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AIRCREW PROTECTIVE CLOTHING AND DEVICES SYSTEM (ROTARY WING AIRCRAFT)

Stan J. Winsko, et al

Naval Air Development Center
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A study was conducted to portray the major mission profiles in which the helicopter community is engaged, and by so doing, to identify the problem areas associated with the current inventory of helicopter aircrew protective equipment toward fulfilling the requirements of these missions. The ultimate objective of this effort is to provide a sound basis from which a series of separate but coordinated engineering developments will be conducted to provide a new generation of mission-specific protective systems

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Thermal Comfort

20. for the helicopter community. The net effect of this program will be to enhance the inflight performance and effectiveness of all helicopter aircrewmen with little or no sacrifice to their safety in the event of an emergency situation.

SUMMARY

This report has been prepared in support of Advanced Development Objective (ADO) 45-67; Aircrew Protective Clothing and Devices System. In response to the objectives of the ADO, a study was conducted to portray the major mission profiles in which the helicopter community is engaged, and by so doing, to identify the problem areas associated with the current inventory of helicopter aircrew protective equipment toward fulfilling the requirements of these missions.

The ultimate objective of this effort is to provide a sound basis from which a series of separate but coordinated engineering developments will be conducted to provide a new generation of mission-specific protective systems for the helicopter community.

The data from this study was derived from direct on-site visits and participation in fleet helicopter training and operational flights. A number of individual interviews were conducted with aircrewmen for each respective helicopter class and mission. From this, key problems concerning the current generation of protective clothing and equipment were identified within their operational context.

Many of the problems of current helicopter aircrew protective equipment are amenable to solution and/or improvement by current state of the art technology.

The net effect of this program will be to enhance the inflight performance and effectiveness of all helicopter aircrewmen with little or no sacrifice to their safety in the event of an emergency situation.

PREFACE

The information contained in this report was derived from extensive observations, discussions and data reviews. There were many data conflicts and some divergence of opinion concerning equipment employment problems, and tactical applications within the broad envelope of helicopter operations. In order to sort out and present this information in its most rational and systematic form, extensive analysis and refinement of the data for each helicopter mission and phase of operation was required.

Final analysis and resolution of this data was accomplished through the careful and persistent supportive efforts of Mr. Murray Sloane of the Sanders & Thomas Corporation. The authors of this report wish to express their deep appreciation for his invaluable assistance in the completion of this task.

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INTRODUCTION

BACKGROUND

Naval aircrewmen are currently equipped with a variety of protective clothing and devices which are intended to protect them against a range of operational hazards which may be encountered throughout the mission profile.

Each item of the aircrewman's protective equipment may be considered generally adequate when assessed on the individual component level. However, when this equipment is worn and utilized collectively during the routine performance of a mission, the aircrewman experiences significant penalties in thermal comfort and mobility because of the weight, bulk and non-integration of the equipment.

In addition to this, some equipment, designed to provide protection to an aircrewman against certain hazards evident in his mission envelope, has been imposed on other aircrewmen who have different protection requirements in their particular mission envelope. The primary cause for this has been solely in the interest of standardization and economy.

The net outcome of all this has been a number of adverse effects on the aircrewman's performance, endurance and efficiency, which have degraded overall specific mission effectiveness. This situation has been compounded by the aircrewmen making unauthorized, but sometimes necessary, modifications to his equipment configuation, or avoiding the use of the equipment altogether to "self-enhance" his effectiveness during non-emergency situations. Using the rationale that "certain hazards or emergency situations will not confront me", many aircrewmen are therefore unprepared when the unexpected occurs. In certain instances authorization for deviation has been granted, but with possible adverse technical consequences.

ADO 45-67 is an advanced development program which will provide each aircrewman with a mission specific, functionally integrated protective system of clothing and equipment which ensures protection against natural and induced environmental hazards encountered during routine, combat, and emergency flight operations; and during escape, survival and rescue following loss of the aircraft.

The mission specific concept for this advanced development was originated at the NAVAIRDEVCEN, as a result of previous efforts during the 1968-1970 period.

A TDP (Technical Development Plan) for this program was issued in April 1972. The ADO 45-67 Advanced Development Program established by the Chief of Naval Operations (CNO), was initiated in July 1973, under the management of the Naval Air Systems Command (AIR-340B).

This development effort will span the period from Fiscal Year 1974 through Fiscal Year 1980.

This program was recently expanded in FY-74 to include development of the related aircraft life support and escape sub-systems, as well as the personal items of equipment typically worn by the aircrewman, for a total systems approach to achieve the full objectives of this program.

RATIONALE

Prior to collecting data and other information upon which to develop engineering programs and ultimately hardware, several judgments in rationale had to be made. The first related to the realization that the success of certain longer term development programs could have a very significant effect on the need and approach taken in other shorter term developments. For example, it should be apparent that if it were possible to develop a flotation system to keep a helicopter upright and afloat upon water ditching and thereby give all the occupants of that helo all the time necessary for a calm egress, this would have an appreciable effect on whether the need existed for one to constantly wear a life preserver during a mission for split-second readiness.

As another example, if a helicopter could be modified structurely to possess sufficient armor plating to withstand the penetration of armor-piercing projectiles, then there would probably be no need to impart that protection into a cumbersome and fatiguing armor vest to be worn by a pilot or crewman during flight.

Since the longer term programs do introduce an element of uncertainty due to their high cost, possible lack of funding support, and the long time span necessary to realize technical accomplishment, it was rationalized that the shorter term programs should proceed as though the longer term developments didn't exist. If the longer term programs do indeed reach completion at some later date, then their impact on the total system will again be reassessed.

Another point requiring judgment in rationale was in the determination of the method by which to define the total helicopter system and all its variables. This was important in helping to determine just how the helicopter information would be sought and categorized into a usable form. It was decided that the helicopter system is made up of three major sub-systems; the aircrew personal equipment (that which is worn by the crewman); accessory equipment (devices that are stowed in the aircraft and aid in performing the mission); and aircraft equipment (equipment that is installed as part of the aircraft). The relationship of the three sub-systems is depicted diagramatically in Figure 1. The use of the triangular concept will be explained in greater detail in the final portion of the report.

APPROACH

The information for this effort was obtained directly from the various operational helicopter squadrons. The investigator conducted direct on-site

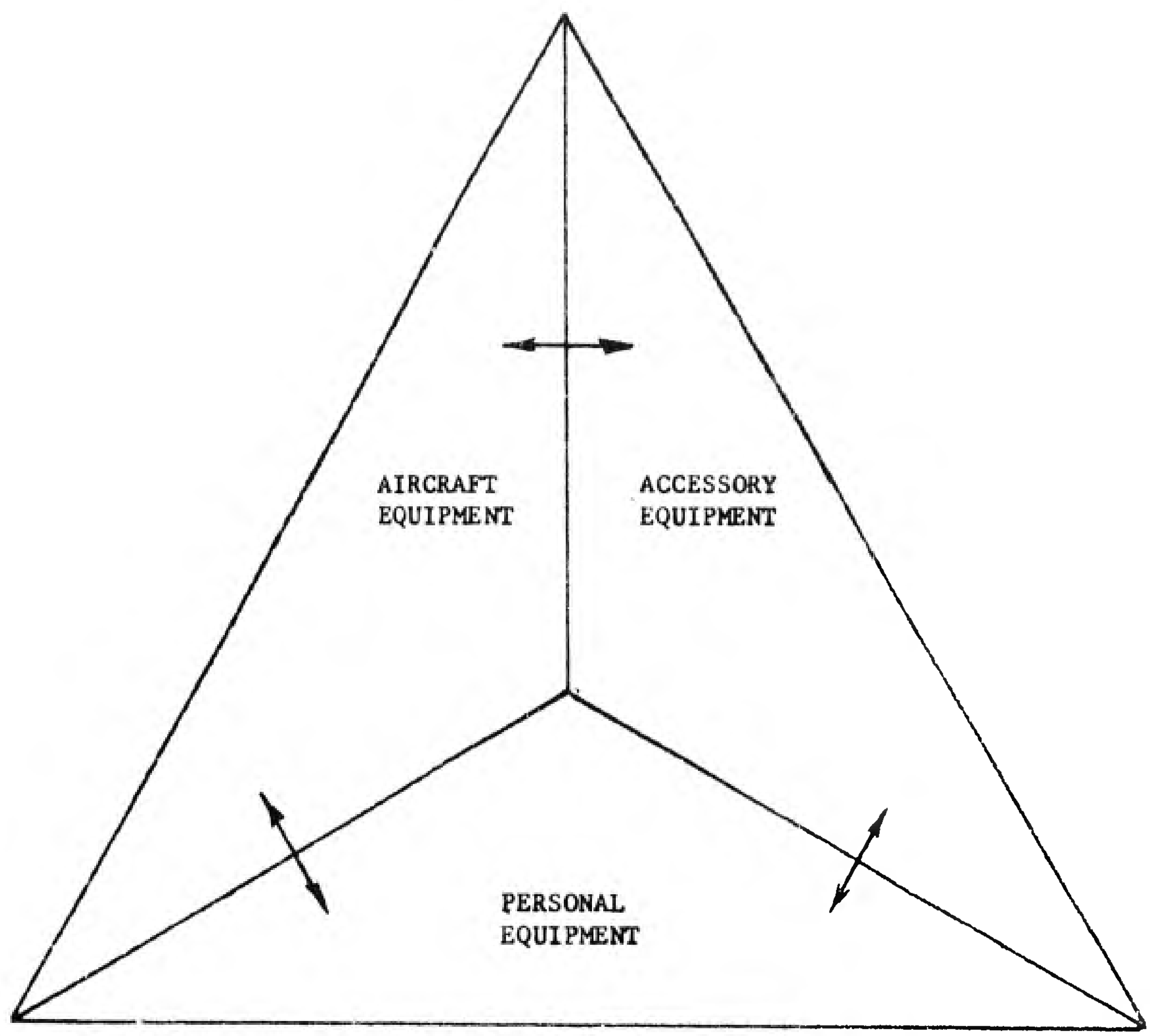

Figure 1. HELICOPTER SYSTEM

visits with the helicopter squadrons, and wore the assigned configuration of aircrew protective clothing and equipment. Whenever possible and practical, the investigator functioned as a crewmember and performed his physical duties and tasks from pre-flight through to mission completion.

