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EH101 SUPPORT HELICOPTER

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1. The first part of the document is a list of names and titles.

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1. Introduction

The EH101 is a new medium helicopter being produced by EH Industries, a company jointly owned by Agusta of Italy and Westland of the UK. The helicopter has been designed from the outset to be capable of a wide range of Military and Commercial roles. The aim of this paper is to examine the technology utilised within the helicopter design and to describe the capabilities of the aircraft.

Particular focus will be put upon the Utility variant and its suitability for the growing worldwide Air Mobility Role.

2 Programme

The EH101 project originated in the early 1980's from the recognition by both Italian and UK Navies of their joint need to replace SH-3 aircraft presently in service in the Anti-Submarine role. Agusta and Westland undertook a worldwide market survey and identified a need for both military transport and civil passenger aircraft of a similar size.

The results of this survey and the joint navies requirement were used to define a specification capable of meeting all roles with a common design.

The resulting project is funded by the UK and Italian Governments as well as by Agusta and Westland.

Production orders have now been taken for Naval Aircraft for the Royal Navy and Canadian Forces. Orders for the Italian Navy are expected shortly.

The Civil passenger variant has been committed for production and a number of major operators have expressed interest in being the lead customers.

The Support Variant is presently being proposed to a number a NATO countries, notably the UK Royal Air Force, the Royal Netherlands Air Force and the US Marines.

3 Basic Features

3.1 Main Rotor Head

Agusta are responsible for the design of this composite component. It can be seen from figure 1 that the main structure is comprised of 2 wound composite "daisies" which are stacked one above the other. Each daisy is made of 5 glass/kevlar windings surrounded by a complete winding on the outside. Within each hole fits a tension link which holds a main elastomeric bearing and connects through to the main blade. The pitch change arm is incorporated into this link. Fig 1 shows the Main Rotor Head and the multiple load paths.

SEPARATE WINDINGS PROVIDE MULTIPLE LOAD PATHS

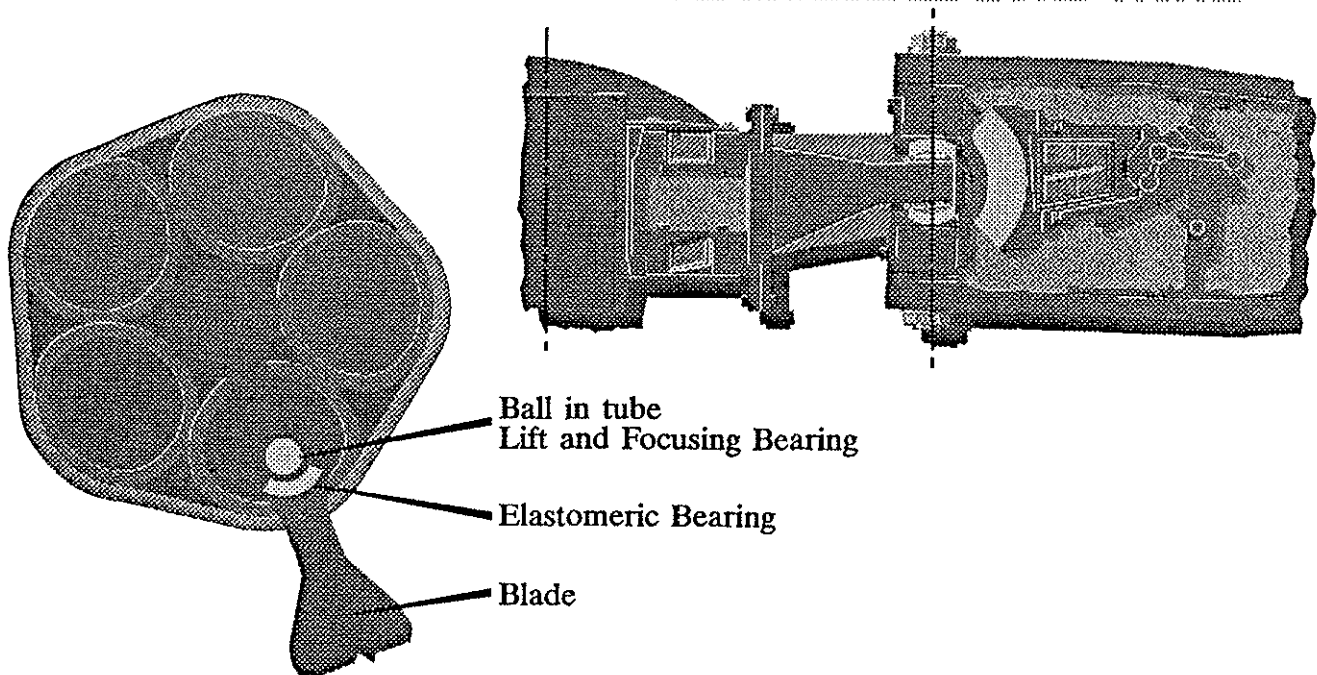


FIGURE 1

Each elastomeric bearing provides flap, lag and pitch movement. Another elastomeric bearing is used as the centering bearing at the end of a metallic arm. This bearing can move slightly in the radial, direction to accomodate main bearing compression whilst acting as the focus for blade movement.

The bearing is also the normal route for lift loads which go through the metallic arms into the core.

Should there be a failure of the lift arm, the lift loads from the blades come into the main bearing for that blade. The separation of the two composite plates provides an 'A' frame to take the lift loads into the hub.

The design of the EH101 hub has produced a structure which is safe, easy to maintain and whose condition can be assessed by inspection and if a failure should occur in service, the result is controllable within a normal maintenance schedule.

3.2 Main Rotor Blade

The main rotor blades on the EH101 represent a significant advance in design. They were the result of the British Experimented Rotor Programme involving Westland and the Royal Aerospace Establishment at Farnborough UK.

The main benefits of the design are high speed, high lift and reduced vibration

The use of innovative composite manufacturing techniques and new aerodynamic profiles has permitted this advance.

