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THE NH90 EUROPEAN HELICOPTER PROGRAMME

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ABSTRACT

FRANCE, R.F.A., ITALY, NETHERLANDS and UNITED KINGDOM having decided to launch the Feasibility and Pre-definition Study (F.P.D.S.) of a medium size helicopter called NH 90, the INDUSTRY has been requested to settle the organization for this study started on September 1985 and limited for 14 months.

Following a brief description of the principles of this organization, the main naval and tactical missions of the aircraft and the main requirements from the Governments are mentioned.

The major part of the presentation is devoted to the description and the justification of the recommended solutions for the vehicle and its systems. These solutions are based upon the technological capabilities in Europe for the next decade and upon the assessment of the associated technical risks.

1 - ORIGIN OF THE PROGRAMME

Further to the preliminary studies performed :

- From July 1981 to October 1982 within the scope of the NATO programme relating to the pre-feasibility of a frigate-based helicopter.

- From May 1982 to April 1983 within the scope of the Helicopter European Co-operation between Aérospatiale, Gruppo Agusta, MBB, and Westland concerning a tactical transport helicopter up to sheet FINABEL 11 A 12, it appeared that an aircraft of a gross weight comprised between 7 and 9 tons could meet most of the specifications of the European countries involved.

- A commonality study was thus conducted under the care of NATO from September 1983 to April 1984 with a view to confirming that a same basic aircraft could be retained for the naval and land-based versions and detailing the penalties imposed by commonality.

In view of the positive conclusions to this latter study, the Ministers of Defence of France, Italy, West Germany, United Kingdom and the Netherlands have indicated their interest in the possibility of developing and manufacturing a medium-weight helicopter (8 to 9 tons) intended for naval and land-based operations and which could be put into service in the middle of the next decade.
A Statement of Work has been set up under the care of NATO for this helicopter called NH 90.

NATO HELICOPTER for the 1990's

At the end of 1984, the five participating nations decided to launch a feasibility and pre-definition study (F.P.D.S.) for this helicopter and to entrust the achievement of this study to a group of industrialists from the countries concerned. Each country designated its own leading company - Aérospatiale for France, Gruppo Agusta for Italy, MBB for West Germany, Westland for the United Kingdom and Fokker for the Netherlands - for the setting up of the industrial organization best adapted to the achievement of this first phase of the project. The general coordination of the study was entrusted with Aérospatiale. The five companies have concretized their agreement by signing, on 10 April 1985, an Industrial Organization Charter ruling their relations during the F.P.D.S. The Memorandum of understanding for the launching of this study was signed on 19 September 1985 by the Ministers of Defence of the participating countries. The study has lasted 14 months, from September 1985 to November 1986 and its results are the subject of the presentation.
In April 1987 , United Kingdom withdrew from the NH90 project, before the launching of the Project Definition Phase by the four remaining countries.

A total of over 600 aircraft of which 200 approximately for the naval version is anticipated to meet the requirements of the four countries. With the civil market openings for a derived version essentially intended for offshore operations and V.I.P. transport, as well as export trade possibilities of military versions, it is expected to cover a total market of at least 1200 aircraft ready for delivery from 1995 to 2005.

2 - OBJECTIVES OF THE FEASIBILITY AND PREDEFINITION STUDY

The Statement of Work of the study specifies the nature of the results to be submitted to the Official Services of the participating countries. It emerges from the S.O.W. that in addition to the results relating to the definition of the vehicle and associated systems, the study must also bear on the preparation of the whole programme (definition, development and production phases).

The main objectives of the F.P.D.S. are summarized as follows :

- elaborate and propose a technical definition of the basic helicopter (structure, engines, systems except specific mission systems).

- acquire precise information about the definition, the technical characteristics, the performance of the dedicated naval and transport versions.

- for the dedicated versions, identify and define a range of possible technical solutions for mission equipments and the corresponding operational capabilities.

- identify the common core system for the basic aircraft and the interfaces between the core system and the systems of the dedicated versions.

- provide the associated technical, cost, risk, planning elements and preliminary developments (if they are necessary) for the recommended solutions and propose fall-back solutions.

- recommend and Integrated Logistics Support System.

- develop a project implementation plan which will show :

. programme benefits.
. resources implications (financial, personal and facilities).
. schedule and organization of follow-on phases.
. proposed schemes for sharing . Research and Development burden in areas of interest.
. proposed management plan for controlling technical and programme aspects.

3 - F.P.D.S. ORGANIZATION

Taking into account the shortness of the study and the uncertainty regarding the next phases, the Government Agencies and the industrialists decided not to set up international groups working at the same place permanently.

The work has been thus performed either at the Government Agencies' or participating companies' premises, or during international meetings scheduled within the framework of each structure.

This working method has implied that the following be catered for before the study could actually start :

- Well-defined structures.

- Liaison procedures between the Government Agencies themselves, between the industrialists themselves and between both of them.

- Setting-up of quick document transmission and distribution media.

- Breakdown, timescale and cost of the tasks to be performed.

- General agenda and planning of the meetings for every set-up structure.

3.1 - GOVERNMENTAL ORGANIZATION STRUCTURES

Governmental organization rests on a Steering Committee and an AD HOC Group ; they interface with the industrial firms dealing with the study.

The Steering Committee is fully responsible for the programme. It is composed of the authorized representatives from the countries participating in the study.

The AD HOC Group assists the Steering Committee and coordinates actions decided by this Committee

3.2 - INDUSTRIAL ORGANISATION STRUCTURES

The organization rests on several principles :

a) It is an international cooperation study and this implies a just share of the tasks and fundings. The study must in particular reflect as far as possible the opinion of all participants.

b) The organization must clearly identify the various responsibility levels and meet the efficiency imperatives ; it must also be adapted to the official organization foreseen hereabove.

c) The study must take into account the technological state of the art foreseen at the beginning of the next decade and must be broadly opened to every information sources, in particular from the vendors.

d) The study will also take into account the export military requirements together with civil requirements to ensure the greatest potential of the project for additional sales, leading to reduced costs and providing the greatest return of royalties to the agencies.

The structures are at 3 levels :

- **Industrial Management Committee** (I.M.C.) composed of five members, every firm being represented by one of its directors.

- **Industrial Project Group** (I.P.G.) composed of ten members (2 by firm) and chaired by a General Coordinator belonging to AEROSPATIALE. One of the AGUSTA representatives is the deputy of the General Coordinator.

The I.P.G. interfaces with the AD HOC Group :

- **Expert Teams** (E.T.), fifteen in all, in charge of a part of the study.

Every Expert-Team is composed of four or five specialists (one per represented firm) and is coordinated by one of the partners with a sharing of the coordination role for the 15 Expert-Teams between the five industrialists. The settlement of those 15 international Expert-Teams allows to collect the knowledge and the know-how of the five participating firms.

4 - THE MISSIONS OF THE NH 90

The missions of the NH 90, defined by the Statement of Work, are summarized in the following paragraphs :

4.1 - TACTICAL TRANSPORT HELICOPTER (T.T.H.)

