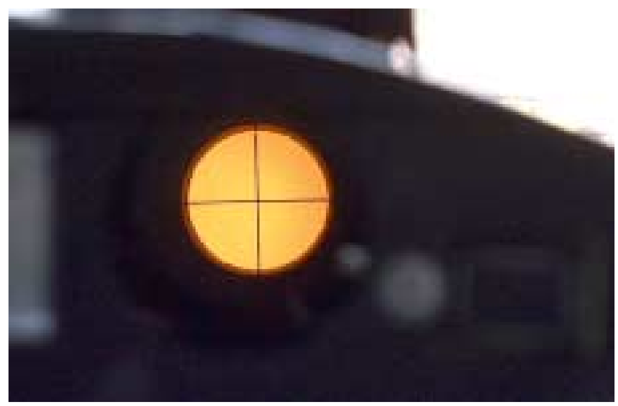


Fig. 11: BRU with reticle

In addition to the display functions the following functions related to the basic helmet will be provided:
- Protection of the helmet’s wearer against impact, penetration and noise.
- Intercom (earphones, microphone)
- Fitting and comfort to the wearer’s head
- Protection against battlefield lasers will be provided by a clip-on visor
- Protection against bright sunlight will be provided by a tinted visor (sun visor)
- Adjustment function of the basic helmet

Each HMS/D equipment set comprises the following major assemblies (LRUs):

- Basic helmet (BM) including magnetic HMS-receiver, FFL (Form Fit Liner), Intercom, interface to DM, retention system
- Display Module (DM) with CRTs, IITs, optics, visors and umbilical cable for electrical interface to CMO with QRC and battery box.
- Cockpit Tracker Module (CTM) is part of the magnetic HMS radiator
- One Boresight Reticle Unit (BRU) for AZ, EL and Roll boresighting
- Connection Module (CMO) close to helmet located inside the cockpit
- Electronics Unit (EU) including the symbol generation
- Control Panel (CP) with switches and controls for HMS/D functions and mode selections

<u>The control panel</u> comprises the following controls:

1	Power	OFF-ON
2	Symbology	Full Symbology
		- Decluttered Symb.1
		- Decluttered Symb.2
	- Decl. Symb. with OWS overlay 1 if available	
	- Decl. Symb. with OWS overlay 2 if available	
3	Brightness Symbol.	High <---> Low
4	Brightness Video	High <---> Low
5	Contrast Video	High <---> Low
6	Boresighting	ON/OFF/CHECK

Other remaining functions will be realized on the DKU: e.g. Test image or selection on Quick Release Pack left-right-both CRTs.

Fig. 12: HMS/D Control Panel with NVG compatible illumination:
PWR (ON/OFF), VIDEO (BRT/OFF/CON), SYM (NORM, DCL1, DCL2, BRT), B/S (ON/OFF/CHK)

FLIR Main Technical Data	
Field of View	30° by 40°
Platform angular limits	AZ ±130°, EL +45° to -70°
Slew rate	140°/s (AZ), 150°/s (EL)
Slew acceleration	>1000°/s²
Roll-axis	fix
Dimensions	295 x 485 x 225 mm³ (WxHxL)
Weight	<20 kg
Power Voltage	115VAC @ 400Hz
Power consumption	<200VA normal, 420VA max

HMS/D Main Technical Data	
HMD-FOV	FLIR: 30° by 40°; IIT: 40° ϕ
Exit Pupil	15 mm x 10 mm
HMS-Field of regard	>AZ ±130°, EL +45° to -70°
HMS-EMB	600 x 600 x 450 mm³
EU-Volume	ARINC 600, 4MCU
Weight	approx. 12 kg per unit incl. helmet with max. 2.2 kg
Power Voltage	28VDC
Power consumption	<180VA

The table above shows the main parameters of the FLIR and the HMS/D.

