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NH-90 THE EUROPEAN TACTICAL TRANSPORT HELICOPTER FOR THE THIRD MILLENNIUM

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1. SCENARIO

The new international "scenario", characterized by rapid evolution of the threat and by an increasing demand for Humanitarian Assistance, Peace Keeping and Disaster Relief operations, envisages tremendous changes of the third millennium land forces features, particularly as far as the following aspects are concerned:

- quality rather than quantity of Land Forces;
- quality to be enhanced, through improvement of man-power profile and weapon system performances;
- more flexibile Force Structure and offensive minded doctrine.

Helicopters are in "pole position" among those weapon systems which will benefit of such a trend, as they are suitable to embed State-of-the-Art technology.

In fact, the most advanced doctrine foresees that the Tactical Movement of Forces by helicopters will provide, in future, the Land Force Commander with an unequalled "force multiplier" tool, provided the features of the third millennium tactical helicopters are properly tailored.

Europe is developing the NH-90 Tactical Transport Helicopter (TTH) to move the Army into the 21st Century.

2. TAILORING TTH FOR THE 3rd MILLENNIUM

Designing and Developing such a helicopter is worthwhile only if a wise balance of effectiveness and affordability is practicable.

Among the most significant Design and Development drivers, it is worthwhile to outline those which are vital for provision of flexible and not dogmatic answer to changing mission requirements which result from volatile world situation and changing threat.

On the side of "Effectiveness":

- AIRCRAFT PERFORMANCES, exploited in Tactical operations at day and night including adverse weather conditions;
- SUPPORTABILITY, optimizing the "ilietes" (RAMT);
- SURVIVABILITY, including "guerrilla" scenarios;
- SAFETY;
- INTEROPERABILITY, in multinational environment;

on the side of "Affordability" we will analize later on:

- MULTINATIONAL COOPERATION;
- "AIRCRAFT FAMILY" CONCEPT;
- LIFE CYCLE COST REDUCTION.

3. EFFECTIVENESS KEY FEATURES

3.1 PERFORMANCES

To fulfil the third millennium mission requirements, the NH-90 performances (in terms of speed, agility, payload, etc.) have been not only significantly increased but also extended in spatial and temporal dimensions. This enables tactical operations by day and night, in all types of terrain, in adverse weather and battlefield environment. The NH90 is designed to operate in winds up to 80 Km/h, gusting up to 110 Km/h with hail and snow falling and recirculating, heavy rain, from minus 40 degrees centigrade to ISA plus 35 degrees centigrade, ceeling 4.000m (full operations) and 6.000m (max flying capability).

To obtain outstanding qualitative and quantitative achievements the most advanced technologies are embedded in the NH-90/TTH, such as:

- Composite Fuselage;
- Modular Integrated Flexible Avionics;
- Fly-by-Wire (quadruple) Control System;
- Diagnostic and Monitoring System;
- Digital Map System;
- Optimized Instrumental Panel Color MFDs (Multi Function Display);
- Integrated Night Vision System (FLIR+NVG);
- State-of-the-Art Engines Rolls Royce Turbomeca 322 or General Electric Alfa Romeo T700-T6E;
- Advanced Transmission and Rotor Design;
- Core Avionics separated from Mission Avionics;
- High Growth Potential (50% Spare Processing Capability);

Such a technological edge enables the NH-90/TTH to fulfil any mission:

- at higher speed;
- with improved agility;
- relaying on improved Navigation System (IRS - DOPPLER - GPS) and Communication System (including high and maritime frequencies);

- with enhanced self deployment range (aux fuel 1.200 Km);
- with a good power margin (HOGE/TOP 17%);
- with 10 times more accurate positioning;
- with a minimum CREW WORKLOAD, achieved through the most user-friendly systems integration and optimized Man-Machine Interface;
- with enhanced safety;
- with effective Monitoring and Diagnostic capability.