- ◆ Profiles are optimised along the span

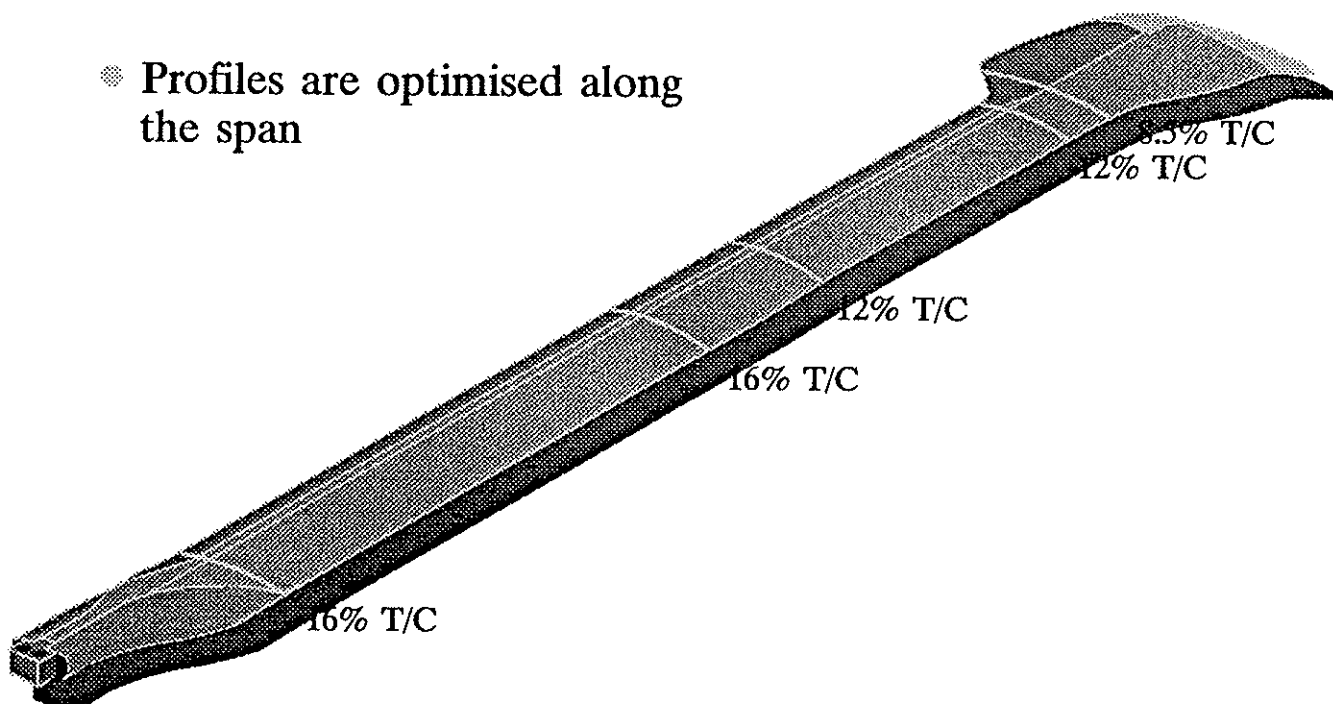


FIGURE 2

The picture at fig 2 shows the overall shape of the blade with its varying profiles along its length and the novel tip design. As this shows, the thickness/cord ratio reduces along the span. This shape could only be possible with composite moulding techniques. The main material is graphite fibre which provides a stiff blade suitable for the wind conditions likely to be experienced by a folded rotor on a ship deck.

The swept tip clearly delays compressibility effects at high Mach numbers on the advancing blade. The retreating blade benefits from the high camber, thicker section at the root which delays the onset of stall. Between these two sections is a "notch" which acts somewhat like a wing fence, isolating the flow on either side of it. The controlled vortex this generates at the tip softens retreating blade stall, making penetration into the stall regime less onerous from the load and handling viewpoint.

The overall benefits of this blade design are high speed, low noise and long fatigue life. It is of note that the small EH101 rotor makes it particularly suitable for shipborne folding and has led to reduced transmission and rear fuselage weights.

3.3 Health and Usage Monitoring System

The constant pressure to reduce life cycle and operating costs has led to the development of advanced health and usage monitoring system (HUMS).

The HUMS being developed for the EH101 is the most comprehensive for any helicopter and combines the experience and expertise of the two leaders in the field. Agusta and Westland have an operational system on board the A129 and the Westland 30 series has had HUMS since 1982.

The EH101 HUMS can be divided up into 3 distinct subsystems:-

- Health Monitoring
- Usage Monitoring
- Status Monitoring

3.3.1 Health Monitoring

Health Monitoring is supplied to the transmission and engines. By monitoring trends in vital parameters, it will be capable of detecting and giving warnings of potential failures before they become hazardous. Health data is provided mainly by accelerometers for vibration monitoring, by quantitative debris monitoring devices for the measurement and counting of debris particles in lubrication circuits and by thermocouples for bearing temperature measurement. Engine power performance index (PPI) is calculated by the system on pilot request and indicates engine degradation.