To round out the investigation, supplemental information was obtained by direct interviews with pilots, aircrewmen and staff members of the helicopter squadron.

After the information was gathered and arranged in mission/aircraft categories it was once again reviewed by additional helicopter personnel for final confirmation before being used as the basis for actual program assignments.

MISSION SPECIFIC ANALYSIS

SEARCH AND RESCUE (SAR)

Aircraft Type: SH-3G;
Crew: Pilot/Co-pilot; Aircrewmen

1. Mission Profile - The primary objective of combat SAR is to effect the most rapid localization and rescue of a downed aviator within a combat environment. Speed and maneuverability are essential due to the large target that a helicopter presents to enemy ground fire.

When possible, the helicopter is accompanied by elements of an Attack Squadron (VA) or a Fighter Squadron (VF) to provide gunfire suppression of enemy ground/sea forces. When such elements are not available in time, the combat SAR helicopter must "go it alone". For this purpose, the helo is configured with hull and engine armor plate and at least two machine guns which are manned by the enlisted crewmen to deliver suppressive fire, while executing the mission. Combat SAR operations are classified according to two types:

(1) Over-Water Operations - The rescue is to be effected by localizing and retrieving the survivor (s) from the water.

(2) Over-Land Operations - The rescue is to be effected by localizing and retrieving the survivor (s) from land.

The mission profile of non-hostile search and rescue is the same as above except that supportive fire suppression is not needed to accomplish the mission. The mission is therefore performed minus the stress of combat but the procedures and operational requirements are otherwise the same.

1.1 Inflight Phase -

1.1.1 Pilot/Co-pilot - Prior to take-off, the pilot and co-pilot conduct a pre-flight inspection of the physical condition of the aircraft in accordance with NATOPS requirements. This includes checking the fuselage of the aircraft, the hydraulic system, the engines, the transmission, and other aircraft functional systems. During final preparation for flight, the pilot and co-pilot must perform a number of physical tasks which are directed at attaching the protective devices to their person. These tasks include donning the survival vest (combat or non-combat configured), the life preserver, the protective helmet, connecting the helmet to the interior communications system (ICS); connecting the aircraft vent hose to the anti-exposure suit (when worn); and securing themselves to their respective seats via the seat harness assembly, and donning flight gloves. For the duration of the flight, the pilot and co-pilot remain seated in their respective seats and perform their assigned flight duties, which involve the exercise of intellective and psychomotor skills rather than distinct physical work.

On those missions involving search and rescue, the pilot and co-pilot are involved in a number of critical maneuvers at the rescue site and decision making responsibilities throughout the mission. These include locating the survivor, making an assessment of the best rescue approach, and deciding where or when to send a rescue-crewman into the water to assist in the retrieval of the downed crewman. These duties require a high degree of skill and coordination.

1.1.2 Rescue Crewmen - While getting underway, the enlisted crewmen conduct a brief last minute check of their equipment and complete the donning of their personal equipment. They secure themselves to their seats and await orders from the pilot to man their stations when approaching the pick-up area.

1.1.2.1 Over-Water Operations -After the survivor (s) has been localized, the helo maneuvers for a quick low and fast "run in" over the water (air speed approx. 100 knots); the rescue crewman stands ready to pay out cable from the hoisting winch while guiding the pilot to the direct overhead position above the survivor. The retrieval device is then readied for the survivor. If the survivor is uninjured, he indicates this by a signal to the helo and then attaches himself to the retrieval device. When the rescue crewman verifies that the survivor is securely fastened to the end of the rescue cable he hoists the survivor free of the water and signals the pilot to proceed. With the helo in forward motion, the survivor is hoisted up and into the interior of the helo. The pilot then accelerates the helo forward and up, and heads out of the area as quickly as possible.

The alternate case in over-water operations occurs when the helo arrives near the survivor in the water, and the rescue crewman observes that the survivor is unconscious or injured, possibly to the extent that he cannot attach himself to the rescue hoist without sustaining further injury. The crewman communicates his appraisal of the situation to the pilot who must consider all factors (e.g. enemy gunfire, sea state, visibility, etc.) and decide whether to send the crewman into the water to render assistance to the survivor.

If the decision is made to send the crewman into the water to render assistance, the crewman (wearing a wet suit, mask and swim fins) enters the water by jumping out of the helo which hovers at an altitude from 10 to 40 feet, depending on sea state, enemy gunfire, etc. With the crewman in the water, the helo moves out of the jump point and conducts an erratic orbit of the area to:

a. Prevent prop wash from hindering the rescue efforts

b. Prevent a target opportunity for enemy gunfire

c. Sweep the area with gunfire suppression to protect the men in the water if necessary.

While the rescue crewman is in the water he must quickly accomplish the following basic tasks:

a. Determine the nature and extent of the survivor's injury and do what he can to assist the survivor.

b. Remove and/or disentangle the survivor from the parachute harness and shroud lines, and take countermeasures against sharks, sea snakes, etc., particularly if the survivor has been bleeding and there is evidence of a shark threat.

c. Prepare and position the survivor for pick-up with the retrieval device.

d. Signal the pilot for pick-up; a light signal at night, and a visual or smoke signal by day.

e. Retrieve and connect the rescue hoist cable hook to the survivor and himself and ride up with the survivor to provide auxiliary support to prevent any further injuries (e.g. to the head or back area).

When the rescue crewman and the survivor have been hoisted into the interior of the helo, the pilot is given the word to proceed. The pilot accelerates the helo out of the area as quickly as possible.

1.1.2.2 Over Land Operations - After the survivor (s) has been localized, the pilot maneuvers the helo for a quick run-in (air speed approx. 100 knots) at an altitude consonant with terrain features (trees, hills, etc.). When the helo is above the survivor, the rescue hoist cable is sent down to him with a retrieval device attached to the end (equipment used varies according to terrain features and prevailing conditions).

The survivor, if uninjured, attaches himself to the rescue device. When the rescue crewman verifies that the survivor is securely attached to the rescue device he rapidly retracts the hoist lift cable (lift speed approx. 200 feet per minute) and brings the survivor up and into the interior of the helo. The pilot is then given the signal to proceed and the helo then accelerates out of the area as quickly as possible.

In the event the survivor is injured to the point that he cannot be hoisted up alone, or if his injuries might be compounded by an unassisted rescue, the rescue crewman must be sent to the ground to assist the survivor. This is done only after the pilot has been informed of the situation and he makes an appraisal of prevailing conditions (e.g. enemy gunfire, fuel remaining, visibility, terrain characteristics).

If the decision is made to send the crewman to the ground (because the area is not suitable for a helicopter landing) to render assistance to the survivor, the crewman connects himself to the rescue hoist cable and is lowered to the ground by another crewman who operates the hoist. If necessary, the helo then conducts gunfire support operation to protect the helo and the men on the ground.

When the rescue crewman is on the ground he must quickly accomplish the following basic tasks:

a. Determine the nature and extent of the survivor's injury and do what he can to assist the survivor.

b. Remove and/or disentangle the survivor from any equipment that would hinder lifting operations.

c. Prepare and position the survivor for pick-up with the rescue equipment that is to be used.

d. Ride up with the survivor, to provide auxiliary support to prevent any further injury (e.g. to the head or back).

When the rescue crewman and the survivor have been hoisted into the interior of the helo, the pilot is given the word to proceed. The pilot then accelerates the helo out of the area as quickly as possible.

1.2 Egress Phase -

1.2.1 Egress Points - The SH-3, regardless of mission, is configured with six evacuation exits; three on the port side and three on the starboard side. The port side exits are arranged as follows:

1 - Pilot's compartment window/door

1 - Cabin door, which is located in the after section

1 - Cabin window located between the above

The starboard side exits are arranged as follows:

1 - Pilot's compartment window/door

1 - Personnel door, which is the normal mode of aircraft ingress and egress

1 - Cabin window located amidship

1.2.2 Normal Egress Procedures -Pilots and crew enter and leave the aircraft through the personnel door on the starboard side. There are no known problems associated with this procedure, unless the latching mechanism of the door malfunctions.

1.2.3 Emergency Egress Procedures

a. Pilot and Co-pilot - Several options are open to them. The quickest and closest escape route would be through the pilot's compartment jettisonable window/door assembly. If this is not possible, emergency egress may be accomplished through the personnel door. A final option would be through either of the two windows, or the cabin door in the after section of the helo. This is the least preferable, due to the length of time and distance involved in reaching these alternate routes. Moreover, the pilots may be competing for emergency exit with the cabin crewmen who are attempting the same procedure.

b. Crewmembers (SAR Mission (Combat and Non-Combat) and Light Cargo Delivery)- The crew composition for this may vary at the discretion of the mission commander.

The emergency egress routes open to the crew are through the port cabin window; through the personnel door forward of them on the starboard side; through the starboard cabin window, or the cabin door in the after section of the helo. This last route is the least preferable, due to the time and distance required to reach and exit from it.