3.2 SUPPORTABILITY

Integrated Logistic Support (ILS) topics were superbly covered in depht by Mr Honeck (NAHEMA ILS Section Leader) last year at the 20th European Rotorcraft Forum with a lecture that I strongly recommend to specialists.

I will now outline the most significant contribution of ILS to the Effectiveness of the helicopter. Later on, when dealing with Affordability, I will mention it again, as ILS is the keystone of Life Cycle Cost savings. To stress the utmost importance of ILS in this programme, equal emphasis has been given to Performances, Reliability, Maintenability and Safety (on the Effectiveness side) as well as to Costs and Time

Shedule (on the Affordability side).
In fact to achieve the target of 87% Availability the NH90 is beeing developed with the following superlative Supportability features:

- Mission Reliability higher than 97% due also to:
  . Design Life higher than 5.000 hours;
  . Redundancies and Automatic Reconfiguration Capability;
  . on-condition Maintenance optimized by Monitoring and Diagnostic System, and its Ground-based Logistic Information Management System appendix (GLIMS);
  . Failure rate lower than 2.5 for 10 flight hours.
- Excellent Maintenability which needs 2.5 maintenance hours per flight hour (engines excluded), due to:
  . Modularity, Accessibility and Interchangeability;
  . Reduction of Time to Repair (line TTR < 30');
  . Line Replaceable Units philosophy;
  . minimized Aerospace Ground Equipment and Special to Type Equipment;
  . Interactive Electronic Technical Manuals (IETMs);
  . Monitoring and Diagnostic System with Diagnostic and Fault Isolation capability and Built-in Testability function;
  . no Overhaul Required.
- Streamlined SERVICING:
  . Lubrification Interval (maturity) 600 flight hours;
  . Maintenance Interval (maturity) 900 flight hours;
- Paperless Technical Publications:
  . Interactive Flight Manual, checklist and logbook are part of the aircraft on-board data base;
  . the huge array of Maintenance manuals shall be available on few CD Roms in Lap-top Computer for flexibility and mobility;
  . Data Input/Output devices will allow easy and fast updating of Interactive Electronic Technical Manuals and relevant on-board data base.

MONITORING AND DIAGNOSTIC SYSTEM (MDS)

MDS has been mentioned several times as it playes a main role on the aircraft Supportability, so it is worth providing few information regarding its tipical functions:

- Pre-flight Testing:
  . Functional Test of monitored Systems and Sub-systems;
- In-flight Monitoring and Diagnostic:
  . Status Monitoring;
  . Health Monitoring;
  . Alarm Monitoring;
  . Provision of inputs for reconfiguration;
- Maintenance Support:
  . Full or Semi Automatic Functional Diagnostic Tests;
  . Faults detection ranging 88-95%;
  . Faults isolation ranging 80-98%;
  . Data exchange through Data Transfer Device (DTD);
  . Maintenance Data and Information via MFD.

3.3 SURVIVABILITY

Improving the NH-90 survivability up to the top level has made it necessary to win four Challenges:

- 1st: to make it difficult to detect the helicopter (H/C);
- 2nd: to allow the H/C to fly where it can not be detected;
- 3rd: to keep flying the H/C even when detected and hit;
- 4th: to perform safe contingency landings anywhere, if flight cannot be continued.

The prevention of easy detection of the H/C is made possible through the reduction of Visual, Audio, Infrared and Radar signatures.

The NH-90 Low Visual Signature is the result of the 9-ton Class Helicopter reasonable size, its reduced glint and optimized camuflage.

Reduction of noise from the NH-90 depends mainly on the articulated four blades Rotor, low speed of blade tips and MIL STD 1294-oriented design.

Engines IR suppressors and no unmasked hot surfaces or spots keep the IR signature of the H/C very low.

Low Radar Signature has been achieved by the composite structure, the special coating, the diamond-shape cross-section, and by avoiding rough-spots.