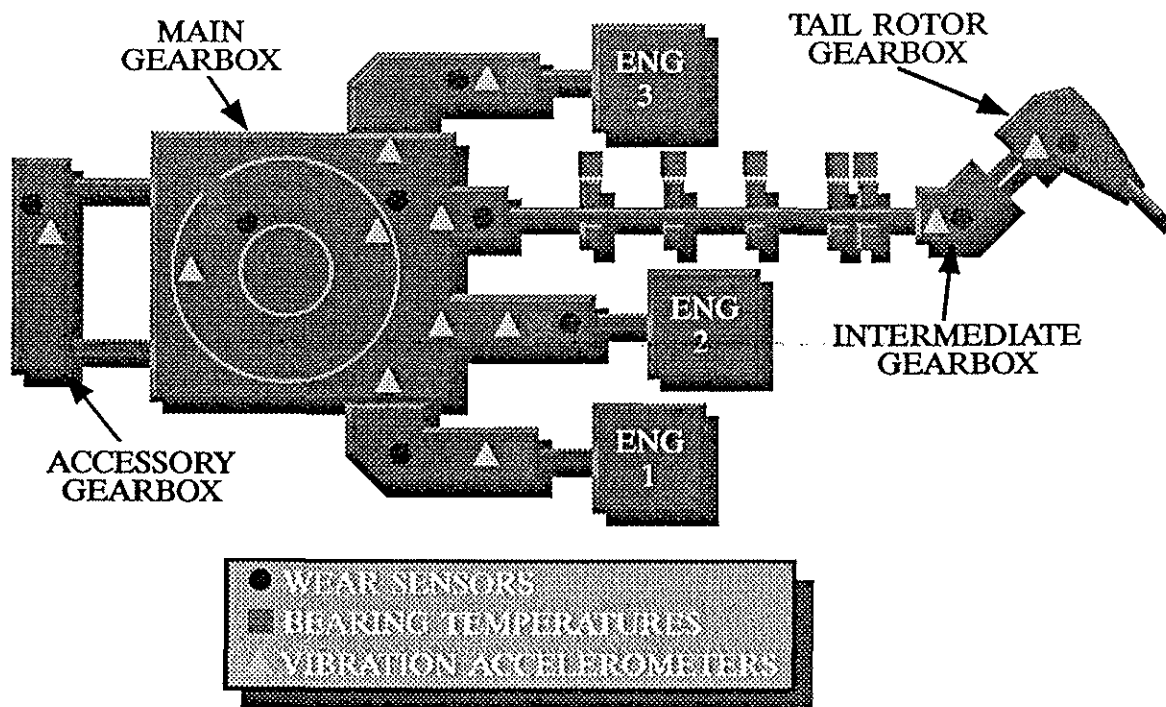


FIGURE 3

Fig 3 shows main sensors which are for wear, temperature and vibration.

Health monitoring, while contributing to improved safety, will lead to an condition maintenance and reduced operating costs.

3.3.2 Usage Monitoring

The application of advance usage monitoring in the EH101 provides the opportunity to replace the practise of replacing lifed components at fixed lives with replacement based on actual usage, thus maximising component utilisation. Usage monitoring in the EH101 covers transmission engine and structure.

Transmission usage is determined mainly by recording torque and torque limit exceedances. A tail torquemeter is incorporated to assist with this. Engine usage is measured by monitoring turbine inlet temperature, turbine speeds, low cycle fatigue, time-temperature index, etc. Monitoring of the structure involves recording of the number of landings, the number of start/stops, aircraft speed, altitude and g-loading.

Accurate, reliable usage monitoring, as provided on the EH101, gives either an enhancement of safety or a reduction in cost of ownership depending upon the individual aircraft usage.

3.3.3 Status Monitoring

With the introduction of powerful on-board computers, electronic displays and modern sensors, the status monitoring on the EH101, provides much more maintenance information to the maintainer than has been possible to date. Integration of the avionic in-built check-out system (IBCOS), with separate monitoring of engines, transmission, hydraulic electrical and other major systems allows warnings to be displayed on the Central Warning System (CWS) or to Electronic Instrument System (EIS) depending upon criticality. The system also displays some maintenance data on request but maximum benefit is obtained by down loading the data from the fault log for analysis by a ground based diagnostic computer.

Overall, the health, usage and monitoring system contributes towards the realisation of improved safety, reduced operating cost and maintenance records capable of being fed directly into a computerised Logistic Support System.

3.4 Active Control Structural Response (ACSR)

Vibration has been an ever present problem in helicopters. Many palliatives have been adopted in an attempt to reduce or absorb vibration with varying degrees of success. Vibration causes fatigue in structures, air crew and passengers. It is also a major source of unreliability in Avionics.

Westland have developed ACSR which takes a new approach to the problem. Active control technology is used to feed cancelling loads into hydraulically powered flexible elements in the main gearbox support struts.

Fig 4 shows the ACSR actuator.

The system senses vibration at points throughout the airframe, processes this data and feeds required signals into the actuators. Being an active system, the vibration levels are being constantly minimised in all flight regimes and whatever the airframe weight and configuration.

Fig 5 shows the ACSR system schematic.

Apart from the clear advantages which reduced vibration brings, such as increased reliability and reduced crew fatigue, the system does not suffer from the traditional deterioration at high speeds experienced by more traditional methods. The high speed capability provided