It should be emphasized that the final selection of one of the emergency egress routes depends on the crewman's proximity to it in an emergency, and his state of mind in assessing the degree of danger posed by the emergency.

1.2.4 Summary and Conclusions - There are adequate provisions, in both size and quantity, for emergency egress by the pilots and crew of this helicopter. There is no evidence of any problem areas associated with emergency egress and the individual's protective clothing and equipment worn during flight.

2. Current Problems

2.1 Personal Equipment

2.1.1. Pre-Flight Gloves- Adequate pre-flight inspection of helicopters requires the actual physical contact of various parts of the aircraft and rotor system. Many of these parts require frequent greasing and manual checking which results in excessive soiling of the flight gloves, thus rendering them unusable for their primary function. Excessive usage rates of flight gloves can no doubt result because of the harsh wear imposed upon them.

2.1.2 Operational Gloves - The rescue crewman who guides the hoist cable as it is being lowered or raised during a rescue pickup or who removes hot barrels from machine guns, experiences excessive glove wear and possible hand injury. The conventional flight glove is not durable enough to withstand the abrasive action of the cable against the palm of the hand nor the heat of gun barrel handling. In addition, the conventional glove does not provide adequate thermal protection during cold water rescue operations.

2.1.3 Rescue Swimmer's Suit- The current two-piece rescue swimmer's wet suit is obtained from civilian sources by open purchase. Suits procured in this manner are often poor fitting, non-standard in design, and difficult to support logistically. They also vary widely in material thickness, structural strength, and durability, particularly at points of wear such as feet, knees and elbows.

In addition, none of the wet suits have any provision for dissipating body heat build-up, which adversely affects wearer comfort and ultimately performance.

2.1.4 Rescue Crewman Communication System - The ambient noise level of a helicopter is extremely high. During SAR operations, particularly under combat conditions when the helo machine guns are in use, the noise level is significantly increased. As a consequence of this, voice communication via the helmet-mounted boom microphone is greatly impaired. In an effort to solve this problem, combat SAR crewmen wear the A-13 oxygen mask with its enclosed microphone in place of the boom microphone. This approach reduces the noise problem to acceptable levels but as a result, the facial area covered by the A-13 mask becomes hot and uncomfortable necessitating frequent disconnection and connection of one side of the mask, particularly in hot weather as experienced in South East Asia.

2.1.5 Body Armor - The current body armor worn by the combat rescue crewman is extremely bulky and subjects him to a high degree of body heat buildup, particularly in tropical climate. The rescue crewman who descends to the ground to render assistance to a survivor is required to wear the armor but because it is bulky, it interfered with his mobility, thus hindering the rapid execution of his tasks.

2.1.6 Rescue Crewman Configuration - The rescue crewman's total configuration consists of a combination of separate items of clothing, accessory equipment, and rescue aids most of which are non-standard and procured from local commercial sources. The variations in equipment among crewmen lead to a non-standard profile and problems in the logistic support of that equipment. The rescue crewman, by virtue of his own selection of a variety of random equipment may be compromising the performance of his duties of assisting a downed survivor and also in insuring his own safe return.

2.2 Accessory Equipment -

2.2.1 Signal Device - The current signal flares carried by the rescue crewman are adequate for the intended purpose of signalling, but they do encompass a number of disadvantages, some of them serious and hazardous.

They are bulky and sometimes subject the crewman to burns and/or irritation from the heat and smoke. Their burning time is extremely short (less than 30 seconds) and their reliability of performance is less than expected of a life-saving device. The current flare is also bulky considering the short duration of light that it produces for its weight.

2.2.2 Multi-Place Life Rafts - Present multi-place life rafts do not meet the requirements for acceptable egress during ditching situations. Due to the soft-container packing method for multi-place life rafts, the rafts do not lend themselves to compact storage aboard present helicopters, nor are they conducive to rapid manual removal via emergency escape hatches.

2.2.3 Rescue Litters - The presently used Stokes litter is too bulky as a litter to easily fit into helicopters and attach to the aircraft securely during flight. Furthermore, the Stokes litter does not posses inherent flotation capability should it be thrust into the water.

2.3 Aircraft Equipment

2.3.1 Escape Hatch Markings - In emergency situations helicopter occupants often become disoriented and fail to find or release emergency escape hatches. Basic instructions for releasing escape hatches given to occupants before emergencies are often forgotten or misunderstood.

2.3.2 Crash Locator Device - There is presently no helicopter crash locator device in existence. At the present, valuable time is lost in searching for a helicopter crash site. A system by which the location of a crash could be determined, would help in locating possible survivors or in determining that further search is futile. Salvaging of submerged aircraft could be attempted if the site of the crash were fixed by a locator device.

2.3.3 Pilot/Co-pilot/Crewmen Seats - Pilot, co-pilot and crewmen seats exhibit a number of serious inadequacies. They lack structural integrity for potentially survivable crash conditions. They offer only marginal seat comfort and body support for long flight missions. The seat restraint is also inadequate for limiting crash loads and controlling the motion of the occupants. In addition, there is little or no commonality of seats or seat components from aircraft to aircraft.

3. Equipment Requirements/Recommended Design Approaches

3.1 Personal Equipment

3.1.1 Pre-Flight Gloves - There is a requirement for a set of pre-flight gloves that will permit the hand dexterity required in pre-flight inspection of aircraft, and protect the hands from minor injuries. The gloves should be durable and readily cleanable.

The approach to the glove solution may be by means of a durable stretch knit overglove designed to snugly fit over the flight glove with a minimum addition of bulk to the hand.

The solution may also be achieved by a new utility glove that is durable, cleanable, and economical in cost. A glove design requiring as few sizes as possible would be a decided advantage.

3.1.2 Operational Gloves - Due to the nature and conditions under which the rescue crewman uses his hands in the performance of his duties, such as guiding the hoist cable or handling hot gun barrels, there is a requirement to provide him with a utility glove which not only permits the necessary dexterity but also affords adequate physical and thermal protection for the hands. The glove should be designed to protect against below freezing temperatures, chill factors and dampness.

After an assessment of the rescue crewman's performance of duties, design features of the utility glove should be determined. A survey of industrial gloves should then be made in the interest of expediency and economy and with the thought of adapting an existing glove to meet the requirements.

If no potentially suitable commercial glove is found to be available, then the development of an entirely new glove would be necessary.

3.1.3 Rescue Swimmers Suit - A requirement exists for a wet suit designed for the rescue crewman that would have provisions for body heat dissipation; permit ease of donning, doffing and mobility; feature reinforcements against tearing and abrasion; be fire retardant; have size adjustment features; and be treated with a chemical that would facilitate rapid dry-out.

The suit should include as part of its total assembly, thermal protection for the swimmer's feet, hands and head; fins to aid in swimming; a face mask; and coral boots to take the abuse of walking.

3.1.4 Helmet Assembly- There is a general requirement for an overall improved helmet design. The required helmet should (1) incorporate ambient noise attenuation that is superior to current SPH-3 levels of performance; (2) be of lesser weight and thus induce less fatigue to the wearer; (3) be constructed of higher strength per weight material; (4) incorporate a non-protruding "mike" technique of voice transmission having a higher signal to noise ratio; (5) permit earphone adjustment for optimum fit to various head contours (6) incorporate a visor system having both clear and tinted capabilities; and (7) have improved peripheral vision.

3.1.5 Body Armor - A requirement exists for a lightweight and cooler body armor for the rescue crewman that would provide adequate protection against gunfire, but would not unduly restrict his mobility while performing rescue duties. The body armor should integrate with other personal survival equipment worn by the crewman.

3.1.6 Rescue Crewman Configuration- There is a requirement to design an integrated assembly of personal equipment to be worn by the rescue crewman which would enable him to tolerate the in-flight phase of the mission and yet permit him to expeditiously be capable of performing the full responsibility of jumping into the water to assist a disabled survivor to safe recovery.

The integrated assembly will have to include a thermally protective wet suit previously discussed; a flotation device which will not hinder movement and the performance of duties; an adjustable harness and/or chaps that will serve as a foundation for lift rings, rescue aids (knife, lights, flares, etc.); and swimming aids such as fins, goggles, etc.

The assembly of equipment once established should become the officially prescribed and supplied assembly of equipment for all rescue crewmen.

3.1.7 Anti-Exposure Protection - In view of the problems associated with the wearing of the CWU-33/P anti-exposure suit, and the highly physical nature of certain crewman's duties, it is required that anti-exposure protection be provided in a manner that is acceptable to the crewman from an operational standpoint. If the protection is accomplished by means of a garment, then the garment shall permit the necessary mobility and also means for dissipating body heat buildup. If this can't be achieved because lack of a satisfactory suit design approach or lack of suitable means to bring ventilation to the suit, then anti-exposure protection must be accomplished by a supplementary system.

3.1.8 Life Preserver - There is a requirement to develop a constant wear preserver which, in the stowed or uninflated condition, imposes a minimum of encumberance to the wearer and permits the wearer to perform the inflight role to which he has been assigned. The preserver shall offer buoyancy consistent with the weight of the equipment worn by the crewman and should be compatible with the wearer's total configuration, work function, and assigned seating. The preserver shall not require helmet removal in order to prepare the preserver for inflation. The buoyancy of the preserver shall be so distributed as to place the user in a properly angled face-up position in the water. In addition an easily donnable preserver is required for non-combat clad or VIP personnel. The preserver shall require little or no indoctrination in its use and shall be easily stowable and maintenable. An automatic light feature should be included.

3.1.9 Knee Protection - There is a requirement to provide flexible knee pads, that the crewman can easily attach and detach over his flight clothes, to protect his knees and clothing from effects of deck abrasion and impact with equipment.