To win the second challenge, effective NOE flight is crucial. To provide the TTH with the most effective day and night NOE flight capability, the following features have been embedded during the Design & Development phase:

- outstanding Automatic Flight Control System;
- specific mission aids, such as Obstacle Warning System and Cable -Cutters;
- Integrated Night Vision (FLIR, NVG);
- Head Up Display Capability (HMSD).

Furthermore, Tactical Situation Representation and optimized Navigation/Communication System will help the pilot to find out safe routes to fly.

But, despite of its ability to avoid the threat, when the Helicopter becomes a target and is subject to ground fire and hit the third challenge is to provide an adequate survivability, to the maximum possible extent, by an appropriate design and by EWS (Electronic Warfare System).

Appropriate Design can enable the Helicopter to survive the enemy fire, since proper features have been embedded, such as:

- extensive use of redundancies;
- use of damage-tollerant materials;
- Separations of Redundant Elements;
- Transmission Dry-Running Capability;
- Effective Monitoring and Diagnostic System (Automatic Reconfiguration);
- Shielding of Critical Components and Armoured Pilot Seats.

In addition the Electronic Warfare System will provide a good protection against guided weapons by means of a dedicated system, comprehensive of:

- Radar Warning;

- Laser Warning;
- Missile Launch Detector;
- IR Jammer (option);
- Chaff and Flares Dispenser;

Unfortunately these electronic devices are likely to be blinded by other signals generated by helicopter avionics and furthermore may mistake friendly for enemy signatures; for this reasons they are provided with "smart" features to be able to:

- ensure a full time "clever" coverage, thanks to Blanking and Suppression features;
- detect and process simultaneous emissions;
- identify threats using a dedicated library;
- activate the proper countermeasures;

NBC protection is provided as well.

Finally, if the helicopter is forced to land or crash,it must relay on its crashworthness to save crew and passengers lives and to limit aircraft damages.

To improve its crashworthness, the helicopter is provided with:

- High-Energy Absorbing Structure and Landing Gear;
- Crashworthy Seats and Fuel Tanks;
- Self Sealing Fuel Tanks;
- Limited Cabin Deformation in Crash-Landing.

3.4 SAFETY

Due to time constraints, I will mention only General Safety Objectives although Safety has got as much importance and dignity as Survivability in the Effectiveness factors hierachic scale chosen to Design and Develop the NH-90:

- Designing for minimum risk:
  NH90 has been designed to eliminate hazard or to reduce the associated risk by increasing safety through design (for example embedding safe landing and fly-away capability in the AFCS);
- Minimizing risk:
  Risk resulting from system faillures due to excessive environmental conditions, temperature, pressure, lightning, vibration, etc. have been minimized through FMECA (Failure Mode Effects and Criticality Analysis) and with the contribution of a Monitoring and Diagnostic System (designing an active vibration control can provide a suitable example);
- Incorporating Safety Devices:
  Reduction of risk to an acceptable level has been achieved through the use of fixed, automatic devices (Weight on wheel switch is an example) or through appropriate design features (as for example automatic reconfigurations;
- Providing Warning Devices:
  When neither design nor safety devices could effectively eliminate identified hazards or adequately reduce the associated risk, warning devices have been introduced;
- Developing Procedure and Training:
  Where it was impractical to eliminate Hazards or adequately reduce the

associated risk with the above mentioned measures, appropriate procedures have been set and/or relevant training has to be tailored accordingly.

3.5 INTEROPERABILITY

Interoperability is expected to become more and more "a must" in the third millennium scenario which will privilege "out of the area" and "multinational" operations.

Contractual clauses have been esthablished to stress standardization goals by quoting standards as binding prerequisites.

Furthermore, a policy has been established to privilege selection of available and suitable equipment and parts already developed or selected for the italian-british EH 101 and french-german TIGER helicopters.

