

Protective Respirator For The U.S. Army Advanced Attack Helicopter

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INTRODUCTION

The US Army at the US Army Chemical Research Development and Engineering Center (CRDEC) has successfully completed an accelerated development program to provide respiratory protection for the latest advancement in US Army weapon systems, the Advanced Attack Helicopter, "Apache."

The background and development philosophy utilized in designing and fabricating the M43 protective mask system for the U.S. Army AH-64 Attack Helicopter will be discussed in this paper.

The AH-64 helicopter developed for the Army by Hughes Helicopters has a requirement for Chemical and Biological (CB) protection. The helicopter employs very sophisticated weapons and flight systems which require close optical coupling to various devices. Because of these interfaces, available protective masks cannot be used effectively.

In early 1982, the U.S. Army Chemical Systems Laboratory at Edgewood, Maryland developed a unique close fitting mask prototype. It used a radically different approach to eye lens placement and air distribution from a filtered air source. A development contract was issued to fully develop this protective mask to interface with the AH-64 Integrated Helmet and Display Sight System (IHADSS). This system employs an optical device which is attached to the flight helmet of the pilot and copilot after they ingress the helicopter. The optical device, called the Helmet Display Unit (HDU), is hardlined to the on-board computer



AH64 "Apache"

system. The barrel of the HDU rests on the pilot's right cheek, directly under the eye, and a combiner lens attached to the barrel is located in front of the eye. The flight image is projected by the HDU to the combiner lens. The flight picture is computer-assisted through images picked up by an infrared turret mounted camera in the nose of the helicopter.

This system allows the AH-64 to operate in all types of inclement weather and dust conditions with precision and safety. The lenses of current mask systems are located too far from the eye to allow the proper focal length which is required for effective use of the HDU.

DESCRIPTION OF AH-64 HELICOPTER

The AH-64 Helicopter is an attack helicopter with diverse weapons sys-

tems. The aircraft is powered by 2 GE turboshaft engines with 1694 shaft horsepower each. Two stub wings are mounted on the fuselage aft of the cockpit (left and right) with a wing span of 17 feet. Weapon pylons on the underside of the stub wings provide mounting for missiles and rockets. A 30mm chain gun is mounted under the helicopter. There are two turrets mounted on the nose of the helicopter which contain the largest Acquisition and Designation Sight (TADS), the Pilot Night Vision Systems (PNVS), and the Forward Looking Infrared Radar (FLIR). The primary weapon system is Hellfire Anti-tank missiles with suppression fire power provided by the 30mm chain gun and 2.75 rockets.

The mix of weapons depends on the mission, altitude and climatic conditions existing in the battlefield. The weapons are primarily controlled by the copilot/gunner, located in the front

cockpit. Both the pilot and the copilot use the IHADSS system with the Helmet Display Unit. However, the copilot/gunner has an ancillary fire control sight called the Optical Relay Tube (ORT). The ORT provides a duplicate larger image of the HDU display and has additional imagery for fire control. The TADS, PNVs, and FLIR in the turrets are directed by the pilot and his head movements. The turrets containing the above systems turn in any direction that the pilot turns his head. This feat is accomplished by initial registration of the helmet with respects to the boresight of the helicopter.

On entering the aircraft, the pilot boresights through the HDU. Once boresight is obtained, he locks in the on-board computer. His head location is determined by four IR emitters in the helmet. The beams of IR are picked up by two IR cameras, mounted on either side of the seat back. By tracking the IR beams, information on change in emission length is fed to the computer which directs turret movement corresponding to pilot head movement.