The technical approach can initially begin with a survey of industrial or sporting goods equipment and if need be, modify or completely redesign the available equipment to meet the specific needs of the crewman.

3.2 Accessory Equipment

3.2.1 Signal Devices - A requirement exists for a signal device that would have less bulk than the current flare (MK 13); perform with almost 100% reliability; incur no hazards when in the presence of inflammable materials; perform under the extremes of operational and emergency condition temperatures; produce light of sufficient intensity to be seen at least 100 ft. away; and incorporate a shielding device so as to permit covert signalling between swimmer and aircraft.

Technical approaches toward meeting the requirement should include the investigation of lights powered by batteries of recent technology which permit improved operation under cold temperature environments; and the investigation of chemical sources of light.

3.2.2 Multi-Place Life Rafts - A requirement exists to provide a multi-place life raft a (MK-7 or MK-4 in the case of the SH-3 series) that is packed in a rigid container designed to accommodate the raft and the desired emergency equipment, and is capable of easy removal through the emergency hatch of the aircraft.

Safety Center data and recommendations available from other sources should be analyzed with regard to the minimum required list of accessory equipment necessary to be packaged with the raft in a container system. The container system design should then be based upon stowage techniques in the aircraft and the ease with which the system can be removed from the aircraft during an emergency egress. Utilization of the container system and raft assembly in darkness should be considered in the design.

3.2.3 Rescue Litters - There is a requirement for a rescue litter that is collapsible or foldable and that can be easily handled by one crewman at the helicopter hatch while making a hover-type transfer of a patient.

The litter could be an inflatable mattress type or a foldable metal frame with buoyant bags. The litter should incorporate means for being lifted by a helicopter hoist system.

As an interim measure it is recommended that the Stokes litter be equipped with a flotation apparatus such as sections of styrofoam or inflatable members.

3.3 Aircraft Equipment

3.3.1 Escape Hatch Markings- There is a requirement to provide large egress signs near all escape hatches to be continuously within view of passengers. It is also desired that there be continuous or an automatically activated illumination of the escape hatches and their respective release handles. Clear, recognizable instructions should be placed near all emergency exits so that during flight or emergencies, occupants will be informed.

3.3.2 Crash Locator Device - A requirement exists for an electronic device which would signal the location of a crashed helicopter. The device should be capable of performance in either a land or sea crash situation. The device should be dislodged from the aircraft by the forces of the crash and/or by submergence in water. The range of the signal should be a minimum of 40-50 miles. The device should have flotation capability, an underwater noisemaking feature, and a nighttime visual capability.

3.3.3 Pilot/Co-pilot/Crewmen Seats- There is a strong requirement to improve the crashworthiness of the pilot, co-pilot and crewmen seat systems. This can be achieved through the use of new structural materials such as honeycomb aluminum to reduce weight and improve structural strength; the addition of a negative G strap to reduce submarining; the provision of an inflatable body and head support; and the improvement of the structural strength of the aircraft floor and seat-floor interface track.

There is also a requirement to improve the comfort of the seat. This can be approached by contouring the seat cushion, adding lumbar support, improving ventilation to the seat cushioning, providing an adjustable headrest and incorporating vibration isolators.

ANTI-SUBMARINE WARFARE (ASW)

Aircraft Types : SH-3 (A,D & H)
Crew: Pilot, Co-pilot, Sonar Operator, Asst. Sonar Operator

1. Mission Profile - The primary mission of this aircraft is to conduct flights over assigned ocean areas for the search, detection and identification of submarines. This aircraft operates in conjunction with surface forces, e.g. ASW task groups, and as such is an operating component of a task group. In this capacity the helo may direct additional surface/air forces to a detected contact for further tracking and localization, leading to prosecution.

A secondary mission of this aircraft is search and rescue (SAR) and/or onboard delivery of light cargo (e.g. mail) and passengers.

1.1 Inflight Phase -

1.1.1 Pilot/Co-pilot - Prior to take-off, the pilot and co-pilot conduct a pre-flight inspection of the physical condition of the aircraft in accordance with NATOPS requirements. This includes checking the fuselage of the aircraft, the hydraulic system, the engines, the transmission, and other aircraft functional systems. During final preparation for flight, all crewmembers must perform a number of physical tasks which involve attaching the protective devices to their person. These tasks include donning the survival vest (combat or non-combat configured), the life preserver, and the protective helmet; connecting the helmet to the interior communications system (ICS); connecting the aircraft vent hose to the anti-exposure suit (when worn); and securing themselves to their respective seats via the seat harness assembly; and donning flight gloves. For the duration of the flight, the pilot and co-pilot remain seated in their respective seats and perform their assigned flight duties, including dipping sonar, which involve the exercise of intellective and psycho-motor skills rather than distinct physical work. Night sonar dipping operations are regarded by all members of the SH-3 helicopter community as the most difficult of all their operations. Night dipping required a high degree of vigilance, coordination, and communication between all crewmembers.

1.1.2 Sonar Crewmen - Prior to flight, the sonar man and assistant sonar man conduct visual checks of the interior of the aircraft and for completeness and stowage of equipment. During final preparation for flight, they will perform a number of physical tasks which involve attaching the protective flight equipment to their person such as donning the survival vest (combat or non-combat configured) and helmet; connecting the helmet to the interior communications system (ICS); connecting the aircraft vent hose to the anti-exposure suit (when worn); and securing themselves to their respective seats via the seat harness assembly, and donning flight gloves. During sonar dipping operations, which is conducted during flight, the duties of both men are centered around operating the sonar display and raising and lowering the sonar dome. No particular problems of a physical nature are evident here since their tasks are oriented only to the operation of automatic equipment and they periodically switch duties to relieve each other at station. The duties of the sonar man and assistant sonar man when performed during night operations give rise to certain problems which do not exist when those duties are performed during day operations.

Occasionally, an ASW aircraft (SH-3) and its crew will be required to perform a secondary mission involving search and rescue.

Search and rescue (SAR) operations require the coordinated effort of all crewmembers, but the physical efforts involved in the actual execution of the rescue effort fall exclusively on the sonarmen who perform a number of physical duties and are confronted with a number of problem areas while they are conducting the rescue. The duties of the sonarmen can be divided into the following three categories when conducting SAR operations:

- Provide supplemental visual locating and directional information to the pilot and co-pilot to vector the helo to the area of the person(s) to be rescued.

- Steer the helo, via the auxiliary steering control, directly over the person to be rescued and maintain a stable position for rescue.

- Lower the rescue hoist cable to the person(s) in the water, observe the person hook-up to the hoist cable, and raise and retrieve the rescued person into the helicopter.

All of the above tasks require close coordination and communication with the pilot and between the two sonarmen since one man performs the tasks and the other man stands by to assist him in various phases of the operation.

After the person(s) to be rescued has been spotted, the sonarman opens the rear hatch and proceeds to drop a straight line pattern of three smoke markers to guide the pilot on a straight line vector to the pick-up zone.

The SH-3 helicopter contains an auxiliary steering system which permits the sonarman to steer the helo in a two-dimensional plane, backward and forward, left and right; this gives the sonarman the ability to position the helo directly over the person in the water. In order to do this, the sonarman regulates the steering stick with his left hand while maintaining his head outside of the hatch in order to keep the man in the water in full sight.

After the helo has been positioned to the desired location over the person in the water, the sonarman lowers the rescue cable and retrieval device to the man in the water via the winch control.

1.2 Egress Phase

1.2.1 Egress Points- The SH-3A, D and H, regardless of mission, is configured with six evacuation exits; three on the port side and three on the starboard side. The port side exits are arranged as follows:

1 - Pilot's compartment window/door

1 - Cabin door, which is located in the after section

1 - Cabin window located between the above

The starboard side exits are arranged as follows:

1 - Pilot's compartment window/door

1 - Personnel door, which is the normal mode of aircraft ingress and egress

1 - Cabin window located amidship

1.2.2 Normal Egress Procedures- Pilots and crew enter and leave the aircraft through the personnel door on the starboard side. There are no known problems associated with this procedure, unless the latching mechanism of the door malfunctions.

1.2.3 Emergency Egress Procedures-

a. Pilot and Co-pilot- Several options are open to them. The quickest and closest escape route would be through the pilot's compartment jettisonable window/door assembly. If this is not possible, emergency egress may be accomplished through the personnel door. A final option would be through either of the two windows, or the cabin door in the after section of the helo. This is the least preferable, due to the length of time and distance involved in reaching these alternate routes. Moreover, the pilots may be competing for emergency exit with the cabin crewmen who are attempting the same procedure.

b. Crewmembers (ASW Mission)- the usual crew composition for this mission consists of two men; a Sonar Operator and an Assistant Sonar Operator. During the course of a mission, they can interchange duties. Their position is fixed by two side-by-side seats located at the port cabin window.

The emergency egress routes open to the crew are through the port cabin window; through the personnel door forward of them on the starboard side; through the starboard cabin window, or the cabin door in the after section of the helo. This last route is the least preferable, due to the time and distance required to reach and exit from it.

c. Crewmembers (SAR Mission (Combat and Non-combat) and Light Cargo Delivery)- The crew composition for this may vary at the discretion of the mission commander. The distinguishing feature of these two missions (vs the ASW mission) is that the two seats for the sonar men, as well as the dipping sonar equipment, have been removed to increase payload.

In addition, the interior of the helo is configured with the tubular frame troop seats for the crewman, instead of the dual fixed seats. This affords greater flexibility for individual movement.

With respect to emergency egress, the remarks in paragraph b above, are equally applicable here.