Main missions

Heliborne operations (radius of action of 250 km)
Helitransport

Specialized use

Search And Rescue
Intelligence Gathering
Electronic Warfare

Secondary missions

Airborne Command Post
Fire Support
Miscellaneous : parachute drops and mine-scattering operations

4.2 - NAVY VERSION (N.F.H.)

Primary missions

- ***A.S.W.***
Detection, classification, tracking and weapon launch.

- ***A.S.U.W.***
Detection, tracking, classification, identification by type.
Capability of providing Over-the-Horizon-Targetting (OTHT)

- ***A.A.W.***
Self-defence capability.
Detection of aircraft and anti-ship missiles.

Secondary missions

- ***VERTICAL REPLENISHMENT***
- ***SAR***

Optional missions

Personnel Transport
Troop Transport
Minelaying (lightweight mines)

5 - NH 90 VEHICLE

5.1 - GENERAL DESCRIPTION

The NH 90 is an aircraft which has to meet very strict requirements imposed by the shipborne or land-based version operators :

- Outside air temperature between -40°C and +50°C

- All-weather flying (rain, snow, hail, lightning strikes, icing conditions) by day and by night.

- Ceiling : 6000 m.

- Starting, take-off and landing up to 4000 m - ISA +10°C.

- Take-off in winds up to 45 kt from any directions up to 1500 m ISA+20°C.

- Preparation for flight from ship up to sea state 6 by day and by night, in Instruments Meteorological Conditions (I.M.C.).

Moreover, it is designed to offer an increased level of survivability owing to :

- Low detectability (acoustic, radar, infrared...).

- Reduced vulnerability (mission completed after a 7.62 mm impact, flight continuation for 20 min. after being hit by a 23 mm HEI round).

- Crash resistance as per MIL-Std 1290 (85 %).

- Integration of the requirements regarding protection against NBC environment.

Finally the reliability and maintenance aspects are taken into account right from the present stage in order to minimize operating costs and to optimize in-service availability.

Two different versions of the NH 90 will be available :

The **Navy version** NFH : an 8.6 T shipborne version capable of A.S.W., A.S.U.W., A.A.W. missions, as well as secondary missions such as units supply, search and rescue, transport, etc. owing to its versatility and the possibility to proceed to rapid configuration changes.

Fig. 1 - NFH MOCK-UP

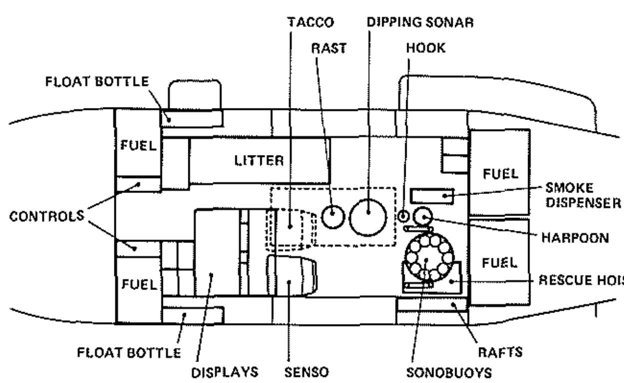

Fig. 2 - NFH CABIN LAYOUT CAPABILITIES

The cabin design is spacious (length = 4.3 m, floor width = 2 m, height = 1.60 m) and is compatible with the equipment items associated with the types of mission considered (SONAR, BUOY LAUNCHER, DECK-SECURE SYSTEM, WINCH).

The helicopter is equipped with a tail boom and main rotor blade automatic folding system for embarkment on NFR.

The **8-ton T.T.H. land-based version** permits a 14 to 20-man commando to be transported, with provision for rapid evacuation owing to two 1.60 m central sliding doors. As an option, a rear ramp permits rapid embarkment and disembarkment of a light tactical vehicle within the battlefield.

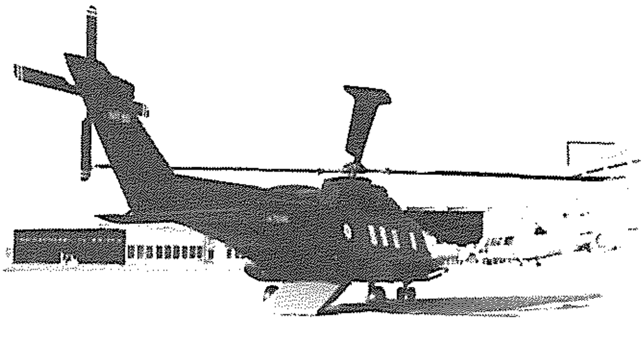

Fig. 3 - TTH MOCK-UP

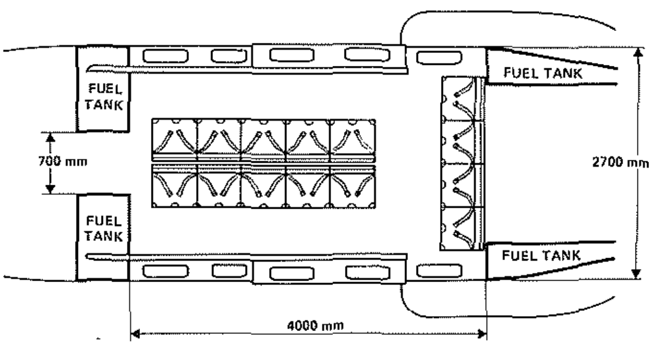

Fig. 4 - TTH CABIN LAYOUT (with 14 troop seats)

5.2 - MAIN FEATURES

Main rotor

4-bladed hinged rotor of the Spheriflex type

Rotor diameter 16 *m*

Tail rotor

4-bladed semi-rigid rotor of the crossbeam type

Rotor diameter 3.2 m

Main dimensions

	Overall	Folded
Length (m)	19.4	13.2
Height (m)	5.2	4
Width (m)	3.55	3.8

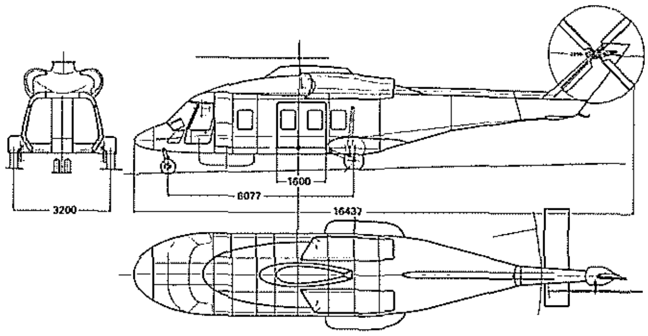

Fig. 5 - NH 90 3-VIEW DRAWING

Engines

2 RTM 322-01/2	TOP 1567 kW or
2 GE CT7/6	TOP 1507 kW

Weights

- Empty weight (basic helicopter) — 4 Tons
- A.U.W. — TTH 8 Tons; NFH 8.6 Tons

Performance data

- Max. Speed — TTH > 160 Kts; NFH > 140 Kts
- Range — TTH > 700 km
- Range (with auxiliary tank) — TTH > 1400 km
- Hover flight ceiling (ISA +20°C) — TTH > 3500 m
- Vertical rate of climb (sea-level, ISA) > 7 m/s (AUW = 8 T)

5.3 - MAIN ROTOR

The most recent improvements are used for the blade aerodynamics (profiles, tip shape)

The blade, will be made of composite materials. It consists of a fiber glass 2-box spar filled with foam and of a honeycomb rear section. The fiber glass + KEVLAR skin is covered with a conductive paint to minimize the radar signature. The leading edge, capable of an integral electrical deicing system, is protected by an anti-erosion metallic cover strip. This definition constitutes a good compromise between weight, tolerance to 23 mm HEI projectile, radar signature and resistance to erosion.