OPERATIONAL CAPABILITIES OF THE AH-64

The AH-64 TADS and PNVs Systems provide the crew with the capability to detect, recognize, and engage enemy targets during day, night, and/or adverse weather including snow, fog, smoke, dust,

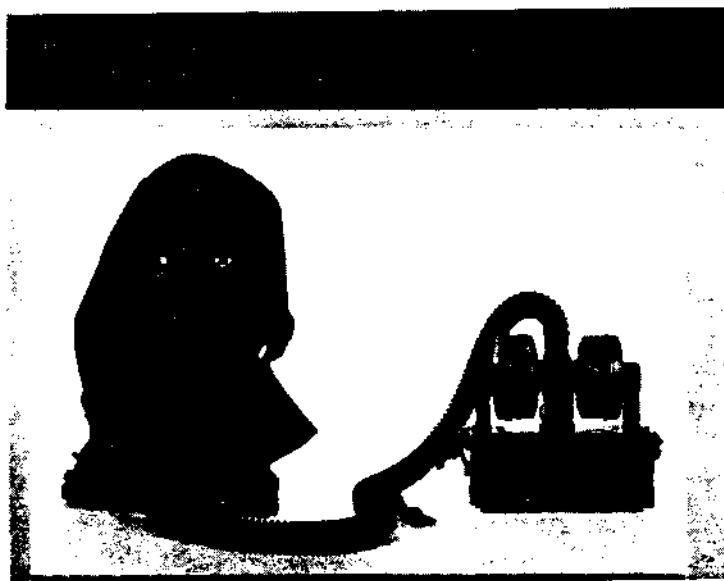
etc. The IHADSS provides superior map-of-the-earth capability with a maximum forward speed of 160 knots. The aircraft is highly maneuverable and is capable of 3g turns, and is furthermore a very stable weapons platform.

MASK SYSTEM REQUIREMENT

The operation and general description of the AAH-64 provided some insight into the level of sophistication designed into this complex aircraft. This sophistication, combined with stringent CB protection requirements, dictates a mask system which would ultimately evolve from a revolutionary approach to protective mask design. These CB protective requirements can best be summarized as follows:

- The system shall protect the face, eyes and respiratory tract of the wearer in field concentrations of chemical and biological agents, and radioactive fallout particles.
- All materials utilized in the fabrication of the system shall meet a chemical agent resistance requirement of 6 hours required, 12 hours desired, against known chemical warfare agents.
- The system shall permit unobstructed and undistorted forward vision and provide optimal peripheral vision to aircrew members. The mask shall provide for refractive error correction and have antifog and defog features.

- Without the wearer being contaminated by CB agents, the system shall allow the wearer to drink water at the desired rate of .25 quarts/minute.
- The system shall be fully compatible with all aircraft subsystems, especially the Integrated Helmet & Display Sighting System (IHADSS) and the Optical Relay Tube (ORT).
- The system shall not cause head pressure hot spots during prolonged flight wear. Heat build-up to the head and face shall be minimized to allow mission performance.
- The system shall fit the 5th to the 95th percentile aviator population. It shall be compatible with two IHADSS sizes of medium and large. The number of sizes of the mask system shall not exceed four.
- CB Protection shall be provided by motor/blower/filter assembly during flight operations. A battery assembly shall be provided for use of the mask system during ground operations. During flight operations, the motor/blower/filter assembly shall use aircraft power.
- The system shall allow for freedom of movement within the close confines of the cockpit with no restrictions in performance of critical flight and combat tasks. The system shall allow for emergency egress and val salva capabilities.
- The system shall not interfere with or require adjustment of helmet shell, light sensors, visor assembly.
- The mask system shall contain a M-166/AC microphone and shall be capable of being adapted to the M101 microphone.
- The system shall provide intelligible voice communication when on the ground and external to the aircraft.
- The system, when in the ground operational mode, shall be capable of being donned within 9 seconds.
- The system shall be capable of being decontaminated by the individual using available field decontaminants.
- The system shall be designed so that fully trained personnel not suffering from facial and head injuries shall be capable of wearing the mask for periods of 8 - 12 hours while performing their assigned military duties.
- The system, when suitably packaged, shall remain serviceable when stored



HDU on Helmet

for a minimum of 10 years in climatic design types hot through severe cold.

- The system shall be capable of being worn without any significant degradation in performance within climatic design types hot and basic.
- The system shall not require any maintenance other than normal care, cleaning, and replacement, which can be performed by the user at the organizational level.
- The MAV mean wear time between failures (MWTBF) shall be 1000 hours.
- The system shall remain serviceable after one year of operational use.
- The system shall be capable of being worn in conjunction with the full-up CB ensemble, consisting of flight coveralls, body armor, survival vest, gloves and boots.