It should be emphasized that the final selection of one of the emergency egress routes depends on the crewman's proximity to it in an emergency, and his state of mind in assessing the degree of danger posed by the emergency.

1.2.4 Summary and Conclusions- There are adequate provisions, in both size and quantity, for emergency egress by the pilots and crew of this helicopter. There is no evidence of any problem areas associated with emergency egress and the individuals protective clothing and equipment worn during flight.

2. Current Problems

2.1 Personal Equipment

2.1.1 Pre-flight Gloves- Adequate pre-flight inspection of helicopters requires the actual physical contact of various parts of the aircraft and rotor system. Many of these parts require frequent greasing and manual checking which results in excessive soiling of the flight gloves, thus rendering them unusable for their primary function. Excessive usage rates of flight gloves can no doubt result because of the harsh wear imposed upon them.

2.1.2 Operational Gloves (SAR)- Occasionally, the sonar crewman and the helo of which he is a member are called upon to perform a search and rescue mission. When the sonarman is in the SAR role he will, during the rescue pickup, guide the hoist cable as it is being lowered or raised. This procedure causes excessive glove wear and possible hand injury. The conventional flight glove is not durable enough to withstand the abrasive action of the cable against the palm of the hand. In addition, the conventional glove does not provide adequate thermal protection during cold water rescue operations.

2.1.3 Eye Protection- When the helo hovers in a crosswind at low altitude; i.e., below 50 ft, the sonarman is subjected to prop wash, water spray and, under certain conditions, engine fumes and exhaust particles. These elements can pass under his helmet visor and adversely effect his vision.

2.2 Accessory Equipment

2.2.1 Multi-Place Life Rafts- Present multi-place life rafts do not meet the requirements for acceptable egress during ditching situations. Due to the soft-container packing method for multi-place life rafts, the rafts do not lend themselves to compact storage aboard present helicopters, nor are they conducive to rapid manual removal via emergency escape hatches.

2.2.2 Ventilation Hose Assembly- In the final preparations for flight, the crewmen will connect the aircraft ventilation hose to the anti-exposure suit inlet fitting and adjust the air flow as required. This procedure is unnecessarily cumbersome due to the short length of aircraft vent hose located behind, to the left, and below the crewman's seat, and the small size of the knob on the valve in the connection fitting which regulates the air flow from the vent hose into the exposure suit fitting.

2.3 Aircraft Equipment

2.3.1 ICS Connection and Cable System- The cable from the helmet microphone and earphones must be plugged into the helicopter ICS to permit communications among all crewmen in the aircraft. This is quite simple to effect, however it is very easy to accidentally disconnect the cable from the ICS as a result of pulling or snagging. The ensuing loss of communications, particularly during the critical moments of a mission, presents an unnecessary hazard.

2.3.2 Escape Hatch Markings- In emergency situations helicopter occupants often become disoriented and fail to find or release emergency escape hatches. Basic instructions for releasing escape hatches given to occupants before emergencies are often forgotten or misunderstood. Also, due to poor visibility in darkness, location and engagement of escape hatch handles are difficult to accomplish.

2.3.3 Heating and Ventilation- The aft section of the SH-3 helicopter does not offer any heating or ventilating air to the crewmen. In cold weather operations, heat would be an obvious asset to the crewmen. Lack of ventilation air precludes the proper utilization of the air distribution network in the CWU-33/P anti-exposure suit or in any other suit of future design.

2.3.4 Pilot/Co-pilot/Crewman's Seats- Pilot, co-pilot and crewman's seats exhibit a number of serious inadequacies. They lack structural integrity for potentially survivable crash conditions. They offer only marginal seat comfort and body support for long flight missions. The seat restraint is also inadequate for limiting crash loads and controlling the motion of the occupants. In addition, there is little or no commonality of seat components from aircraft to aircraft.

2.3.5 Sonar Dome Seating - When the sonar hoisting operation has been completed, the sonarman or the assistant sonarman visually verifies that the sonar dome has been fully retracted and properly seated in the housing. This visual check is done to supplement the information shown on the sonar console control panel. The crewman then reports to the pilot that he can proceed to the next search point. The dome housing is transparent and located directly behind the sonarmen seats. During night operations, it is extremely difficult to see the sonar dome through the transparent housing since there is no illumination in the area.

3. Equipment Requirements/Recommended Design Approaches

3.1 Personal Equipment

3.1.1 Pre-Flight Gloves- There is a requirement for a set of preflight gloves that will permit the hand dexterity required in pre-flight inspection of aircraft, and protect the hands from minor injuries. The gloves should be durable and readily cleanable.

The approach to the glove solution may be by means of a durable stretch knit overglove designed to snugly fit over the flight glove with a minimum addition of bulk to the hand.

The solution may also be achieved by a new utility glove that is durable, cleanable, and economical in cost. A glove design requiring as few sizes as possible would be a decided advantage.

3.1.2 Operational Gloves (SAR)- Due to the nature and conditions under which the sonar crewman uses his hands in the performance of his SAR duties such as guiding the hoist cable, there is a requirement to provide him with a utility glove which not only permits the necessary dexterity but also affords adequate physical and thermal protection for the hands. The glove should be designed to protect against below freezing temperatures, chill factors, and dampness.

After an assessment of the crewman's performance of duties, design features of the utility glove should be determined. A survey of industrial gloves should then be made in the interest of expediency and economy and with the thought of adapting an existing glove to meet the requirements.

If no potentially suitable commercial glove is found to be available then the development of an entirely new glove would be necessary.

3.1.3 Eye Protection - A requirement exists for an improved helmet visor assembly for sonar crewmen that would afford better protection in terms of an easier cleaning capability and a better seal around the eyes which would prevent air and exhaust fumes from flowing up under the visor opening into the eyes when conducting operations from the rear hatch.

3.1.4 Helmet Assembly - There is a general requirement for an overall improved helmet design. The required helmet should (1) incorporate ambient noise attenuation that is superior to current SPH-3 levels of performance; (2) be of lesser weight and thus induce less fatigue to the wearer; (3) be constructed of higher strength per weight material; (4) incorporate a non-protruding "mike" technique of voice transmission having a higher signal to noise ratio; and (5) permit earphone adjustment for optimum fit to various head contours; (6) incorporate a visor system having both clear and tinted capabilities; and (7) have improved peripheral vision.

3.1.5 Anti-Exposure Protection- In view of the problems associated with the wearing of the CWU-33/P anti-exposure suit, and the highly physical nature of certain crewman's duties, it is required that anti-exposure protection be provided in a manner that is acceptable to the crewman from an operational standpoint. If the protection is accomplished by means of a garment, then the garment shall permit the necessary mobility and means for dissipating body heat build-up. If this can't be achieved because lack of a satisfactory suit design approach or lack of suitable means to bring ventilation to the suit, then anti-exposure protection must be accomplished by a supplementary system.

3.1.6 Life Preserver -There is a requirement to develop a constant wear preserver which, in the stowed or uninflated condition, imposes a minimum of encumberance to the wearer and permits the wearer to perform the in-flight role to which he has been assigned. The preserver shall offer buoyancy consistent with the weight of the equipment worn by the crewman and should be compatible with the wearer's total configuration, work function, and assigned seating. The preserver shall not require helmet removal in order to prepare the preserver for inflation. The buoyancy of the preserver shall be so distributed as to place the user in a properly angled face-up position in the water.

3.1.7 Knee Protection - There is a requirement to provide flexible knee pads, that the crewman can easily attach and detach over his flight clothes, to protect his knees and clothing from effects of deck abrasion and impact with equipment.

The technical approach can initially begin with a survey of industrial or sporting goods equipment and if need be, modify or completely redesign the available equipment to meet the specific needs of the crewman.

3.2 Accessory Equipment

3.2.1 Multi-Place Life Rafts A requirement exists to provide a multi-place life raft (a MK-7 or MK-4 in the case of the SH-3 series) that is packed in a rigid container designed to accommodate the raft and the desired emergency equipment, and is capable of easy removal through the emergency hatch of the aircraft.

Safety Center data, and recommendations available from other sources should be analyzed with regard to the minimum required list of accessory equipment necessary to be packaged with the raft in a container system. The container system design should then be based upon stowage techniques in the aircraft and the ease with which the system can be removed from the aircraft during an emergency egress.

3.2.2 Ventilation Hose Assembly - A requirement exists to lengthen and reposition the aircraft vent hose, which would make it easier to connect and disconnect with the exposure suit and increase the diameter of the knob on the valve, which would facilitate adjusting the air flow rate when wearing gloves. This improvement should incorporate a flexible support, that will prevent the aircraft vent hose from falling below the seat when it is disconnected from the exposure suit, thereby causing the crewman to fumble for the connector when attempting to reconnect.

3.3 Aircraft Equipment -

3.3.1 ICS Connection and Cable System - There is a requirement for a quick, reliable and more secure connector that will prevent accidental separation from the ICS and yet permit easy disconnect during emergencies. In addition, a requirement exists for a simple and reliable piece of equipment to control cable slack so that the crewman can draw extra cable when needed and automatically retract the cable when not needed. Both of the above items should be coated with a durable color-coded luminescent material that will facilitate location and connection during night operations when the helo is in a "darken ship" condition.

The solution to the connector separation may be attempted by designing a modification of current hardware that will increase the separation force sufficiently to preclude inadvertant disconnect and yet permit an unencumbered manual separation. The connector may be "bridged" by a snap type clip that withstands high pull forces and which can easily be released when desired.

The retraction system can be devised along the lines of commercially available systems now in use with vacuum cleaner line cords and other such devices. It would naturally be necessary to determine the economic and logistic impact of introducing such a design.