The Spheriflex rotor head/mast assembly is mounted onto the MGB via a single bearing and will be made of titanium (mast, head and sleeve). The pitch control, external to the mast, comprises a swashplate sliding on splines and hinged on laminate and swivel bearings.

The flapping restrainers consist of a composite droop restrainer ring and coning stops integrated to the sleeve. The rotor head is compatible with the deicing system and blade folding system. The rotor head/flying controls assembly permits satisfactory weight and drag values to be obtained and offers improved maintenance and reliability with respect to the results obtained on present rotor heads and this, without sacrificing vulnerability and tolerance to damage.

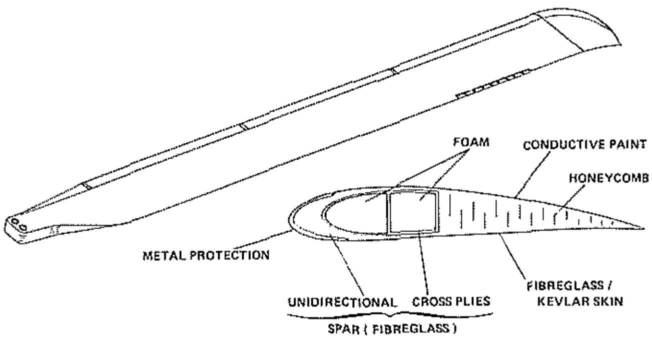

Fig. 6 - MAIN ROTOR BLADE

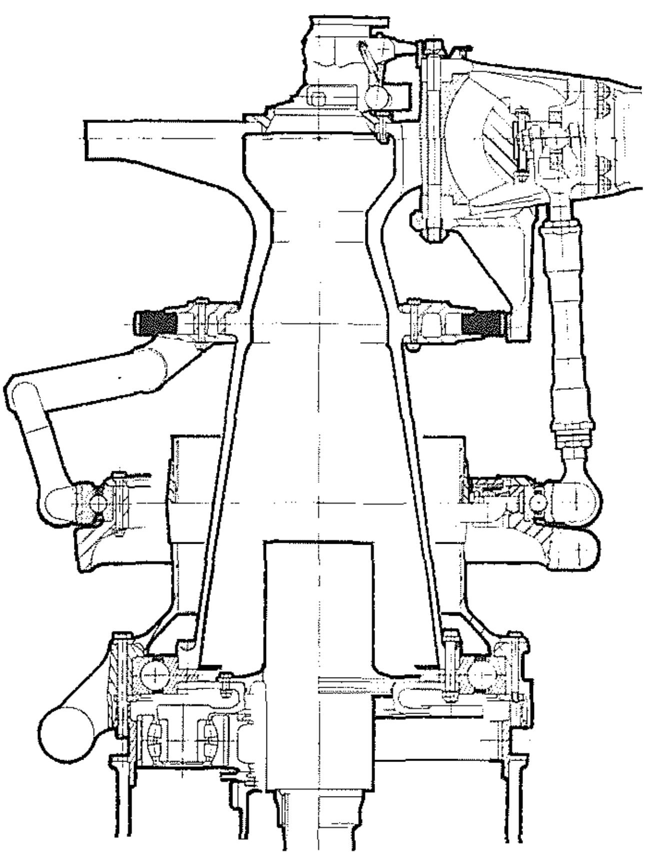

Fig. 7 - MAIN ROTOR HUB AND MAST

5.4 - TAIL ROTOR

The electrically anti-iced crossbeam type rotor head is equipped with 4 composite blades resisting to 7.62 mm shots. The aerodynamic definition features a 14° twist, spanwise tapered airfoils and a parabolic tip beyond 0.9 R. The selected dimensioning and airfoil characteristics confer high-grade manoeuvrability to the aircraft in keeping with cross wind requirements and high engine power.

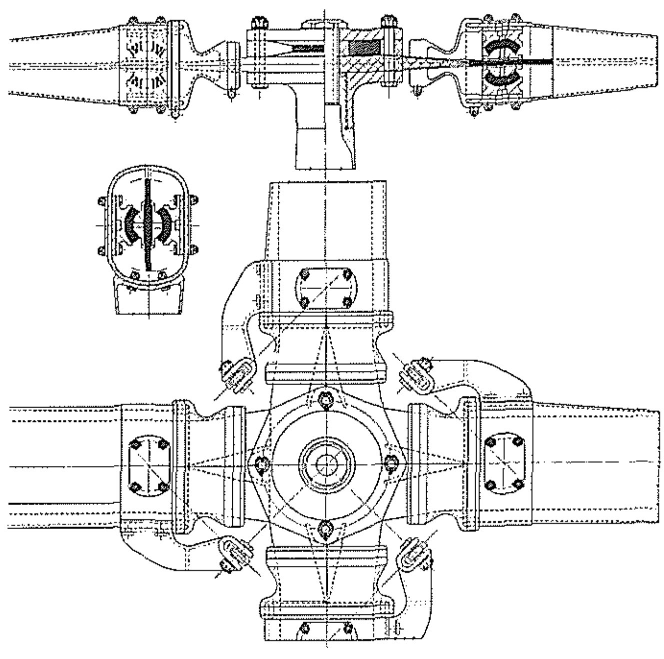

Fig. 8 TAIL ROTOR

5.5 - TRANSMISSION SYSTEM - POWER PLANT

The two engines RTM 322-01/2 or General Electric CT7/6 governed by a Full Authority Digital Electronic Control (F.A.D.E.C.) are installed aft of the MGB in semi-pod configuration in order to facilitate engine maintenance. An optional APU is installed between the two engines in order to ensure starting at very low temperature and permit on-ground aircraft system tests with engines stopped.

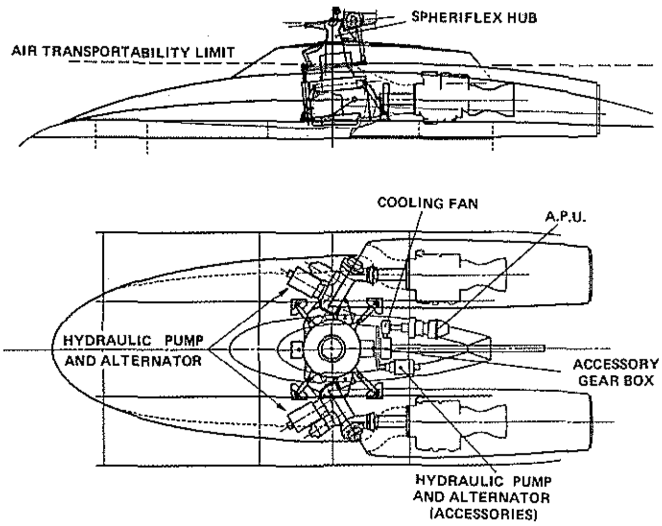

Fig. 9 - UPPER-DECK INSTALLATION

The MGB comprises 4 reduction stages between the input at 20500 rpm and the output at 260 rpm :

- First and second reduction stages : bevel gear

- Third reduction and combiner stage : cylindrical wheel and gear

- Fourth stage : epicyclic.