The most critical of these requirements is providing CB protection while maintaining compatibility with the IHADSS helmet, Helmet Display Unit (HDU), and the Optical Ray Tube (ORT). Field of view in the HDU is also critical and must be maintained to provide all the pertinent flight data on the combiner lens. Flight data is lost at a very rapid rate as the distance between the eye and the combiner lens increases. This critical interface has proven to be the single most important design driver during the course of the mask system development.

M43 MASK SYSTEM DESCRIPTION

Having defined all the interface criteria and design requirements for the mask system, a general mask design concept was established utilizing close in swimmer's goggle type lenses, conformal facepiece, integral hood, front-mounted exhalation valve assembly, and a left-side-mounted inhalation valve assembly (Figure 1).

As the iterative process of system development continued, specific design features were established, tested and refined. The final mask configuration still maintained the established baseline concept, but with greatly improved features and operational capabilities. The IHADSS mask, which consists of three basic elements: 1) facepiece, 2) protective hood, and 3) suspension system.

- The facepiece is a transfer molded, bromobutyl/natural rubber blend, conformal fitting mask which

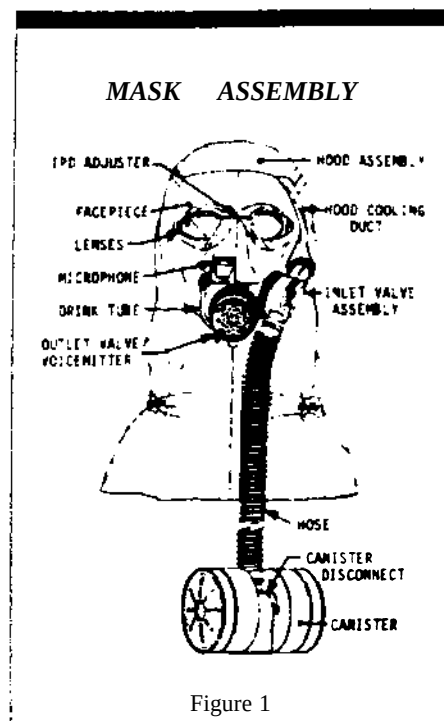


Figure 1

provides mounting provisions for lenses, exhalation valve assembly, inhalation valve assembly, hood cooling duct, microphone, drink-tube assembly, hoses, and canisters.

- The lenses are injection molded polycarbonate with a hard coating to provide scratch and solvent resistance. They are bonded into facepiece flanges using a urethane adhesive and are designed to give adequate eyelash clearance. The right lens is notched to provide HDU compatibility.
- The exhalation valve assembly utilizes a silicone valve disc to effect a seal against a flat seat. The cover assembly consists of a hinged cover, a voicemitter assembly and an adjustable flow control feature to increase head cooling.
- The inhalation valve assembly incorporates a flapper valve, hose fitting, cooling duct fitting with check valve, and adjustable flow control features for the lenses and hood cooling duct.
- The hood cooling duct is attached to the inhalation valve and serves as a passageway for air to enter a thin plenum inside the hood.
- The mask will accommodate either the M-133 or the Tempest secured

M-166 by the use of an interchangeable adaptor.

- The drink tube assembly consists of a canteen quick disconnect, external drink tube, drink tube pass-thru and an internal drink tube. This system allows the user to plug into a canteen and drink water in a contaminated environment.
- The hood is a butyl-coated nylon fabric bonded together and then bonded to the facepiece periphery. The hood incorporates a plenum to allow the passage of air to the head while wearing the tight fitting IHADSS helmet.
- The suspension system consists of a spandex skullcap and two adjustable straps for positive retention of the mask. The mask is donned, suspension adjusted and the hood pulled back over the head.

BLOWER SYSTEM DESCRIPTION

The mask system has been designed to be used in conjunction with a portable blower system which will provide filtered air at a flow rate of 4 SCFM. The blower assembly which consists of the plenum, cover, air distribution tubes, base and handle (Figure 2).