3.3.2 Escape Hatch Markings - There is a requirement to provide egress signs near all escape hatches to be in continuous view of the aircraft's occupants. It is also desired that there be a continuous or an automatically activated illumination of the escape hatches and their respective release handles at the time of ditching.

3.3.3 Heating and Ventilation - There is a requirement to provide ventilation air to the crewman's anti-exposure suit in the after section of the helo in order to reduce the body-heat buildup that occurs during the performance of his duties. If anti-exposure protection is to be achieved through the use of a garment that required ventilation during the inflight phase, then an after station vent air system is an extremely important requirement. In addition, it is equally as important to provide a well regulated warm air system for those periods of the year when the crewman is exposed to cold ambient environments.

3.3.4 Pilot/Co-pilot/Crewman's Seats - There is a requirement to improve the crashworthiness of the pilot,co-pilot and crewman's seat systems. This can be achieved through the use of new structural materials such as honeycomb aluminum to reduce weight and improve structural strength; the addition of a negative G strap to reduce submarining; the provision of an inflatable body and head support; and the improvement of the structural strength of the aircraft floor and seat-floor interface track.

There is also a requirement to improve the comfort of the seat which can be approached by contouring the seat cushion, adding lumbar support, improving ventilation to the seat cushioning, providing an adjustable headrest and incorporating vibration isolators.

Logistic support of seat structures and components can be greatly enhanced by standardizing designs among various aircraft.

3.3.5 Sonar Dome Seating - A requirement exists to provide a better means for visually confirming that the sonar dome is properly seated in its housing.

Although the housing is a transparent plastic material, excessive dirt accumulation on the housing surface plus a factor of poor lighting in the vicinity of the housing, makes visual confirmation difficult.

The solution may involve providing better illumination or a modification of the housing to enable a visual determination of the dome seating.

3.3.6 Crewman Safety Belt - A requirement exists for a redesign of the locking assembly of the crewman's safety belt which would prevent it from being accidentally disengaged and yet enable it to be quickly released when an emergency arises.

VERTICAL REPLENISHMENT OF CARGO-

Aircraft Types: CH-46 (Models A,D & G)
Crew: Pilot/Co-pilot; 2 to 8 enlisted crewmembers

1. Mission Profile - The mission of this aircraft is to provide a rapid pickup, transport, and delivery of cargo and material from a supply source to various operating elements of the fleet at sea and ashore. The cargo load is carried externally from point to point, thus enabling the aircraft to rapidly load and unload the cargo with a minimum of time and manpower. This capability is employed for emergency deliveries of critical material and routine deliveries as underway replenishment for the fleet at sea.

1.1 Inflight Phase -

1.1.1 Pilot/Co-pilot - Prior to take-off, the pilot and co-pilot conduct a pre-flight inspection of the physical condition of the aircraft in accordance with NATOPS requirements. This includes checking the fuselage of the aircraft, the hydraulic system, the engines, the transmission, and other aircraft functional systems. During final preparation for flight, the pilot and co-pilot must perform a number of physical tasks which involve attaching the protective devices to their person. These tasks include donning the survival vest (combat or non-combat configured), the life preserver, and the protective helmet; connecting the helmet to the interior communications systems (ICS); connecting the aircraft vent hose to the anti-exposure suit (when worn); and securing themselves to their respective seats and perform their assigned flight duties, which involve the exercise of intellective and psychomotor skills rather than distinct physical work.

1.1.2 Vertical Replenishment Crewman - Prior to engine start the vertical replenishment crewman removes the hatch cover from the deck of the CH-46 helo to inspect the hook assembly for proper functioning. He does this by testing the latching and releasing mechanism by manual operation and informs the pilot of his checkout results via the ICS. After this has been completed, he attaches the life preserver and protective helmet to his person and secures himself to the side seats with a lap belt and waits for take-off.

After the aircraft has reached and descended to the operational area the vertical replenishment crewman and one assistant assume a prone position on the deck on either side of the deck hatch opening when vertical replenishment operations are to begin. This is done for two reasons:

a. To afford visual sighting of the cargo pickup and drop zone so he can guide the pilot to the precise overhead location for cargo pickup and drop.

b. To manually activate the hook release for cargo drop and to reset the hook for cargo pickup.

For the duration of the operation these men remain in this position until relieved by the other enlisted crewmembers.

When the cargo transfer has been completed, the cargo hook is secured in its mounting, the hatch cover is replaced and secured and the vertrep crewman returns to his flight station to secure himself to his seat. The aircraft then returns to its point of origin.

Occasionally, a cargo-transport aircraft (CH-46) and its crew will conduct SAR operations through the use of the forward boom and pallet assembly if it is installed in the helicopter.

1.2 Egress Phase -

1.2.1 Egress Points - The CH-46A/UH-46A, regardless of mission, are configured with seven evacuation exits; three on the port side and four on the starboard side. The port side exits are arranged as follows:

1 - Pilot's compartment window/door

1 - Main entrance door (personnel door), which is the normal mode of aircraft ingress and egress

2 - Escape hatches with windows

The starboard side exits are arranged as follows:

1 - Pilot's compartment window/door

1 - Emergency exit door immediately aft of the pilot's window/door area

1 - Escape hatch with window located in the after section

In addition to the above listing, there are four windowed emergency cut-out panels; two port and two starboard, which must be physically cut out with tools to effect rescue/escape. Due to this fact, they are considered useless exits in emergency and will not be considered in the following discussion.

1.2.2 Normal Egress Procedures - Pilots and crew enter and leave the aircraft through the main entrance door (personnel door) on the port side. There are no known problems associated with this procedure, unless the latching mechanism of the door malfunctions.

1.2.3 Emergency Egress Procedures -

a. Pilot and Co-pilot - Several options are open to them. The quickest and closest escape route would be through the pilot's compartment jettisonable window/door. If this is not possible, escape may be effected through the port side main entrance door, or the starboard side emergency exit door. In the event this is not possible, escape may be effected through the two windowed escape hatches on the port side or the single windowed escape hatch on the starboard side. The final option for escape is through the tail ramp; but this can only be effected if the ramp is in the down position.

b. Crewmember - The crew composition and size will vary according to the mission (2-3 for vertical replenishment ops; 1-2 for passenger transport). In any case, the crewmen do not have any fixed seated positions for the conduct of a mission. The men do have assigned stations (locations) at which they perform their mission duties; however, this is conducted while standing, or in a prone position when conducting vertical replenishment operations.

Despite this apparent latitude of freedom, there are potential problem areas that can arise under certain conditions if and when personnel or bulk cargo is carried internally. In such cases, the crowded interior of the helo can impede the free flow of personnel movement, especially in an emergency situation.

Large quantities of bulk cargo carried internally can subject the escaping personnel to such hazards as snags, entrapment, cuts, tears and lacerations.

The emergency egress routes open to the crew (and passengers, if any), are as follows:

(1) Exit through the rear ramp, if it is in the down position.

(2) Exit through the main entrance door.

(3) Exit through the emergency exit door.

(4) Escape through any of the three windowed escape hatches as a final option.

It should be emphasized that the final selection of one of the above routes will depend on the crewman's proximity to it in an emergency, and his state of mind in assessing the degree of danger posed by the emergency.

1.2.4 Summary and Conclusion - This helicopter has enough amply-sized points for emergency egress by the pilots and crewmen. There is no evidence of any problem areas associated with emergency egress and the individuals protective clothing and equipment worn during flight.

2. Current Problems -

2.1 Personal Equipment -

2.1.1 Eye Protection - When the helicopter is approaching the cargo pickup zone, the vertical replenishment crewman extends his head and neck over the hatch opening to obtain a better view for guiding the pilot directly over the cargo zone. As a consequence of this, the crewman is subjected to windblast which comes up under the helmet visor and into his eyes with the attendant possibility of incurring dust or dirt particles in his eyes and premature visual fatigue. All of these conditions can adversely affect his vision which is critical to his performance requirement of guiding the pilot to a direct overhead position for cargo pickup or discharge.

2.1.2 Life Preserver - Current NATOPS directives require that the currently prescribed life preserver be worn by all crewmen when the helo conducts flights over water. Since the vertical replenishment crewman must assume a prone position during the vertical replenishment operation, the MK-2 and LPA-series of preservers have been a constant source of discomfort and complaint due to the frontal body positions they assume, when worn. The vertical replenishment crewman regards the unsuitability of the life preserver design (in the stowed condition) as a problem in need of early solution.

2.1.3 Operational Gloves - The operation of the cargo hook release and reset, is manually effected by the vertical replenishment crewman by a striking motion of the palm or heel of his left hand on the control levers. Over a protracted period of time this can become unnecessarily uncomfortable. This is especially true during cold weather operations due to the low thermal protection of current flight gloves.

2.1.4 Pre-Flight Gloves - Adequate pre-flight of helos requires the actual physical contact of various parts of the aircraft and rotor system. Many of these parts require frequent greasing and result in excessive soiling of flight gloves, thus rendering them unusable for their primary function. Pilots are now providing their own "second" set of gloves which are not intended for pre-flight.

2.2 Accessory Equipment -

2.2.1 Helicopter Deck Surface - The interior deck surface of the CH-46 helicopter is configured to carry and store internal cargo (and troops). As such, it has multiple fittings and irregular surfaces which can cause snagging and tearing of the protective clothing and devices especially as the vertrep crewman assumes a prone position at the deck hatch to perform his duties. Many crewmen report bruising their knees, shins, arms and parts of the torso on these surfaces. In addition, the deck surfaces collect dirt, grease and other foreign matter which in turn soils the crewman's clothing.