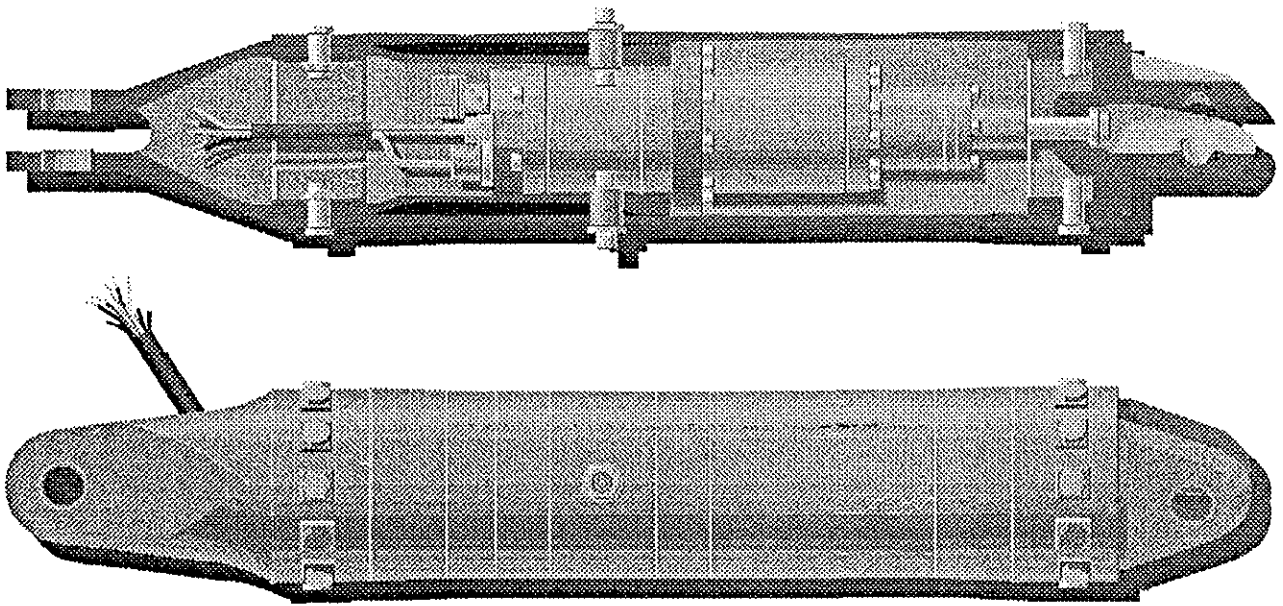


FIGURE 4

SYSTEM SCHEMATIC

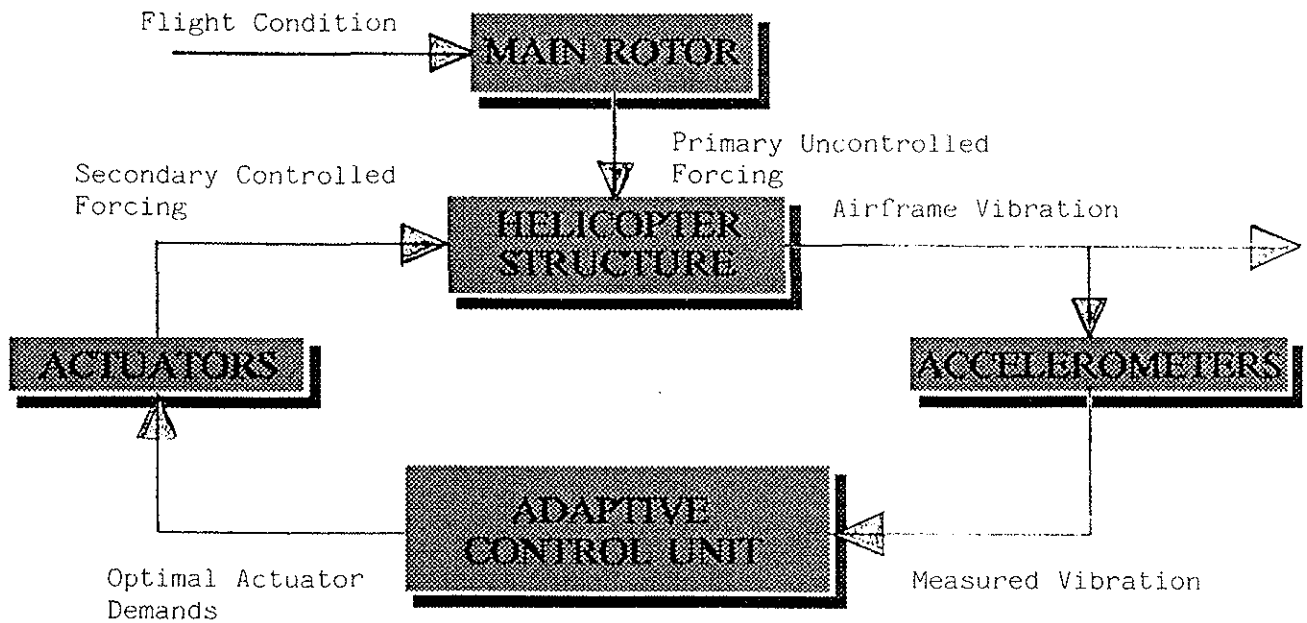


FIGURE 5

second failure will not create a hazard before pilot intervention.

The military aircraft is designed to be flown by a single pilot in IFR with all the necessary controls and instruments appropriately situated in the cockpit.

3.5.2 Electronic Instrument System

The EH101 Electronic Instrument System is an advanced integrated cockpit information system which provides optimum presentation of flight, navigation and aircraft systems data.

The data is presented on 6 identical full colour, high resolution shadow mask cathode ray tubes.

Two screens in front of each pilot's position display primary flight and navigation data.

Two centrally mounted display units present primary and secondary power systems information.

Information is displayed on a "need-to-know" basis, the majority of data being suppressed until either thresholds are reached or the pilot has selected it on the Display Mode Selector (DMS). The EIS can tolerate up to two major failures and can still be reconfigured, via the

DMS, to provide all essential displays. However a standby power display panel provides a back-up to the EIS power displays and a standby conventional instruments provide a back-up for essential flight data.

3.5.3 Aircraft Management System

The heart of the avionic system is the Aircraft Management System. This comprises two Aircraft Management Computers (AMC), two System Interface Units (SIU) and two Common Control Units (CCU).

The system performs the following functions:-

- Signal Conditioning for the EIS.
- Navigational Processing and Control.
- HUM Processing.
- Communications Control.

4 Utility Features

4.1 Rear Ramp

It was shown in troop loading trials that the aircraft could be unloaded with a full complement of troops within 30 seconds. The loading was achieved within 75 seconds.

The ramp can be partially lowered for troop loading and fully lowered when loading vehicles and freight, Fig 7 shows the two angles. There is an internal winch to assist in loading and the optional roller floor can also be fitted for use with pallets.