Main features of the TTH-HMS/D are:

- ⇨ Selection of FLIR or IIT images and superimposed symbology without time delay
- ⇨ Very low weight including the helmet and low volume
- ⇨ Optimized Center of Gravity of basic helmet
- ⇨ Visor Projection and large exit pupil
- ⇨ Brightness and resolution uniformity without vignetting
- ⇨ Flexible serial links to MIL-BUS, to FLIR and to Control Panel
- ⇨ High HMS-accuracy and low delay time
- ⇨ Advanced software design with symbology generation

HMD-Display Modes and presentation

The HMD is the aiding display for piloting. Pilot and copilot can independently select their display modes consisting of symbology and a sensor image.

The flight symbology for the HMD is generated in the symbol generator allocated in the respective HMS/D-EU. Therefore both symbol generators have a direct connection to the IRS (Inertial Reference System). The flight symbology can be supplemented with OWS symbology. The entire symbology can be switched off, or can be used in a HMD direct view mode without a sensor image or as overlay for the FLIR, the IIT or the OWS-Video image.

The steering of the FLIR is done by the crew member, who has the piloting priority. The other crew member can get exactly the same FLIR-image on Multi Function Display (MFD) as the piloting crew member (as a copy). The HMD display modes are independent from the MFD display modes.

Symbology projection

The system incorporates symbology projected into one or both eyes for day/night application. The HMS/D incorporates a binocular arrangement with two separate IITs and separate left and right CRTs, thus enabling full flight symbology or an outside world scene seen via a TI, both to be displayed in the helmet. The technique of presenting information to a pilot in this manner is complex and requires the pilot's eyes and brain to integrate the information displayed, to produce a single and not a double image. An example of symbology is shown in Fig. 13.

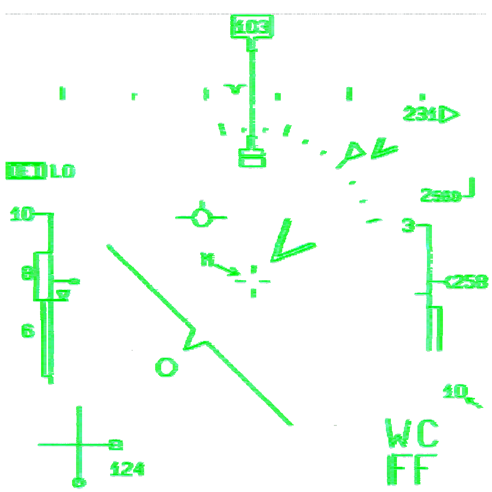


Fig. 13: An example of the HMD-Symbology

Flight Trials with Mission Flight Aids

The Flight Trials of the HMS/D and FLIR are split into different phases.
Phase I (MMI) is the basic evaluation of the HMS/D and partly FLIR with the following aspects:

- Ergonomic assessment
- Functional assessment with CPs
- Optical assessment
- Assessment of Tracking system
- NOE night flight assessment

The qualitative assessment of the HMS/D and FLIR during Phase I shall give the information whether the systems are usable in the helicopter for MMI aspects.
Ergonomic assessment shall evaluate e.g. the fit of the helmet, weight, and if the helmet can be worn for long periods.
Functional assessment shall evaluate e.g. the knobs of the CPs, the handling of the different parts (Display Module, IITs, QRCs, ...) and the Intercom capability.
Optical assessment shall evaluate e.g. the readability of the symbols and quality of the displayed FLIR image.
Assessment of Tracking system shall evaluate the steering of the FLIR by the HMS/D (e.g. ranges of LOS, steering velocity and deviation of LOSs).
NOE night flight assessment shall evaluate the performance of the IITs and of the FLIR in the helicopter environment (cockpit structure, windscreen) e.g. FoV, parallax error of IITs, FLIR and detection range.
To assess the above listed points, 30 flights with NH90 PT4 (16 Day flights and 14 night flights) were performed in the year 2000/2001 with 28 flight hours in total (14h day and 14h night). After the Industry flight evaluation, the OTC (Official Test Center) assess the HMS/D during the 1st OTC Preview in Manching (30.10 – 07.11.2001).

For the IIT and FLIR Night flight evaluation, a special flight path at the military facility WTD 61 (Manching) was specified (see Fig. 14).
The first part from point 4 until point 12 is a dedicated low level route (minimum height 75ft above ground) with dark wooden areas for IIT assessments down to 0.7 mLux. The second part is a route above 300ft (from point 12) with cities and motorway for FLIR assessments. Figure 15a to 15c shows images of a tree at the NOE route (see red point in Fig. 14) recorded with CCD camera, NVG and FLIR. Fig. 15d and 15e shows images of a motorway with NVGs and FLIR.