This system represents a good compromise as regards weight, compactness, reliability and vulnerability. The ancillary equipment items (alternators, hydraulic pumps, fan) are located on the side gearboxes and the central unit to which the APU is connected.

The assembly meets the modularity and reduced vulnerability requirements set by the operator and permits an on-condition maintenance in connection with a Health and Usage Monitoring System.

The rotor shear stresses and moments are transmitted through the MGB casing to 4 oblique struts secured to the structure. The rotor torque is taken up by a crown bolted onto the transmission deck. This arrangement remains compatible with a passive suspension system though the primary solution for vibration reduction purposes remains the multicyclic active control at servo-control units (Higher Harmonic Control). The rear transmission system, taken up at the combiner wheel through a bevel gear, will be constructed with composite materials in order to reduce the rear transmission linkage vulnerability and weight.

The engines, coupled aft of the MGB via a cardan coupling tube, will be installed on the transmission deck using rod-mounted fittings. The engines can optionally be equipped with Vortex-effect sand filters and Infra Red Suppressor to reduce infrared signature.

The aircraft shall be equipped with 4 crashproof self-sealing tanks having a total capacity of 1250 kg for the TTH version ; the fuel capacity for the NFH version will be increased to 1800 kg in order to perform a 4-hour mission.

5.6 - FLYING CONTROLS - AFCS

The flying control system will use fly-by-wire controls instead of the conventional flight controls. The collective lever and cyclic stick displacements will be electrically controlled and a quadruplex system will generate electric command signals to the main and tail servo-units.

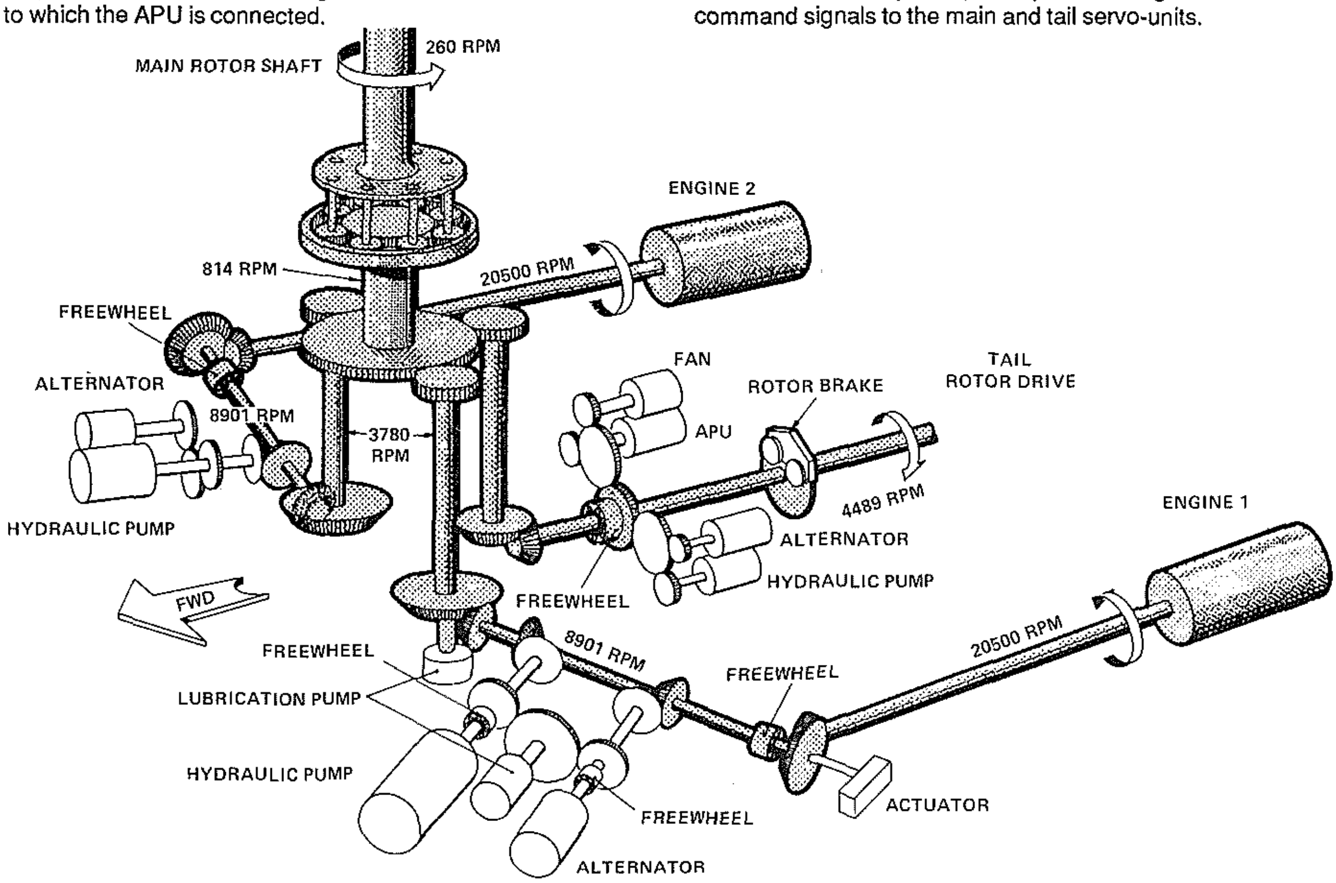

Fig. 10- MGB CONCEPT

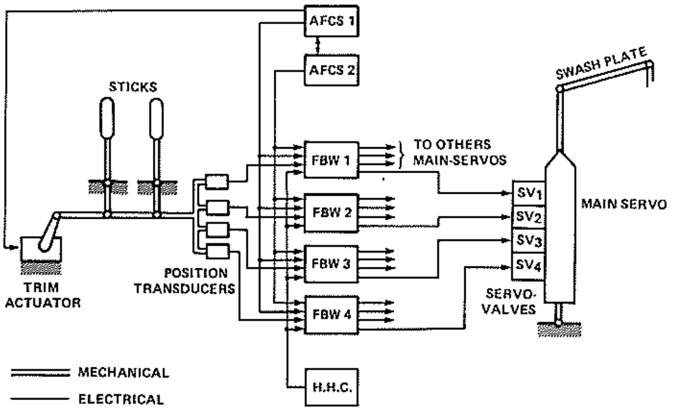

Fig. 11 - FLIGHT CONTROLS DIAGRAM

The computers will process flying control laws more elaborate than what is presently available with the mechanical controls and will ensure the aircraft basic stabilization through the AFCS. Extensive research and study is under way in order to find a solution to potential problems : actuator technology, Nuclear Electro-Magnetic Pulse Hardening, vulnerability, electrical power supply reliability, certification...