2.2.2 Multi-Place Life Raft - Present multi-place life rafts do not meet the requirements for acceptable egress during ditching. Due to the soft-container packing method for multi-place life rafts, the rafts, do not lend themselves to compact storage aboard present helicopters, nor are they conducive to manual ejection via emergency escape hatches.

2.3 Aircraft Equipment -

2.3.1 ICS Connection and Cable System - The cable from the helmet microphone and earphone must be plugged into the helicopter ICS to permit communication among all crewmen in the aircraft. This is quite simple to effect, however it is very easy to accidentally disconnect the cable from the ICS due to pulling or snagging. The ensuing loss of communications, particularly during the run-in for cargo pickup or discharge, presents an unnecessary hazard.

2.3.2 Crewman Safety Belt - When conducting vertical replenishment operations, the vertical replenishment crewmen are required to wear a safety belt around their waist which in turn is attached, via a nylon belt, to a fitting in the deck of the helo. The belt is worn primarily to protect the crewman from falling out of the aircraft. Due to the fact that the deck of the helo has many protruding surfaces, such as fittings, cargo track rollers, etc., it offers a significant hazard in terms of surfaces that might accidentally catch on the buckle and locking assembly, thereby, releasing the locking assembly and defeating the protective function of the belt.

2.3.3 Helicopter Ventilation System - Most CH-46 helicopters currently are not configured to provide vent air to the exposure suit. In addition, pilots are enlisted crewmembers indicate that the heating system (forced hot air), which provides heated ambient air, performs either excessively or inadequately.

2.3.4 Emergency Egress System - The CH-46 vertical replenishment configured helicopter has very poor amphibious capability in water due to the lack of water-tight integrity in the deck access hatch (upper) of the cargo hook which will begin to immediately admit water into the aircraft upon a hard contact with the water. In addition, the emergency escape hatches are difficult to distinguish at night since they are not easily identifiable in darkness.

2.3.5 Pilot/Co-pilot Seats - Pilot and co-pilot seats exhibit a number of serious inadequacies. They lack structural integrity for potentially survivable crash conditions. They offer only marginal seat comfort and body support for long flight missions. The seat restraint is also inadequate for limiting crash loads and controlling the motion of the occupants. In addition, there is little or no commonality of seats or seat components from aircraft to aircraft.

2.3.6 Troop Seats - Troop seats and their restraint systems are found not to be crashworthy. The total restraint is inadequate by virtue of the lack of upper torso restraint. The crashworthiness of the seat system is further compromised by the poor attachment of the basic seat to the floor.

3. Equipment Requirements/Recommended Design Approaches -

3.1 Personal Equipment -

3.1.1 Eye Protection - The problem as stated earlier makes it obvious that there is a valid requirement to provide a more effective facial seal to minimize or prevent the injurious and incapacitating effects of wind blast to the eyes. The seal should be comfortable and produce no skin chafing or excess pressure to the face.

The design approach to the problem may be achieved through the addition of a removeable molded rubber edging to the lower portion of the helmet visor. The molded seal may be a foamed product which when slipped on the edge of the visor, presses against the skin while producing a minimum of discomfort and yet effectively sealing the upper face area to the entry of dirt particles.

Another technical approach may be that of introducing a separate set of goggles which will attach to the helmet while the visor is in the UP position. The goggles should not compromise the field of vision of the vertrep crewman in the performance of his duties.

Still another consideration may be the complete removal of the visor and visor housing assembly from the helmet worn by the vertrep crewman and providing a complete eye protection subassembly to specifically meet the vertrep mission requirements.

3.1.2 Life Preserver & Survival Equipment Stowage - As a result of the incompatibility of the current life preserver in the normal performance of the duties of the vertical replenishment crewman, a requirement arises for a preserver design which will permit its constant wear through the entire activity-envelope of this specialized crewman. The requirement entails such design factors as optimum location on the body (which is prone during replenishment operations), the need for rapid actuation and utilization of the preserver in a split second emergency, and its compatibility with or its provision for stowing accessory equipment required by the vertrep crewman.

A design approach for the preserver could be a flat, single compartment cell stowed unfolded over the chest with no protruding hardware that would cause pressure points against the body. This would resemble an LPP-1 (unfolded), or a commercial "DACOR" type preserver.

Another approach would be a folded design but located on the body so as to cause no interference during the crewman's prone position phase of vertical replenishment. Serious consideration should be given to little or no repositioning or orientation of the preserver prior to actuating it, in order to minimize its readiness time. Regardless of the design approach taken consideration should be given to the vertrep crewman's total configuration of protective clothing and other sub-systems. Consideration should also be given to including in the design of the preserver, means for stowing the necessary survival aids and other accessory items required by the crewman in the performance of his duties and possible survival. A design of a special simplified harness which could provide the foundation for attaching a preserver, stowing accessory equipment, and supporting a "D" ring for retrieval of the vertrep crewman, should also be investigated. Another method for accessory equipment stowage may be through the use of a set of chaps.

Vertical replenishment crewmen have expressed the need for carrying flares (MK-13) and a survival knife in the event of an emergency.

3.1.3 Operational Gloves - Due to the nature and conditions under which the vertrep crewman uses his hands in the performance of his duties there is a requirement to provide him with a utility glove which not only permits the necessary dexterity but also affords adequate physical and thermal protection for the hands. The glove should be designed to protect against below zero temperatures, chill factors and dampness.

The technical approach should include the observance of the vertrep crewman in his performance of cargo hook engagement and disengagement to determine whether the glove design will need reinforced areas or whether a glove of uniform construction is adequate. A survey of industrial gloves should be made in the interest of expediency and economy and with the thought of adapting an existing glove to meet the requirement.

If no potentially suitable commercial glove is found available, then the development of an entirely new glove would be necessary.

3.1.4 Pre-Flight Gloves - There is a requirement for a set of pre-flight gloves that will permit the hand maneuvers pertinent to pre-flight inspection of aircraft, and protect the hands from minor injuries. The glove should be durable and readily cleanable.

The approach to the glove solution may be by means of a durable stretch knit over-glove designed to snugly fit over the flight glove with a minimum addition of bulk to the hand.

The solution may also be achieved by a new utility glove that is durable, cleanable, and economical in cost. A glove design requiring as few sizes as possible would be a decided advantage.

3.1.5 Helmet Assembly - There is a general requirement for an overall improved helmet design. The required helmet should (1) incorporate ambient noise attenuation that is superior to current SPH-3 levels of performance; (2) be of lesser weight and thus induce less fatigue to the wearer; (3) be constructed of higher strength per weight material; (4) incorporate a non-protruding "mike" technique of voice transmission having a higher signal to noise ratio; (5) permit earphone adjustment for optimum fit to various head contours; (6) incorporate a visor system having both clear and tinted capabilities;and (7) have improved peripheral vision.

3.1.6 Anti-Exposure Protection - In view of the problems associated with the wearing of the CWU-33/P anti-exposure suit, and the highly physical nature of certain crewman's duties, it is required that anti-exposure protection be provided in a manner that is acceptable to the crewman from an operational standpoint. If the protection is accomplished by means of a garment, then the garment shall permit the necessary mobility and means for dissipating body heat buildup. If this can't be achieved because lack of a satisfactory suit design approach or lack of suitable means to bring ventilation to the suit, then anti-exposure protection must be accomplished by a supplementary system.

3.1.7 Knee Protection - There is a requirement to provide flexible knee pads, that the crewman can easily attach and detach over his flight clothes, to protect his knees and clothing from effects of deck abrasion and impact with equipment.

The technical approach can initially begin with a survey of industrial or sporting goods equipment and if need be modify or completely redesign the available equipment to meet the specific needs of the crewman.

3.2 Accessory Equipment

3.2.1 Helicopter Deck Surface - A requirement exists for a durable, fire and abrasion resistant pad which could be positioned and secured on the deck so that the vertrep crewman could lie on it during operations and be protected from the hazards mentioned in the problem statement earlier. The pad should measure approximately 3 feet by 6 feet and at the end of the mission, the pad should be detachable and stowable until the next operation.

In the choice of materials for the pad design, care should be taken that the materials do not exhibit stiffness under cold temperature conditions. The pad cover should also be removeable for frequent cleaning or replacement in the event of damage.

3.3 Aircraft Equipment -

3.3.1 ICS Connection and Cable System - There is a requirement for a quick, reliable and more secure connector that will prevent accidental disconnection from the ICS and yet permit easy disconnection for emergencies.

In addition, a requirement exists for a simple and reliable system to control cable slack behind the crewman so that he can draw extra cable when needed and automatically retract the cable when not needed. Both of the above items should be coated with a durable color coded luminescent material that will facilitate location and connection during night operations when the helo is in a "darken ship" condition.

The solution to the connector separation may be attempted by designing a modification of current hardware that will increase the separation-force sufficiently to preclude inadvertant disconnection and yet permit an uncumbered manual separation. The connector may be "bridged" by a snap type clip that withstands high pull forces and which can easily be released when desired.

The retraction system can be devised along the lines of commercially available systems now in use with vacuum cleaner line cords and other such devices. It would naturally be necessary to determine the economic and logistic impact of introducing such a design.

3.3.2 Crewman Safety Belt - A requirement exists for a redesign of the locking assembly of the crewman's safety belt which would prevent it from being accidentally disengaged and yet enable it to be quickly released when an emergency arises.

The redesign of the latch should stress the reduction in protrusion of the hardware in order to minimize discomfort to the vertrep crewman when he is lying in the prone position.