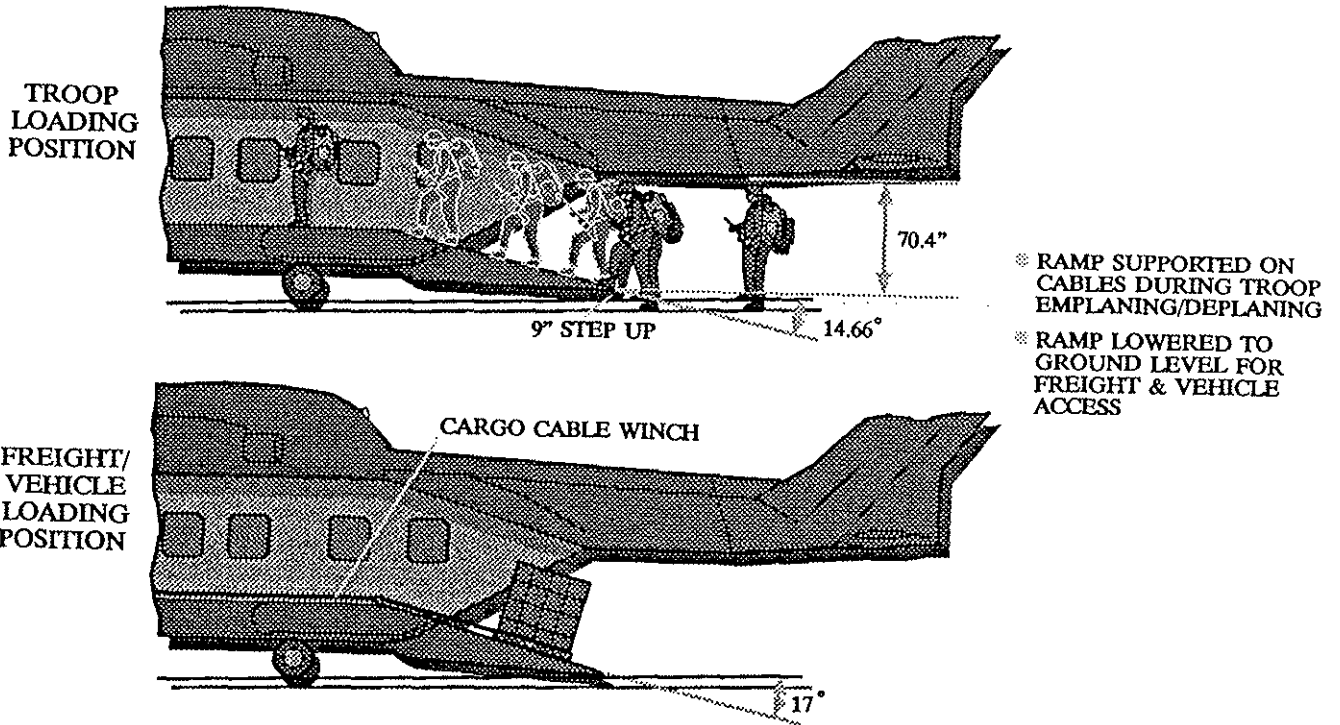


FIGURE 7

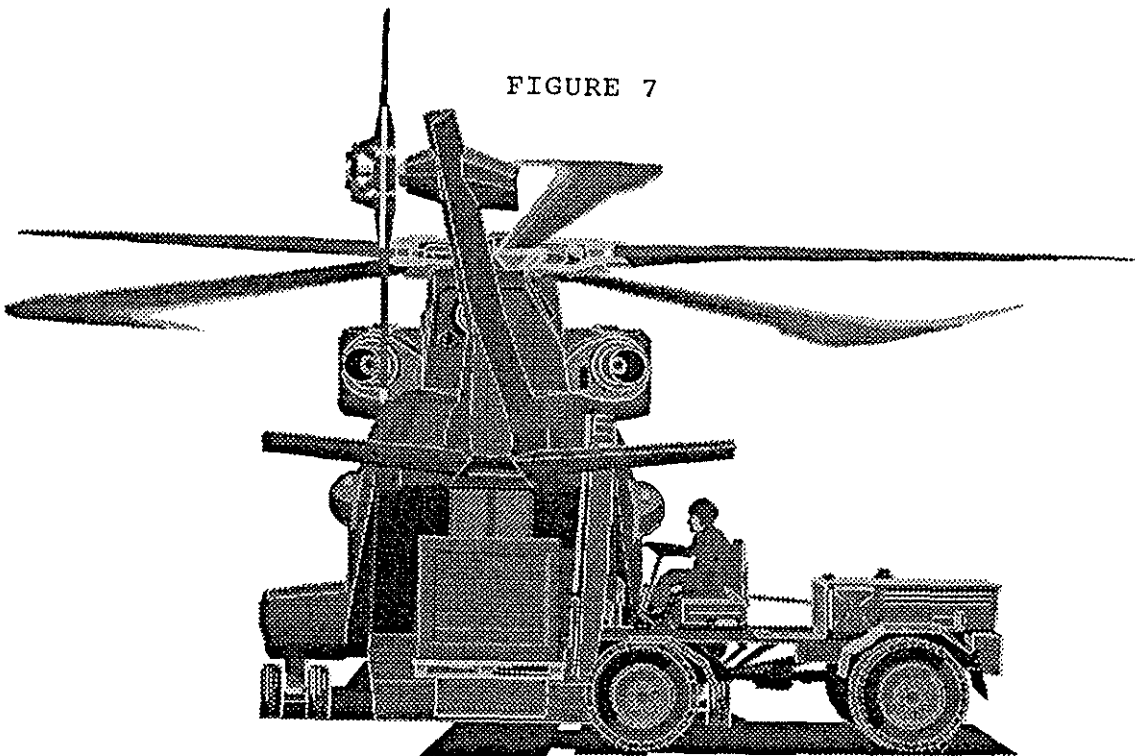


FIGURE 8

The height underneath the rear fuselage aft of the ramp allows access by fork lift trucks as shown in fig 8. The ramp dimensions are:-

Width 2.0 m
Height 1.8 m

4.2 Main Cabin

Although the main cabin structure of the support variant is essentially common with the Naval Variant, there are some modifications to optimise the design for the support role.

Most notable of these changes is the use of a metal-skinned cabin floor.

This floor will have an aluminium-lithium skinned honeycomb construction which will be very robust in terms of the concentrated loads and impact loading typical of the military support environment.

The floor has conventional cargo tie-down rings with surface ribs to support cargo movement and provisions for plug-in rollers to facilitate the movement of loads within the cabin.

Fig 9 shows a typical palletted load in the cabin.