- The housing components are injection molded nylon; the air tubes are investment cast aluminum and the handle is investment cast stainless steel.
- The plenum serves as an air passage system as well as the mounting platform for the blower motor, printed circuit board, battery pack and air tubes. This plenum, then, is the heart of the blower system.
- The cover attaches to the top surface of the plenum with screws and forms the fourth wall of the air passage-ways in the plenum, and also houses the latch mechanism.
- The air distribution tubes are mounted to the bottom surface of the plenum and serve to continue the air passageways from the plenum to the canisters. Each air tube is fitted with an elastomeric wiper seal which effects a seal against the face

BLOWER ASSEMBLY

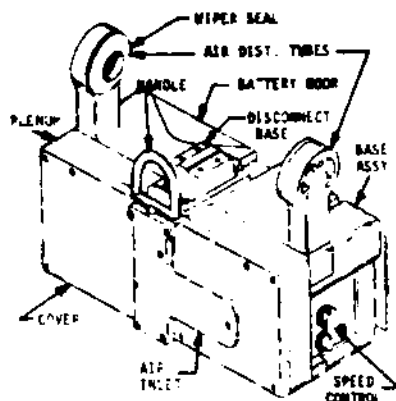


Figure 2

of the canisters.

- The base assembly attaches to the bottom surface of the plenum and serves as a closure to protect the motor, PC board and the battery pack. The base incorporates a door through which the battery pack may be changed. On the side of the base is a bracket, which will accommodate the canister assembly to break away from the blower housing.
- A mounting bracket attaches to the arm or wing of the seat for installation of the blower assembly into the aircraft.
- The latch mechanism is a spring-loaded, cable-actuated handle assembly which lifts a latch at the bottom of the base, thus releasing the blower assembly from the mounting plate.

SYSTEMS OPERATION

Currently, the operational scenarios for the IHADSS mask in the AH-64 mission requires that the mask be donned in a ready room. The blower unit is belt-mounted

and switched on to supply the crewmember with filtered breathing air during preflight and ground operation.

After preflight, the pilot and copilot ingress the helicopter and remove the filter-blower from their belt mounting and stow it in its mounting bracket on the left wing of the seat. The electrical connection in the bracket automatically disconnects the blower from its integral battery and connects it to the aircraft power supply. The mission then continues in this mode. Airflow in both modes is regulated by means of a blower speed control potentiometer.

After completion of the mission and return to the base of operations, the pilot and copilot shut down the aircraft and egress using the battery-operated belt-mounted blower for breathing air. On arriving at the decon area, the helmet is removed and the pilot and copilot go through standard decon procedures prior to doffing the mask.

In the event that the blower is inoperative, the filter assembly may be detached from the blower and the mask may be operated in the "unblown" mode.

DEVELOPMENT PROGRAM OVERVIEW

An advanced Development (AD) contract was awarded to ILC Dover in the 4th quarter FY82 to begin the development cycle. Concept prototype fabrication began immediately thereafter and continued until the 4th quarter FY83. During this period, extensive design verification testing and aircraft interface testing was conducted. Ten prototype units were delivered and tested to insure compliance with systems

requirements. Tooling and hardware fabrication occurred and the AD contract culminated in the delivery of sixty masks and twenty blowers to be used in the Development Tests I (DT.I).

An Engineering Development (ED) contract was awarded in July 1984 and an engineering refinement effort was begun based on DT I results. An extensive tooling fabrication effort is currently underway in preparation for system production. A delivery of 250 masks and 125 blowers was made in March 1985 to support the commencement of a special DT/OT II. This test phase was run for six months with a special IPR Type Classification of the system scheduled immediately thereafter. A second delivery of 250 masks and 125 blowers for initial fielding of this system was also scheduled.

The complete development of the M43 mask system was completed in 48 months. The normal development cycle for this type of product is usually 7 to 8 years. Schedules were compressed to insure timely fielding of the M43 mask system as required by the AH-64 helicopter production schedule.

This kind of successful schedule compression is directly attributed to proper program management, close coordination between the user, contractors and subcontractors, extensive testing programs, and most of all, to the dedication and devotion of all the individuals involved with this program.

SUMMARY

In conclusion, the accelerated development of the M43 mask system will allow the U.S. Army to field the AH-64 helicopter on schedule with the ability to operate in chemical, nuclear, and biological environments found on the modern battlefield.