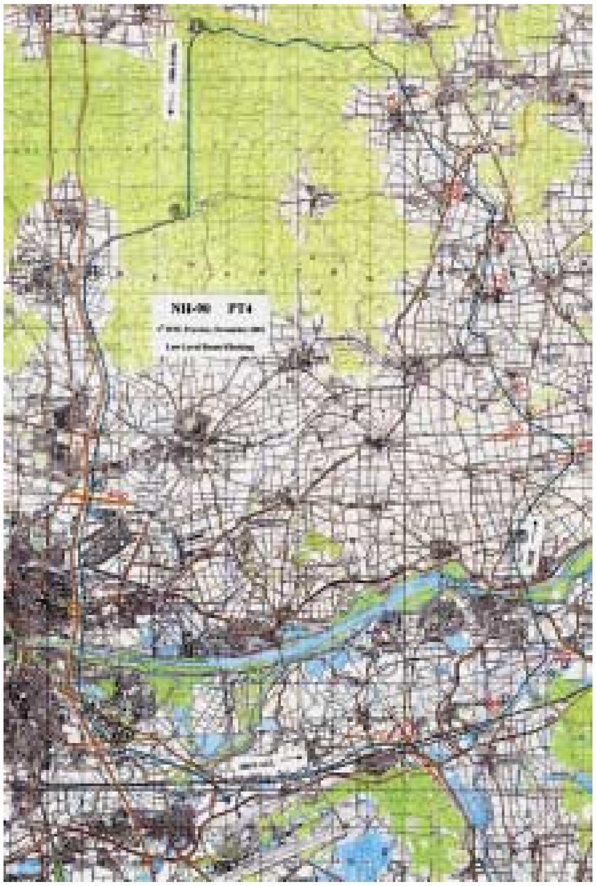


Fig. 14: Low level route Kösching at Manching

Phase II of the HMS/D flight trial program will be the detailed assessment of the new symbology in flight and repeated assessments of Phase I after improvements of the HMS/D and FLIR features. The Phase II is planned after implementation of the new symbology (see Fig. 13) during 2002/2003.

Results of Phase I for HMS/D

In general, the results of the Phase I are:

<u>Ergonomic assessment:</u> the weight and the fit (with personalization liner) of the helmet is good and the wearing of the helmet is comfortable also for long periods.
<u>Functional assessment:</u> all parts of the HMS/D are easy to use and the CPs can be operated with gloves. The quality of the Intercom system is good.
<u>Optical assessment:</u> the symbols are always readable (brightness of the symbology is sufficient during day and night). The quality of the displayed video image has to be improved. The quality of the symbology could be improved. This will be realized with the new symbology of the next SW phase.

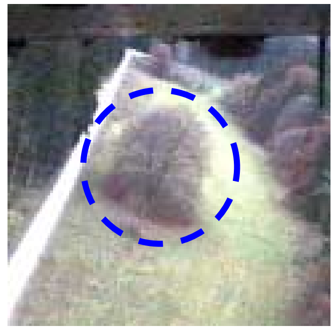


Fig. 15a: Tree at NOE Route recorded with a CCD camera outside of helicopter during daytime (see red point in Fig. 14)

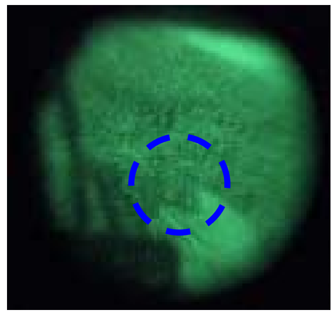


Fig. 15b: The same tree at NOE Route recorded with a CCD camera fitted behind NVG during night (see red point in Fig. 14)