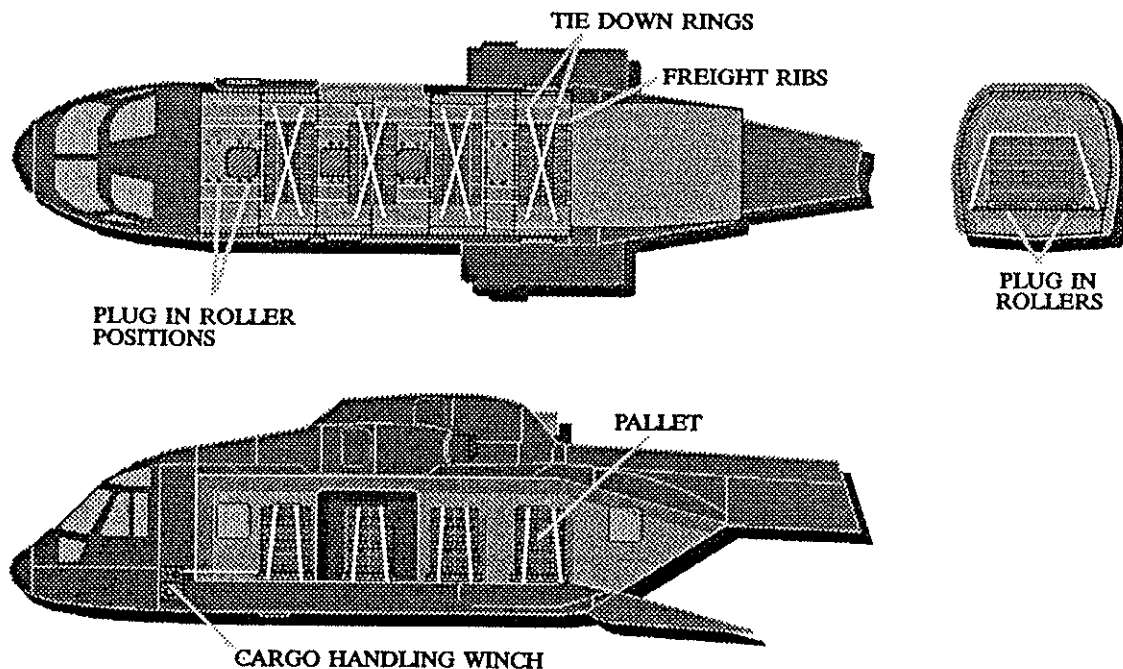


FIGURE 9

As can be seen from this picture, the wide cargo door on the starboard side can be used for loading directly into the cabin.

4.3 Avionics

As described above the basic EH101 has a comprehensive integrated digital avionics system based upon MIL-STD-1553B. This system is also ideally suited for the support variant with little change.

The navigation system, which uses autonomous sensors such as a Laser gyro inertial system and doppler are supplemented by area aids such as GPS and TACAN as required by individual operators.

A comprehensive communications fit exists which can provide all the V/UHF requirements, HF and any of the normal frequency hopping provisions.

Although the 1553B system could be extended to provide a fully integrated mission system, it is expected that many operators will fit defensive systems on a stand-alone basis. Such systems planned are:-

- Chaff & Flare
- IR Jamming
- Radar & Laser Warning
- Hostile Fire and Missile Approach Warning

4.4 Cargo Hook

EHI have recognised that a permanent heavy lift cargo hook is essential to the support role. It is therefore planned to produce a 12,000 lb hook for the aircraft which is retractable and combined with a viewing hole. This will permit the load master to view the hook and the load from within the cabin. Fig 10 shows the hook installation.

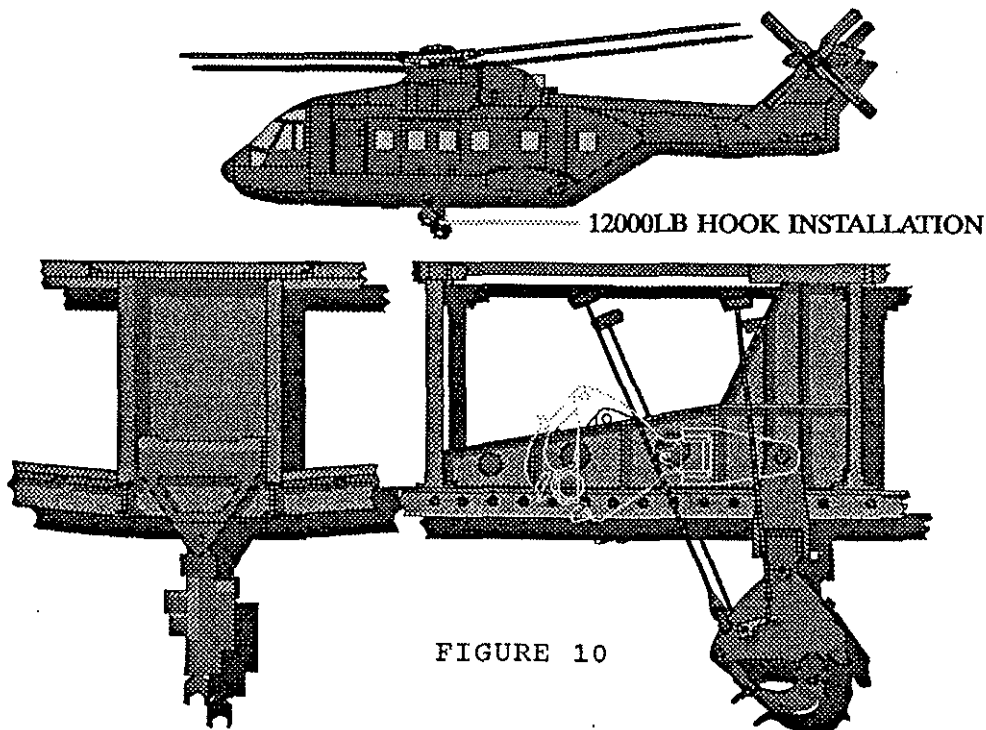


FIGURE 10

5. Aircraft Performance

The EH101 already has many variants with different engine and external configurations which affect the overall performance. For the purposes of this paper the Military Utility Variant performance will be discussed.

The payload-range curve shown in figure 11 shows the aircraft in Tactical Support Configuration carrying an internal load at 160 kts on a hot day, landing at 3000ft. This mission is typical of the extreme conditions being demanded for a worldwide rapid reaction role.