Selecting the fly-by-wire system also permits a better integration of the rotor Higher Harmonic Control, which is retained for reducing the aircraft vibratory level.

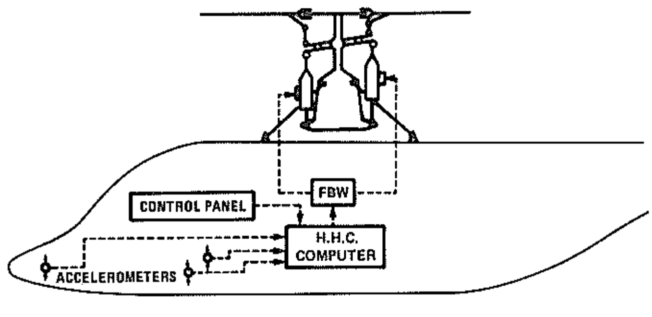

Fig. 12 - HHC ACTUATION

In the cockpit the cyclic pitch control will be achieved using either side-by-arm sticks mounted on the arm rests or conventional sticks secured to the seat. In either case, protection by shielding is facilitated.

5.7 - STRUCTURE

The structure is broken down into 4 modules :

- Fuselage forward section
- Fuselage lower central section
- Fuselage upper central section
- Fuselage rear section.

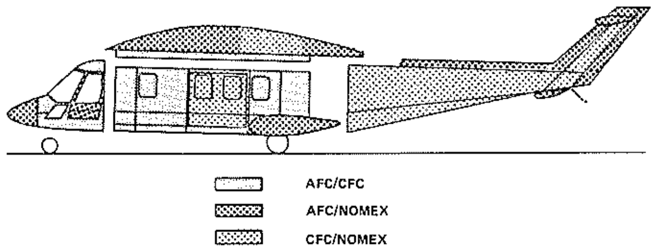

Fig. 13 - STRUCTURAL MATERIALS

The composite technology is widely used in order to meet the objectives set in terms of reduction in weight and production costs. Also, the requirements for crash resistance (MIL-Std 1290 - 85 %), NBC protection, and vulnerability are taken into account right from the initial design stage. The shape retained originally uses straight inclined sides with a view to reducing the radar signature.

The fuselage forward section comprises the bottom structure made of longitudinal beams, frames, skin panels and cockpit floor panels, the nose gear well in the centre, provisions for emergency floatation gear and the cockpit with the canopy structure, doors, windows and radome.

The fuselage lower central section comprises the front and rear fuel tank compartments, the electrical racks and flying control cabinet located within a composite structure (frames, longerons, skin panels). It includes two 1.60 m long - 1.50 m high lateral sliding doors as well as hard points for the main landing gear and weapon system pod attachment.

The fuselage upper central section is constituted by the upper sections of frames, longerons and skin panels and it incorporates the attachment points for the MGB and engines. It will be either a full composite structure or a metallic framework with metallic sandwich skin.

The fuselage rear section has a shape compatible with the installation of an optional ramp for embarkment of a light tactical vehicle. This section will be provided with an automatic (NFH) or manual (TTH) pylon folding system permitting space requirements to be met for use on ship.

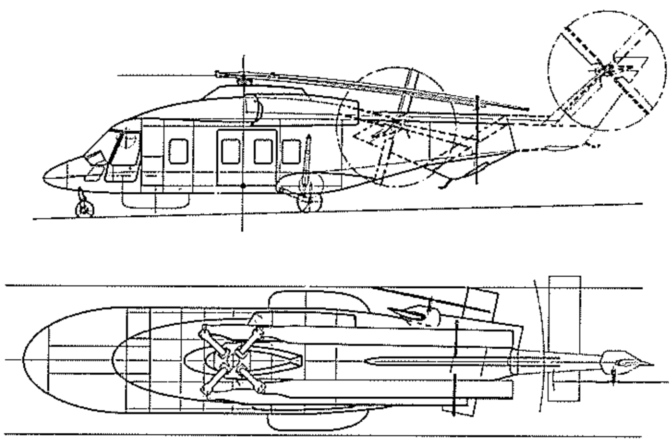

Fig. 14 - BLADES AND PYLON FOLDING

5.8 - MAIN AND AUXILIARY LANDING GEAR UNITS

The aircraft will feature a retractable tricycle landing gear with a trailing arm nose wheel to facilitate handling on ground and on ship deck. It is designed to resist hard landing conditions (4 m/sec.) on ship deck (NFH) and to meet MIL-Std 1290 (85 %) for the TTH version.

The auxiliary landing gear is of the twin-wheel type and retracts backward.

The main landing gear is of the trailing arm type with independent shock absorbers. It is planned to use it as a jack for lifting up the helicopter rear section in order to facilitate embarkment of the light tactical vehicle in the TTH version via the ramp.

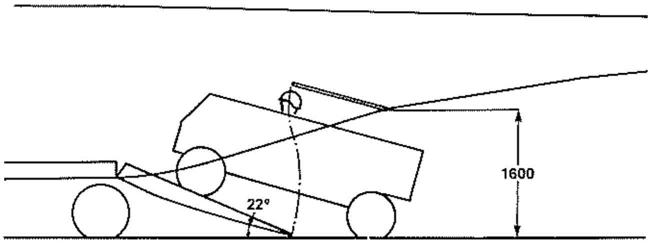

FIG. 15 - TTH RAMP CAPABILITY

The wheels of the main landing gear as well as the blades, main rotor hub and mast and tail pylon are dismounted for airtransportability inside HERCULES C130 or TRANSALL C160.

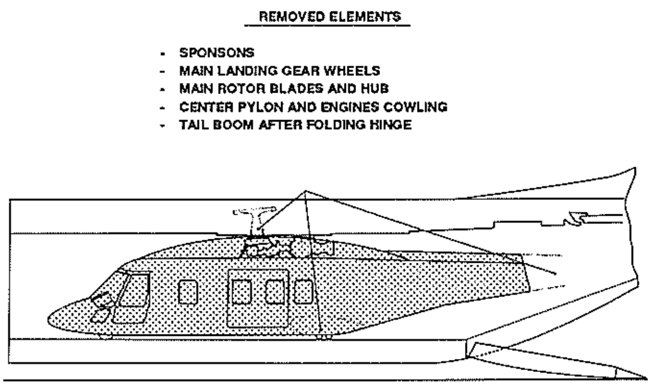

Fig. 16 - AIR TRANSPORTABILITY IN C130

6 - NH90 MISSION SYSTEM

6.1 - BRIEF REMINDER OF THE RESULTS OF PREVIOUS STUDIES

The prefeasibility study undertaken in 1981 and 1982 for an on-board helicopter has demonstrated that 5 concepts ranging from 6.8 to 13 tons are available.