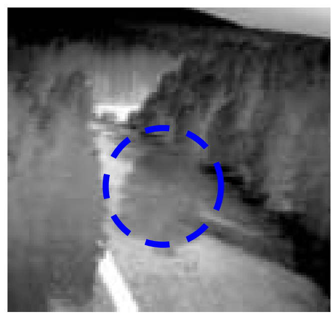


Fig. 15c: The same tree at NOE Route recorded with the FLIR during night (see red point in Fig. 14)

Fig. 15d: Motorway at second part of flight path (FLIR evaluation) recorded with CCD camera fitted behind NVG during night

Fig. 15e: Motorway at second part of flight path (FLIR evaluation) recorded with FLIR

Fig. 15: Important route points in the low level path

Assessment of the tracking system: an acceptable delay of the FLIR image displayed in the HMS/D was detected. The LOS ranges are sufficient.

NOE night flight assessment: the performance of the IITs is sufficient. The image display in the HMS/D seems to be darker compared to standard NVGs which is due to the different phosphor screens used in both systems. The parallax error which is present because of the IITs fitted at the side of the helmet need a dedicated training of pilots. An advantage of the side fitted IITs are, the capability to look around the doorframe. An obstacle, which is covered by the doorframe of the helicopter, can be detected. The detection range is similar to the standard goggles.

Results of Phase I for FLIR

In general, the results of the Phase I are:

Functional assessment: all parts of the FLIR are easy to use and the CP can be operated with gloves. The cool down time at normal operation is the half of the required 8 min. The polarity change is good without changes of image brightness and contrast. The manual and automatic gain adjustments are good.

Optical assessment: the FLIR image has a good homogeneity, the thermal image sensitivity is high with NETD < 40 mK. The MRDT curves are confidential. The Automatic Gain and Level control (AGL) is good during plain level flight, but during bank angles (>15°) an improvement is necessary. The problem is that demanding temperature differences of greater than 40°C for the sky over the horizon and the landscape have to be presented in detail with < 0.1°C in real-time (dynamically).

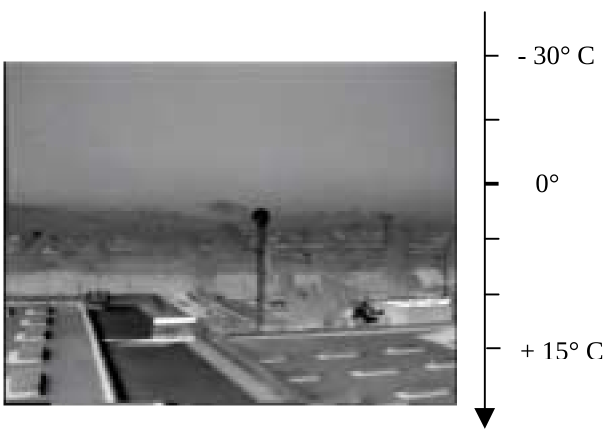


Fig. 16: Big temperature differences are a challenge to the dynamic range of detector, electrical circuits and AGL software

Galileo Avionica has made several loops of AGL-control from 1999 to 2001:

- Uniform IR Scene sampling; weighting of 4096 pixels in an area 50% by 50% of the FoV; flights 15-29
- Weighted IR Scene sampling; flights 29-77;12/1999
- Line by Line IR Scene sampling only in the middle of the image; Line by line sampling; flights 82-191;11/2001
- Line by Line IR Scene sampling equi-distance over the lines. AGL-Improvement from 28.11.2001.

Pilots choose mainly “BLK is HOT” polarity, see Fig. 17. The cold sky appears white; the image is like a black & white photograph.

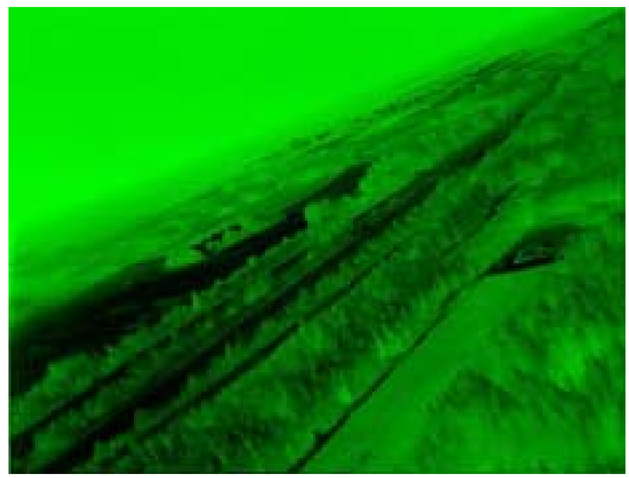


Fig. 17: Automatic Gain and Level Control, hot temperatures are presented in black