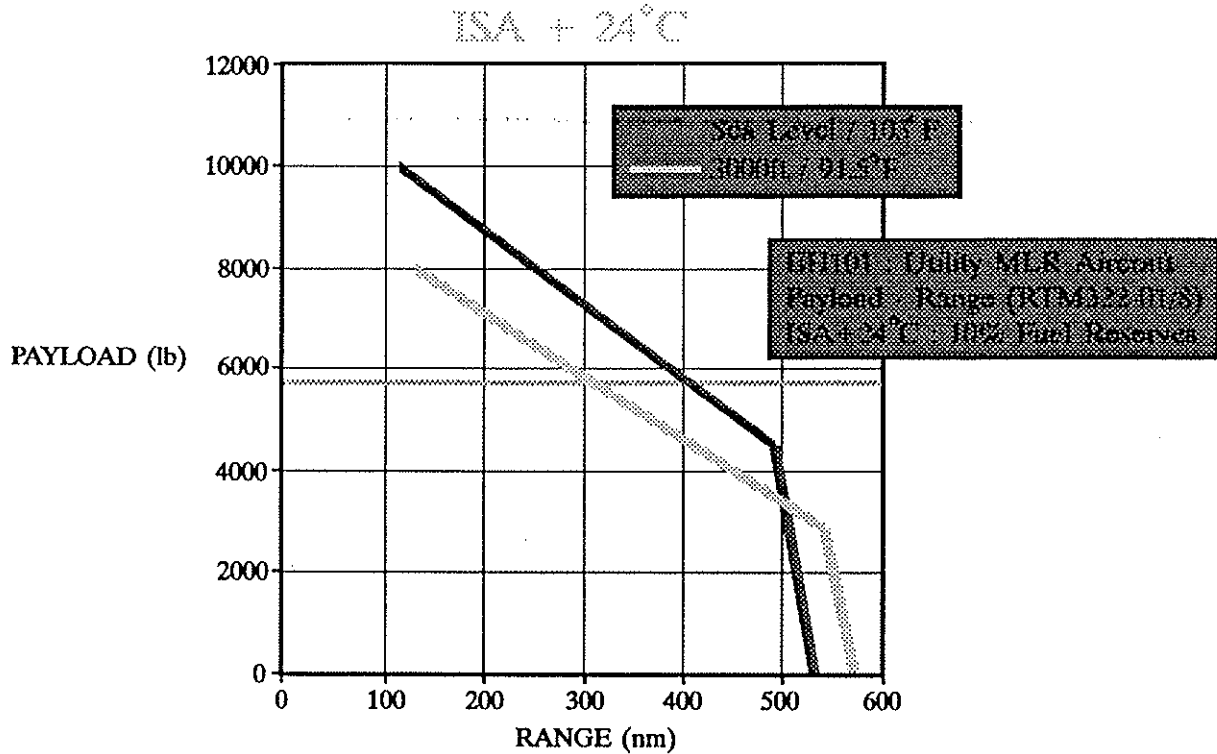


FIGURE 11

The chart shows the EH101 is capable of carrying 24 troops over 350 nm. The engines in this configuration could be an GE T700-401X or an RTM 322-01/8.

Figure 12 shows the aircraft speed against altitude for various weights.

This shows that even using maximum continuous powers the aircraft is capable of air speeds between 160 and 180 kts at normal operating weights.

These are practical cruise speeds because of the low vibration levels provided by the fitting of ACSR.

Figure 13 shows the hover weights out of ground effect using 95% and 100% of engine take-off rated, powers.