- Concept 5 allows performing A.S.W., A.S.U.W and A.A.W. missions autonomously ; this is a 13 tons helicopter.

- A.A.W. mission capabilities are more limited in Concept 4; this is an 11,5 tons helicopter.

- Concept 3 performs 1st detection ; sensors are processed on board the ship ; this is a 10 tons helicopter.

- In concept 2 the helicopter is mainly used in the A.S.W. role upon ennemy contact ; this is an 8.5 tons helicopter operating autonomously.

- A.S.W. and A.S.U.W. mission capabilities are limited in concept 1 and range is lower.

Costs, the need to operate the helicopter on board existing ships and tactical (system autonomy) reasons have led the Navies concerned to select **Concept 2.**

These studies have shown that :

- NFH/TTH commonality is an essential condition for the study to lead the way to development ; because of its cost, the programme may never start if this condition is not met.

- Weight and volume restrictions are essential technical conditions to be observed for the operators to believe in the helicopter :

  - It must be possible to operate the helicopter from existing ships.

  - Air transportability must be observed for TTH.

  - Since a weight is imposed for NFH, it is important that this weapon system be designed for quick reconfiguration.

6.2 - ORIGINAL CHARACTERISTICS AND OBJECTIVES OF THE MISSION SYSTEM

6.2.1 - TTH mission system

The prime mission of the Tactical Transport Helicopter is assault troops in a multiple threat environment.

Tactical coherence requires deploying protection/support helicopters to defend or escort tactical transport helicopters prior to the latter's arrival.

The best TTH defences are above all its contour flying ability to avoid threats and its stealth improved with a marked reduction of its IR, radar, optical and acoustic signature.

The mission system is designed to transport fighting troops into the combat area in any meteorological condition. This involves night flying in poor visibility even with a high relative humidity rate when the FLIR is inoperative.

The various items of visionic equipment (FLIR, night vision goggles, millimetric wave radar) are combined in every case envisaged to achieve a successful mission system design.

TTH efficiency is for the most part measured by the surprise caused as a company is disembarked in a few minutes over the landing area. This had led to use several groups of TTH helicopters (a group is composed of some 10 hélicopters) simultaneously.

Helicopter station keeping

To date, station keeping is not possible in Instruments Meteorological Conditions (I.M.C.) and the landing rate would be low with approximately 1 helicopter every two minutes (scaled let-down).

This is not acceptable and the operators have requested that station keeping be provided in this flight configuration ; this would allow for a close formation let-down, even in I.M.C.

The successful design of this station keeping system will be TTH's original feature. This will require one (or two for safety purpose) sensor measuring distance and angle with respect to the formation leader position and this sensor will be coupled to AFCS.

Finally, mission performance rests on extremely accurate navigation (strapdown, GPS) coupled with a map reader.

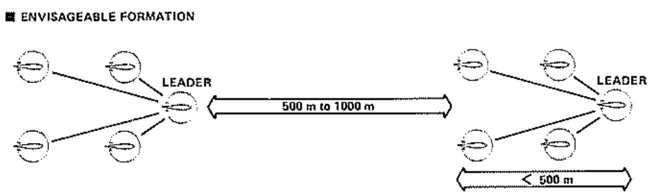

Fig.17- HELICOPTER STATION KEEPING

6.2.2 - NFH mission system

Previous studies have evidenced that the 8.5 tons helicopter is mainly used by the frigate upon primary detection with towed sonar or very low frequency towed passive detectors.

From the NST and SOW, it appears that **the helicopter must be autonomous** and can be used in a preventive role (active sonar screening ; sonobuoy barriers whenever escorting convoys) or reactive role as well as zone search (surface warfare) role.

The mission system must therefore process tactical situation from sensor detections on board the helicopter. Signal processing, correlation and target identification proceed on board the helicopter and the data link with the ship transmits tactical parameters only. The participation in the command and control net quested by the operators will make of this helicopter an autonomous tactical unit which actions are no longer be dictated by its parent ship exclusively.
All-up weight restrictions are the main difficulty for the mission system since the current state of the art does not allow transporting all of the system's components. To meet the operators' requirements, the study has been carried out along two axes to remain within the imposed weight range :

- Quick helicopter reconfiguration and modular concepts for the subsystems.

- **High system integration** which could reduce the aircrew to 3 members only (4 members are normally required in a helicopter of this category) ; from the same station, the copilot would then become the tactical coordinator and have standby flight controls, thus allowing for some weight saving.

Artificial intelligence will be considered in this integration to reduce the aircrew workload and thus facilitate mission performance with reduced aircrew ; voice synthesis is also under study.

The second essential point to be met is the **helicopter tactical interoperability** i.e.

- The ability to operate from ships other than its parent.

- The ability to exchange tactical data and orders with other ships ;

- The ability to operate all types of weapon envisaged with a polyvalent weapon arm and its interfaces.

The third essential point to be met is the **helicopter ability to participate in A.A.W. within the naval force.**

6.3 - CURRENT STUDY STATUS - PROFILES OF MISSION SYSTEMS ENVISAGED

6.3.1 - General architecture

To meet the required leadtimes and fulfil the objectives of a very short study, a number of assumptions and hypotheses have been made as regards the system architecture :

a) **Search for maximum NFH/TTH commonality**

b) **Selection of a federative architecture** recommended in previous studies and arranged around a 1553B standard bus (The 1773 standard optical bus study remains open).

NH90, and particularly NFH, avionics needs have led to select the concept using more than one data bus.

A study of the nature and quantity of the data to be processed on board NFH has given rise to a functional separation between **basic** and **mission-specific** avionics.

This solution is practical as far as the mission bus/basic bus interface transmits only a limited quantity of data.

This architectural selection involves the following consequences :

- Higher bus capacity for data as well as terminals.

- Possibility to develop basic and mission-specific avionics separately.

- Possibility of single certification for the basic avionics separate from the mission equipment connected to the mission bus only.

- Apart from their interfaces, the two buses can be controlled differently for the basic and the mission-specific part.

In terms of data quantity, there is no need for a second bus on TTH. The consequences described earlier are however sufficient to retain a two-bus organization.

c) **Reduction of bus management workload** by selecting to process the signal and to perform a maximum of calculations within the subsystems.

The bus transfers tactical data only (route, speed, heading, identification, etc.) and controls ; pictures are transmitted via screen-specific video junctions.

d) **Search for a high computer growth potential** to take into account the system evolution during its life cycle. ADA language selection to conform with the selection made in the NFR study ; the PASCAL language is considered as an alternative solution only. The federative architecture would allow, should this become necessary, using PASCAL within a subsystem while the main computer is ADA programmed.

e) The naval system is organized around a piloting function, a tactical coordination function and a sensor operation function. **The system is designed for tactical coordination to proceed from** the cockpit.
The development of a fourth crew station can be envisaged in accordance with the Navies requirements. The system is designed so that the addition of this station does not involve modifying the other three and for maximum NFH/TTH commonality.

f) **Systems redundancy**

The redundancy levels of the suggested system have being studied to define the flight safety and mission performance requirements.