But above all, the best interoperability performance of NH-90 is a real "built-in" feature, as the NH-90 is the result of a common requirement harmonized among eight Services of 4 of the most advanced industrial NATO countries.

4. AFFORDABILITY KEY FEATURES

To make the Tactical Transport Helicopter an affordable Aircraft despite the current budget constraints, any suitable opportunity has been evaluated and pursued. In particular, Life Cycle Cost rather than traditional procurement cost has been assumed as affordability main driver. Furthermore spreading the Design, Development and Productionization costs over a large number of helicopters has made such an investment affordable to the partecipating countries. Reducing the Life Cycle Cost up to the assessed ratio of cost/effectiveness will guarantee that the available assets in future can match the financial requirements.

The other affordability key feature is of course the mentioned large number of helicopters to be produced.

4.1 MULTINATIONAL COOPERATION

The European TTH is produced by the NHI under an Inter Companies Agreement (ICA) among Eurocopter France, Agusta, Eurocopter Deutschland and Fokker. The NH90 has been designed, is beeing developed and, at last will be produced under joint requirements by France, Italy, Germany and the Netherlands. So far the D & D programme is running smoothly, on cost and on time and the first flight of Prototype number one is expected before the end of the current year.

4.2 HELICOPTER FAMILY CONCEPT

To exploit the available market provided by European NATO Countries, the appropriate common harmonized requirement has been established among the three different services (Army, Navy and Air Force) of the partecipating countries, to be fulfilled by two distinct versions of the same family of Helicopters:

- the TTH version;
- the NFH version.

A wide common trunk, identical for the TTH and NFH, comprehensive of the General Vehicle and Plants System, is the standing point for TTH and NFH. Within the two versions, minor National Customizations have been estabilished to tailor each version to the peculiar country requirements.
International Cooperation and the "large common trunk" concept implemented in the MOU, signed in 1991 to build up the European Tactical Transport Helicopter fleet, resulted in a common effort to procure 726 helicopters, with the prospect that more Services in more countries in future will join the NH-90 club.

4.3 LIFE CYCLE COST SAVING EXERCISE

The third means to make the TTH affordable is the cost reduction in all phases of its LIFE-CYCLE: Design and Development, Productionization and Production, In Service.

DESIGN AND DEVELOPMENT PHASE

In the current Design and Development phase the most effective cost reductions are achieved with a wide utilization of already available state-of-the-art equipments developed for the third millennium, and by limiting the development to those products, (like, for example, avionics and SW), for which the investment in the D & D phase may lead to substantial savings in the other phases.

PRODUCTIONIZATION AND PRODUCTION PHASE

Cost savings are the result of a lower Unit Production Price (UPP) in virtue of:

- optimized number of production lines, which will be extablished only in some partecipating countries;
- state-of-the-art integrated equipment SW, developed or selected assuming the UPP cost saving as the main driver;
- new materials (composites and elastomers).

PROCUREMENT COST

Lower procurement cost can also be the result of the reduced number of needed Helicopters, as their Availability can be dramatically increased. To replace a fleet of 100 helicopters whose Availability averages 70% in theory you need to procure just 80 helicopters whose Availability averages 87%, saving 20% of the investment cost. In reality this simple algorithm is not sufficient to define the size of the fleet, but this example can provide the right order of the amplitude of possible cost savings.

IN SERVICE PHASE

The Operation costs are kept to a minimum mainly by low fuel and oil consumption, allowed by state-of-the-art engines.
The Support costs are minimized thanks to:

- maintenance-free or low-maintenance components and equipments selected off-the-shelf or designed "ad hoc";
- effective Monitoring and Diagnostic System which allows to fly with very wide inspection intervals (600-900 h) and hopefully, no-overhaul at all;
- consequently shrinked Major Items and Spare parts inventories and special to type AGE.