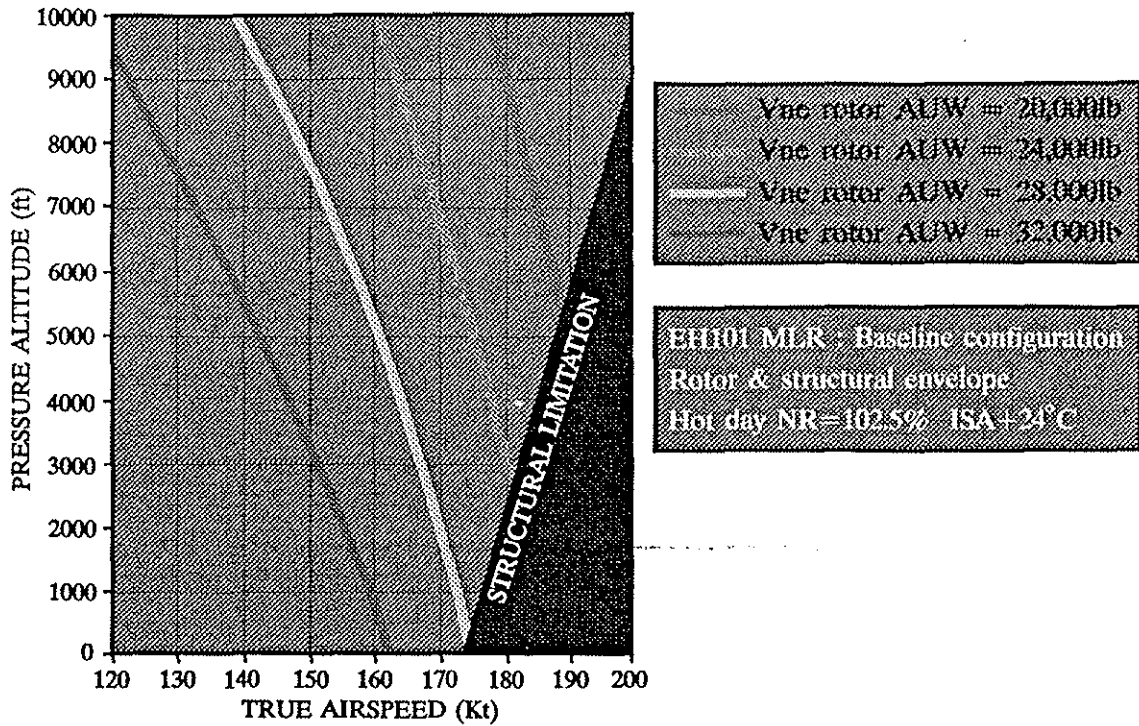


FIGURE 12

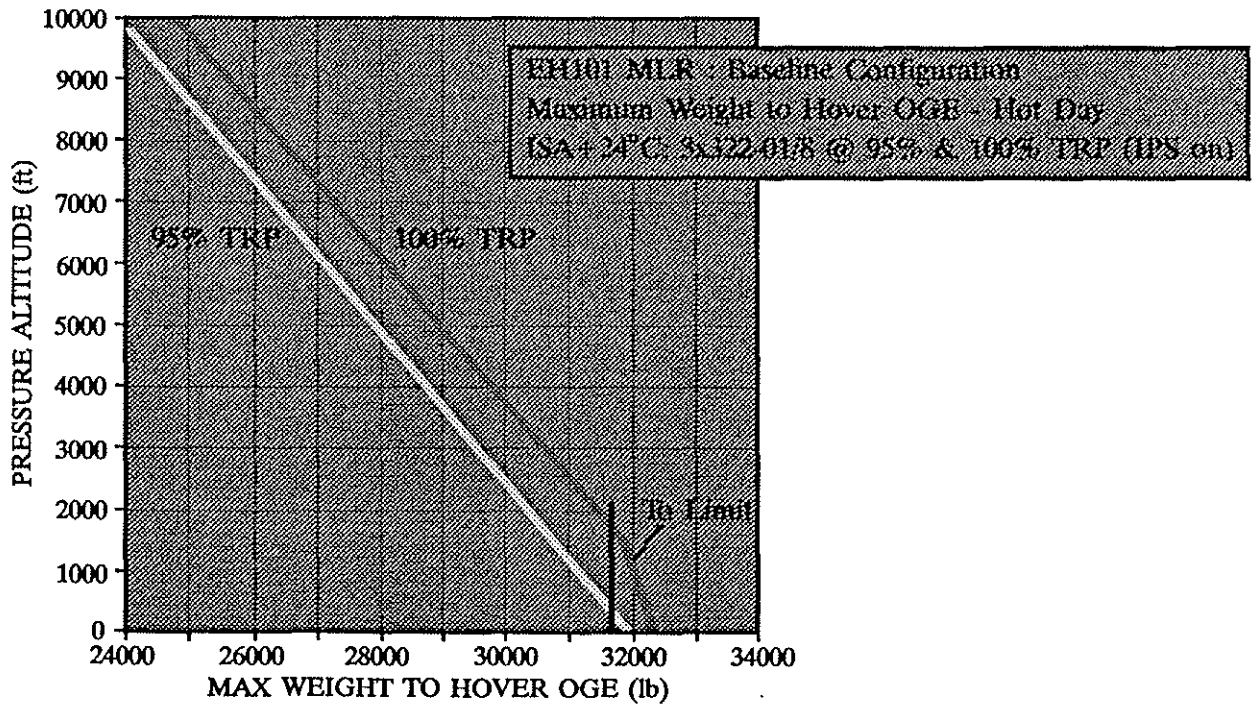


FIGURE 13

6. Reliability & Maintainability

As has been stated earlier, the design philosophy has been to avoid risky technologies. This has not only limited the expense of the development activities but

also has given the basic design an inherent reliability. The reliability is being grown by a dedicated Reliability Enhancement and Maturity Programme which will provide an excellent level of reliability at entry into service as well as very good overhaul lives on the transmission system.

Westland and Agusta are running a "closed-loop" failure reporting and corrective action system which has been functioning throughout the life of the project.

Figure 14 shows the present status of the reliability measurements for the Naval aircraft.

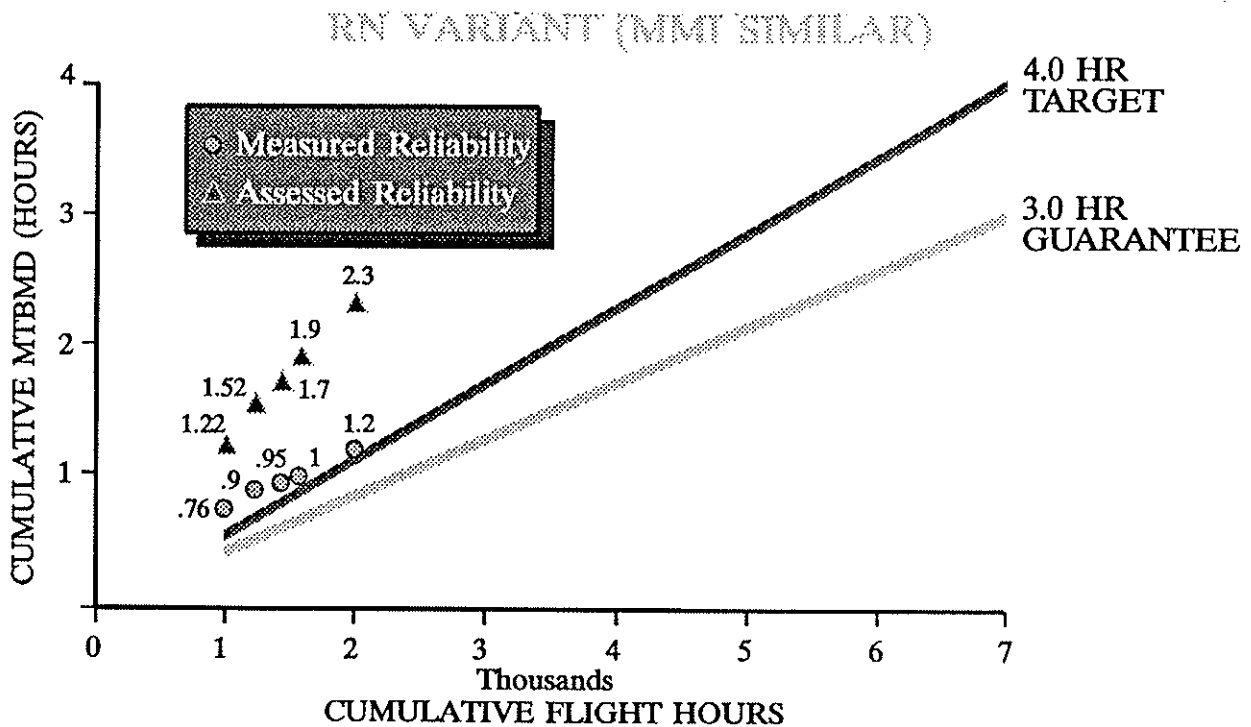


FIGURE 14

It can be seen that we are presently ahead of our targets for both measured and assessed reliability. The assessed reliability is the figure related to the measured reliability adjusted by the fixes identified for faults experienced during tests.

7. Conclusions

It can be seen by the items described in this paper that the Utility EH101 incorporates many interesting and innovative design features.

It combines the best of tried and tested technology with the latest advances where it provides significant benefits in operational capability and lower cost of ownership.

The result is a new generation, medium lift helicopter capable of fulfilling a wide variety of customers requirements in a cost effective manner.

Many more examples of the EH 101 technology could be shown but space does not permit. However the utility features described in this paper are deemed sufficient to demonstrate that, because of its versatility, the Utility EH 101 has the potential to support different roles with improved payload-radius and performance capability.