The system is structured in such a way that the fields requiring the hightest integrity are not dependent upon or impaired by those of lower integrity. This applies in particular to the most critical functions which are those handling the helicopter's flight characteristics.

6.3.2 - System description

a) **Basic system**

Apart from stabilization with the digital A.F.C.S., the basic system will also perform navigation with a self-contained, strapdown, hybrid, Doppler-Navstar (GPS) system and health monitoring.

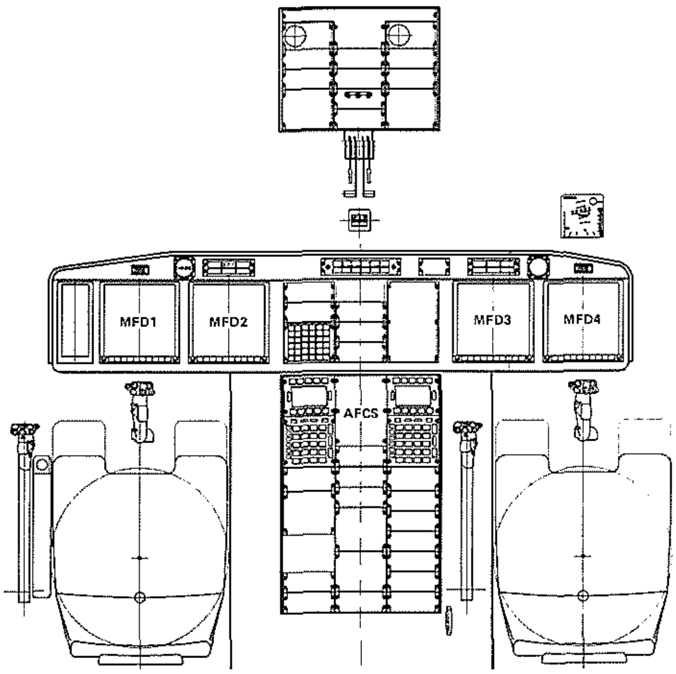

Fig.18 - NFH COCKPIT

The cockpit will be equipped with four 8 x 8 inches screens capable of displaying the complete piloting symbology. Tactical or sensor pictures will be displayed on the copilot screen (the copilot may be the Tactical Coordinator in the NFH version).

Use of flat LCD screens is envisaged and a fifth screen is foreseen for system displays (engines, hydraulics, Health Usage Monitoring...).

The modes and controls philosophy consists in attempting to reduce the crew's workload :

- by grouping controls on CDUs ("touch overlay" system).

- by optimizing symbologies.

- by including future use of voice synthesis.

- by including future use of artificial intelligence.

- by attending to ergonomics :

  . aircrew comfort improvement.

  . fly-by-wire mini-sticks optimization.

- by improving outside visibility as permitted by the instrument panel.

b) **Mission systems**

The mission computer and the processing units use fast, modular, built-in processors applying hybridation techniques. Data insertion devices are provided. The complete system is systematically hardened against all types of jamming and interferences. Likewise, the helicopter shall operate in NBC atmosphere and will have to be made resistant to NBC combinations ; in order to increase system capabilities, it is therefore envisaged to use an optical bus if the state of the art allows designing one within the required leadtimes.

• TTH mission system (Chart 1 in Annex)

This system is mainly composed of :

- Visionic equipment (Night Vision Goggles or piloting FLIR connected to the helmet mounted sight).

- An obstacle warning radar used as a complement of FLIR.

- Tactical navigation equipment (map reader coupled to Nav. system) at crew's disposal.

- Helicopter station keeping already mentioned above.

- Self-defense equipment and weapons including :

. Laser, IR and radar warning sensors coupled to flare and chaff release installation.

. Simple weaponry (gun, rocket pods) for fire support missions.

. Capability of carrying air-to-air self-defense missiles.

Apart from the self-defense contribution evoked earlier, performing electronic warfare missions with TTH implies developing a specialized version.

• NFH mission system (chart. 2 in Annex)

- Operator :

As for pilots and Tactical Coordinator, the operator station ergonomics is carefully looked after with screen based consoles, multifunction CRTs and roll-ball markers.

- The anti-submarine system includes a low frequency sonar, a sonobuoy suite and an inboard MAD. Sonar and sonobuoy data are handled with the same processor. MAD data handling with the same processor is under consideration. Although the detection system is self-contained (processing on board the helicopter), the need for non-tactical acoustic data exchanges with the ship cannot be overruled at this stage. In this case a specific data link complementing tactical link could prove necessary.

- The above-surface warfare system includes a radar able to detect small targets in heavy sea clutter and also air targets of low radar equivalent area to contribute to the ship defence system. These two requirements are difficult to reconcile in terms of radar technique and a specific study is foreseen for the next phase.

- Identification is a major problem and NIS i.e. IFF is not enough. FLIR will solve the problem over a short distance and it is planned to use an identification FLIR but the extension in the ship's weapons range makes it necessary with the correlative extension of stand-off distances to look for another procedure. Research has been initiated in the radar classification field and should lead to significant distance extensions.

- OTHT will proceed via tactical link which rate is compatible with slow tracks (surface ships).

- Electronic warfare and self-defence

Electronic warfare primarily means ensuring self-defence i.e. detecting radar, missile launching, etc, and automatically releasing chaff and flares.
The Electronic Warfare function on board NFH contributes, with ESM use, to a definition of the surface situation and a passive detection of threats. The detection range envisaged must cover the expected range of enemy's fire control and self-guiding radars. Finally, use of a self-defence jammer is envisaged in some cases.

- Weapons :

. Torpedoes are mandatory weapons on NFH.

. Although after a helicopter OTHT, the enemy ship would be handled with missiles fired from the friendly ship, optional anti-ship weapons have been included. Air-to-air self-defence missiles are included as options.

For weapons, the philosophy consists of :

- searching for interoperability and polyvalence

- making the helicopter ready for use with either weapons under development or that currently are and will remain in service after NFH entry in service.

7 - CONCLUSIONS

The NH90 Feasibility and Predefinition Study has been successfully completed in October 1986, and has allowed designing the vehicle and associated systems meeting the Statement of Work specifications for naval and land-based versions with an all-up weight below 9 tons.

The F.P.D.S. will be followed by a Project Definition Phase intended to provide the Governments involved with the data required to take a decision in 1988 on starting the Development Phase . Based on the assumption of a Development Phase starting end 1988, the first aircraft would be delivered in 1995.

The results from F.P.D.S. show that the NH90 will be an advanced aircraft taking advantage of the latest technologies for the vehicle and systems design. Thanks to its high RAM level, better performance and increased operational capabilities, both in its land-based and naval versions, it should normally be the successor of those aircraft currently commercialized in this weight segment.