IMPLEMENTATION OF CALS (Continuos Aquisition and Logistic Support)

Implementation of CALS is under evaluation.There are chances that the programme can be developed in a "CALS-like" environment with possibility of dramatic follow-on cost-savings in the "Productionization and Production" and the "In Service" phases.

5. PRIMARY MISSION

I guess that Heliborne Operations, tipical TTH Primary Missions, in future will cover the relevant tasks of Air Assault and Air Movement.

5.1 AIR ASSAULT

Air Assault is the deployment by helicopter of friendly forces, deeply in the territory even when both the Pickup Zone (PZ) and the Landing Zone (LZ) are insecure or lightly secured; in other words, "Deploying an Offensive Helicopter Force into contact with the enemy.

In this tipical function the Commander applies decisive combat power at critical points anywhere in the battlefield:

- firing, from manouvering Attack Helicopters;
- deploying overwhelming infrantry fire, delivered into combat by Tactical Transport Helicopter.

5.2 AIR MOVEMENT

Air Movement is the transport through the battleplace of Combat, Combat Support and Sustainment Assets.

To carry out Combat Support functions in Ground Operations, the Commander moves troops, critical materials and even ammunitions and fuel using both Tactical Transport Helicopters and Medium-Lift Helicopters.

5.3 DIFFERENCES

According to the above mentioned definitions , the SLIDE provides comparison between the most significant different features of Air Assault and Air Movement. In particular the Assault Squadron deployes Forces often in lightly secured areas to fight the landbattle, task organized in Combined Army Operation where the fire power is provided by Attack or Scout Helicopters. On the contrary the General Support Squadron transports all over the battleplace troops and materials to provide combat support.

5.4 THE TTH KEY PERFORMANCES

Such tactical deployment of combat troops and material is carried out:

- at day and night, including adverse weather conditions;
- in any environment included arctic, jungle, mountains and desert;
- with high navigation precision, even in autonomous mode (without external assistance);
- mostly following terrain in accordance with NOE flight techniques to fly stealthily (undetected).

Those Heliborne Operations are outlined in the following "reference mission", whose main features are:

- re-deployment from the airfield to a Pickup Zone, flying at low level and at high speed (averaging 260 Km/h), to pickup 14 combat ready troops or a light wheeled vehicle;
- terrain flight navigation to the delivery area, flying mainly at lower speed (averaging 140 Km/h);
- return to the airfield;
- quick reconditioning of the aircraft for a Second mission in night-time without refuelling;

- reiteration in night-time of an equivalent mission where the deployment of forces takes place from the airfield straightforward to the landing zone.

6. OTHER MISSIONS

TTH MISSIONS

The TTH is tailored to perform superbly also several missions. As I don't wish to exceed the allocated time I will just:

- list all the secondary missions;
- describe two of them (SAR and MEDEVAC) to highlight how easily can the NH-90 platform accomodate various reconfiguration kits in virtue of properly built-in features as, big volume, internal load capability 2.500 Kg, external load capability 4.000 Kg, Low Electro Magnetic Interference (EMI), low vibrations and the availability of: rear ramp, sliding doors, cargo hook, rescue hoist, mission computer growth capability, Environmental Control System.

  Due to TTH's multirole adaptability, the crew itself can easily and rapidly fit on the field the relevant additional equipment to carry out the following missions :
  - Search and Rescue;
  - Medical Evacuations;
  - Parachuting.

  To carry out the remaining secondary mission, "special-to-type" equipments must be installed at the 1st or 2nd maintenance level:
  - Special Operations;
  - Electronic Warfare;
  - Heliborne Command Post;
  - Self Deployment.

Feasibility evaluations are in progress to include further missions in the already wide spectrum of secondary missions, such as:

- Mine Dispensing;
- Mines and Minefield Detection;
- NBC Detection.