Platform assessment: A stable cast housing, stepper motors, backlash-free gearboxes with belt drive allows precise and smooth movements of the Thermal Imager Line of Sight. Even with full speed the image remains sharp due to short dwell time of the “parallel scanner type” imager. All the platform modes are easy to select and use; they have been successfully evaluated. Additional work is necessary to adjust parameter in the AUTO look-into-turn mode.

Conclusions

For the VSA-equipment (Vertical Situation Aids) the status of the development phase is as follows: the FLIR (Galileo Avionica, Hensoldt and AIM) and the HMS/D (Thales Avionics and Diehl Avionics) have been developed successful on equipment level, while the OWS is selected in 2/2002 as a retrofit. The German TTH will be equipped with a derivative of EADS-Dornier Hellas and the Italian TTH will be equipped with the Marconi LOAM.

On the Mission-Bus are two main subsystems: Mission Flight Aids (MFA) and Electronic Warfare System (EWS).

The Vertical Situation Aids (VSA) consist of a low weight piloting FLIR, HMS/D including symbol generator and OWS. This modern Pilot Vision Systems has day and night flight capability with two different type of sensors: a FLIR and IIT. The IITs are integrated into the binocular helmet and the FLIR is installed into the helicopter nose. The helmet LOS will be measured by an electro-magnetic tracking system to steer the FLIR-platform. Two binocular HMS/Ds (one for the pilot and one for the co-pilot) are used in the NH90 cockpit. The HMS/D and FLIR are fully qualified at equipment level.

The flight trials in Phase I have shown good results with minor improvements of the equipment's. In Phase II of this year the final flight trials will be performed.

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Notation

AGL	Automatic Gain and Level control
ATP	Acceptance Test Procedure
AZ	Azimuth
CCD	Charged Coupled Device
CDU	Central Display Unit
CoG	Center of Gravity
CP	Control Panel
CRT	Cathode Ray Tube
CSAR	Combat SAR
DKU	Display and Keyboard Unit
DMG	Digital Map Generator
EC	Eurocopter
ECD	Eurocopter Deutschland
EL	Elevation
EMI	Electro Magnetic Interference
EU	Electronics Unit
EWS	Electronic Warfare System
FFL	Form Fit Liner
FLIR	Forward Looking Infrared (TI)
FoV	Field of View
HC	Helicopter
HMB	Head Motion Box
HMS/D	Helmet Mounted Sight / Display
HSA	Horizontal Situation Aids
IIT	Image Intensifier Tube
IR	Infra Red
IRCCD	IR-Charge Coupled device
IRS	Inertial Reference System
LOS	Line of Sight
LRU	Line Replaceable Unit
LTV	Light Tactical Vehicle
MCT	Mercurium Cadmium Telluride
MFA	Mission Flight Aids
MFD	Multi Function Display
MMI	Man Machine Interface
MRTD	Minimum Resolvable Temperature Difference
MTC	Mission Tactical Computer
MTF	Modulation Transfer Function
NAHEMA	NATO Helicopter Management Agency
NATO	North Atlantic Treaty Organization
NBC	Nuclear Biological Chemical
NH90	NATO Helicopter of the 90's
NHI	NH-Industries
NOE	Nap of the Earth
NVG	Night Vision Goggle
OM	Optical Module
OTC	Official Test Center
OWS	Obstacle Warning System
PAH	Panzerabwehrhubschrauber (antitank h/c)
PoD	Probability of Detection
PVS	Pilot Vision System
QRC	Quick Release Connector
SAR	Search and Rescue
TI	Thermal Imager (FLIR)
TTH	Tactical Transport Helicopter
VISL	Visionics Laboratory
VSA	Vertical Situation Aids
WXR	Weather Radar

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