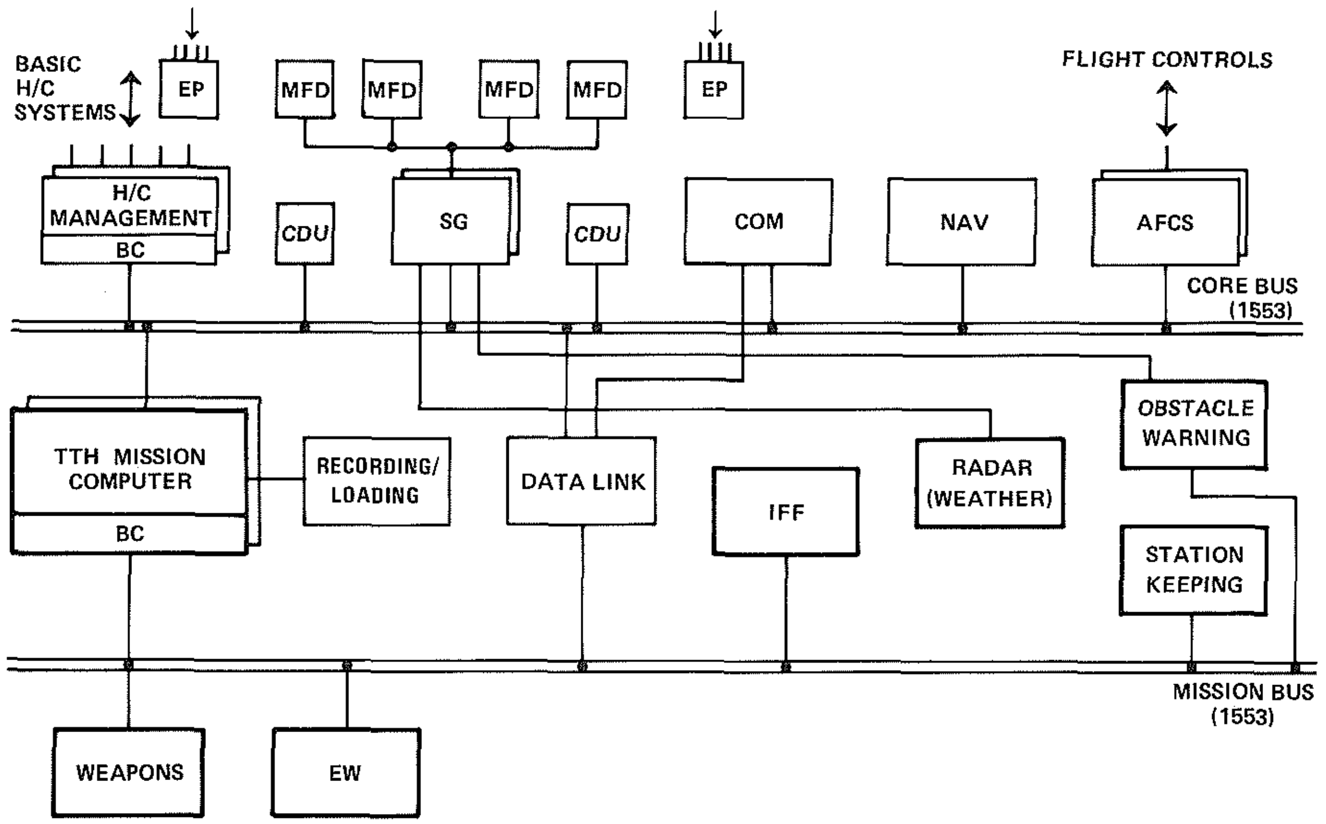

CHART 1 - TTH SYSTEM ARCHITECTURE

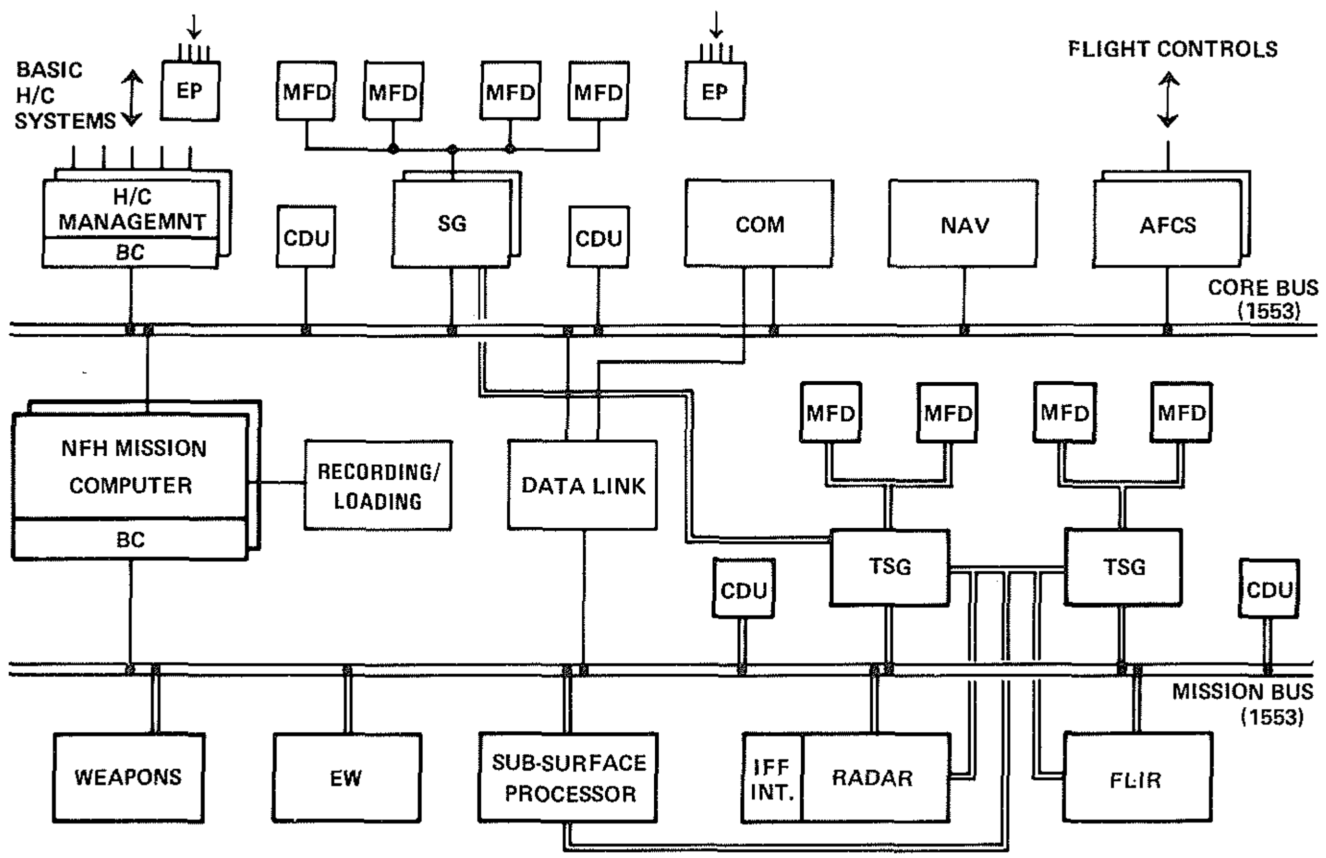

CHART 2 - NFH SYSTEM ARCHITECTURE