6.1 SEARCH AND RESCUE

I can just summarize those key features indispensable to carry out Search and Rescue missions which are already available in the basic helicopter:

- Navigation (IRS-DOPPLER-GPS);
- Communication (Extended frequencies);
- Electro Magnetic Hardening;
- Night Vision (FLIR - NVG);
- Rescue Hoist;
- Extended Range (hovering refuelling capability);
- Accessibility (rear ramp and sliding doors);
- Survivability (outlined in dedicated slides);
- Cabin layout to seat 20 rescued people or accomodate 12 injured people.

In SAR mission, the NH-90 takes advantage primarily of its mission sensors:

- FLIR sensor and Night Vision Goggles which enable the long distance detection of survivers and downed aircrafts with a high success chance;
- automatic hovering flight capability which enables to scoop and rescue people from everywhere with minimum crew workload.

Futhermore in this mission, the built-in search pattern-following capability of the

mission computer, enables the crew to select the best pattern for each search requirement. Since the helicopter follows automatically the desidered pattern, the crew can concentrate on sensors, increasing the probability to spot the survivors.
The outstanding helicopter features enable the NH-90 to join Attack or Scout Helicopters to carry out Combat Search and Rescue Missions as well and will therefore make the NH-90 more and more a real asset in the next century scenario.
In fact importance of Combat Search and Rescue (CSAR) is raising in virtue of:
- shrinking manpower which makes every trained soldier a valuable asset;
- morale builder capability of effective CSAR to those forces which operate in situations where the risk of shoot-down and capture is great:
- risk to make servicemen taken captive a powerful propaganda weapon to unfrendly factions in wartime and in contingency operations.

6.2 MEDICAL EVACUATION

Rapid aeromedical evacuation is crucial:
- in force projection Army that is expected to win wars with minimal casualities;
- when Hospitals cannot be relocated quickly enough to support a fast-paced battle.

Pushing resuscitative surgery down into the Brigade Support Area does not seem able to solve the problem. It is therefore indispensable to enhance the Medical Evacuation by Helicopters to give sick and injured soldiers the best possible chance at survival and recovery. The NH90 reconfiguration time to install 12 stretchers and relevant medical equipment is very short indeed in virtue of the availability of a rear ramp and the two sliding doors.
In such MEDEVAC configuration:
- the full litter capacity of twelve patients, accessible for treatment;
- the electrical outlets located strategically throughout the cabin to provide easy access for the powered medical equipment used in patient care;
- the already available built-in Environment Control System (air condition);
- the outstanding COM and NAV SY with digital data distribution growth capability;
- the "all weather" and "all environment" capability of the NH90;
- the outstanding survivability of the platform;

makes the NH90 the ideal "Heliambulance" to pick up casualities in combat support mission, round the clock, on the spot, saving off the trasportation time to the airfield.
Furthermore because of the above mentioned outstanding platform performances such an Heliambulance is also perfectly suitable to joint Combat SAR formations.

7. CONCLUSION

All challenges to move into the 3rd Millennium the Light Support Helicopter segment, which so far has been the back-bone of all the Army Aviation Work, can be won by the TTH version of NH-90, as:
- NH-90 will fulfil the operators' requirements to expand, the enhanced Tactical Helicopter capabilities in both night and adverse weather operations;

- TTH Life Cycle Cost will also be affordable, mainly reducing:
  . cost of ownership through improved Reliability and Maintenability;
  . Procurement cost through the accordingly improved Availability;
- NH Industries will be equally keen to offer technological solution to all those emerging and demanding requirements.

In the ultimate analysis the customer, while trading-off high technology for a downsized force, will not lose sight, at any time of value for money, as Army cannot afford not to have sufficient and effective Tactical Transport Helicopters now and in the foreseable future, because TTH are the centerpiece of Army Aviation manouvering force in the third dimension.

NHI (which, incidentally, globally partecipates to the funding of the D & D programme, up to the level of 17%), shares such affordability oriented approach keeping well in mind that the NH-90 Helicopter has full capacity to generate a commercial version which could conquer an other large market.

Thank you for you attention.-