3.3.3 Helicopter Ventilation System - There is a requirement to improve the thermal comfort of the pilot, co-pilot and crewmembers of the CH-46. The fulfillment of this requirement is essential if the optimum performance of all crewmembers of the CH-46 is to be achieved. Thermal comfort is deficient because of a lack of a ventilation air system necessary to provide cooling air to wearers of an exposure suit and secondly due to a poorly regulated hot air system designed to warm the ambient air of the aircraft. The provision of a vent air system and the better regulation of the forced air system are extremely important requirements.

3.3.4 Emergency Egress System - There is a requirement to illuminate the emergency escape hatches of the CH-46 in order to facilitate location of the hatches in night emergency situations.

The technique by which this requirement is met can be through the use of chemiluminescent devices which are made to illuminate by the forces of crash impact. More conventional lighting systems, which are battery powered, can also be investigated for effectiveness. Such factors as the performance under low temperature, maintenance, cost and complexity of installation, level of illumination in darkness or under shallow depths of water, should be taken into account in the design choice.

3.3.5 Pilot/Co-pilot Seats - There is a strong requirement to improve the crashworthiness of the pilot and co-pilot seat system. This can be achieved through the use of new structural materials such as honeycomb aluminum to reduce weight and improve structural strength; the addition of a negative G strap to reduce submarining; the provision of an inflatable body and head support; and the improvement of the structural strength of the aircraft floor and seat-floor interface track.

There is also a requirement to improve the comfort of the seat which can be approached by contouring the seat cushion, adding lumbar support, improving ventilation to the seat cushioning, providing an adjustable headrest and incorporating vibration isolation devices.

Logistic support of seat structures and components can be greatly enhanced by standardizing designs among various aircraft.

3.3.6 Troop Seats - A requirement exists to improve the crash worthiness of troop seats.

This may be accomplished by seat designs using new techniques of suspension from the roof of the helicopter; adding energy attenuation between roof and seat; improving restraint by adding upper torso restraint as well as lap belt restraint; and improving strap adjusting hardware.

MINE COUNTERMEASURES (MCM)

Aircraft Types: RH-53, CH53 A/D
Crew: Pilot/Co-pilot; 5 crewmen

1. Mission Profile - Mine Countermeasures involve 4 different types of operations which are as follows:

(1) Mark 103 - MCM operations for defeating moored mines

(2) Mark 104 - MCM operations for defeating magnetic mines

(3) Mark 105 - MCM operations for defeating acoustic mines

(4) Mark 106 - MCM operations which combine MK 104 and 105 equipment to defeat both magnetic and acoustic mines simultaneously.

The MK 103 operation represents the worst operational situation in terms of crewman duties, physical tasks, execution time and hazards. In addition, the MK 103 operation contains all of the tasks and duties of the other operations and more. Due to this fact, the MK 103 operation will be the only MCM operation treated in this study. The MK 103 operation comprises two distinct operations:

- Streaming operations in which the gear is deployed for minesweeping
- Recovery operations in which the gear is recovered and stowed upon mission termination

1.1 Inflight Phase

1.1.1 Pilot/Co-pilot - Prior to take-off, the pilot and co-pilot conduct a pre-flight inspection of the physical condition of the aircraft in accordance with NATOPS requirements. This includes checking the fuselage of the aircraft, the hydraulic system, the engines, the transmission, and other aircraft functional systems. During final preparation for flight, the pilot and co-pilot must perform a number of physical tasks which involve attaching the protective devices to their person. These tasks include donning the survival vest (combat or non-combat configured), the life preserver, and the protective helmet; connecting the helmet to the interior communications system (ICS); connecting the aircraft vent hose to the anti-exposure suit (when worn); and securing themselves to their respective seats via the seat harness assembly and donning flight gloves. For the duration of the flight, the pilot and co-pilot remain seated in their respective seats and perform their assigned flight duties, which involve the exercise of intellective and psychomoter skills rather than distinct physical work.

1.1.2 Mine Countermeasures Crewmen - Prior to engine start the enlisted crewmen check to see if all the MCM (Mine Countermeasure) equipment is properly secured in their mountings. The Crew Chief checks the winch and roller assembly to see if it is functioning properly. The results of these checks are transmitted to the pilot. After this has been completed, the crewmembers attach their protective equipment, i.e., the life preserver and the protective helmet, to their person and secure themselves to their seats with a lap belt and wait for take-off.

When the helicopter is approaching the area to be cleared of mines, the five enlisted crewmen connect their ICS (Interior Communications System) and gunners belt to their person and take their respective stations, which are:

Two men on the aft section of the loading ramp, one left 1/- one right 2/
Two men at the gear stowage location, one left 3/- one right 4/
Crew Chief at the winch 5/

For purposes of convenience, the above numbers after the position location of the crewman will serve to designate the crewman and his general tasks.

Task Sequence I

Upon the pilot's command to commence streaming operations, 3/man removes the first float (approximate weight 45 lbs) from its storage mounting; lifts it over the dam (a 14" high metal barrier across the aft section of the helo, to prevent flooding of the interior in the event the helicopter makes an emergency landing in the water), and hands it to 1/ man who walks aft and connects it to the left winch cable and pays out the cable by his manually held electric control box to the next connection position. 1/man is assisted in the connection action by 2/ man who also assists him in guiding the float over and out the rear rollers into the air.

Task Sequence II

3/ man removes the first otter (approximate weight 95 lbs) from its storage mounting; lifts it over the dam and hands it to 1/ man, who walks aft with the otter to his station where 2/ man assists him in connecting the otter to the winch cable and in guiding the otter over and out the rear roller into the air. 1/ man then pays out the winch cable by his controller to the next connection position.

Task Sequence III

3/ man removes the cutter assembly (approximate total weight 8 lbs) from its storage mounting; hands it to 1/ man who arms and connects the cutter body and fin to the winch cable; locks it in place and pays out the winch cable by his controller to the next connection position. This operation is repeated until all cutters (10 to 20), have been connected to the winch cable.

Task Sequence IV

3/ man removes the second otter from its storage mounting; lifts it over the dam and hands it to 1/ man who walks aft with the otter to his station where 2/ man assists him in connecting the otter to the winch cable and in guiding the otter over and out the rear roller into the air. 1/ man then pays out the winch cable by his controller to the next connection position.

Task Sequence V

3/ man removes the second float from its storage mounting; lifts it over the dam and hands it to 1/ man who walks aft and connects it to the winch cable with the assistance of 2/ man; together they guide the float over and out the rear roller into the air. 1/ man then pays out the winch cable to the next connection position by his control box.

Task Sequence VI

The entire procedure (sequences 1 through V) is also performed by 2/ and 4/ men for the right winch cable so that the cables with gear attached are streamed left and streamed right in the water in the form of a "Y"

Task Sequence VII

3/ man removes a depressor (approximate weight 95 lbs) from its storage mounting; lifts it over the dam and hands it to 1/ man who walks aft and connects it to the "Y" end of the winch cable with the assistance of 2/ man; together they guide the depressor over and out the rear roller into the air; 1/ man pays out the winch cable to the next connection position by his control box.

Task Sequence VIII

The final step in this procedure takes place when 1/ man and 2/ man attach the "Y" end of the cable to the hydraulically dampened tow boom via a locking ball. The remaining excess winch cable is then retracted and the Crew Chief reports to the pilot that "the gear is in tow". The pilot then steers the helicopter through the mine field for sweeping.

The duties and tasks performed in the recovery operations are identical to those performed in the streaming operations, except that they are performed in reverse sequence.

1.2 Egress Phase -

1.2.1 Egress Points - The RH-53 and the CH-53 A/D, regardless of mission, are configured with ten evacuation exits; five on the port side and five on the starboard side. The port side exits are arranged as follows:

1 - Pilot's compartment window/door

1 - Personnel door, which is the normal mode of aircraft ingress and egress

3 - Window ports, all aft of the personnel door; i.e., one amidship over the sponson, and two in the after section of the helo.

The starboard side exits are arranged as follows:

1 - Pilot's compartment window/door

4 - Window ports all aft of the window; i.e., one in the forward section, one amidship over the sponson, and two in the after section of the helo.

1.2.3 Emergency Egress Procedures

a. Pilot and Co-pilot - A number of options are open to them. The quickest and closest escape route would be through the adjacent pilot's window/door to his side. If this is not possible, egress may be accomplished through any of the seven window ports. A final option for the pilots would be through the rear compartment ramp, if it is lowered. This is the least preferable, due to the fact that the pilot must climb out of his seat and take caution to avoid getting snagged on the various protruding surfaces within the length of the helo. This is especially true if the interior of the helo is carrying internal fuel tanks or bulk cargo.

b. Crewmembers - The crew composition and size will vary according to the mission and other requirements. In any case, the crewmen do not have any fixed, seated positions, for the conduct of a mission. The crewmen do have assigned stations (locations) at which they perform their mission duties; however, this is done while standing.

Despite this apparent latitude of freedom, there are potential problem areas that can arise under certain conditions for the mine countermeasure mission.

In certain cases, the interior of the helo is filled to varying degrees with bulk cargo, tie-down cables, etc.; all of which impede the free flow of the crewman's movement. In order to reach a different location within the interior of the helo, the crewman must climb on or step over the various cargo or equipment pieces.

In such cases, he is subjected to such hazards as snags, fouling, entrapment, cuts, tears and lacerations. All of these can impede/injure him in his attempts to effect a rapid emergency egress.

The emergency egress open to the crew in order of expressed verbal preference, are in the following order:

(1) Escape through the personnel door on the port side.

(2) Escape through the rear ramp, if it is in the down position.

(3) If the ramp is in the up position, the final option open to the crewman would be through any of the seven window ports.

It should be emphasized that the final selection of one of the above routes will depend on the crewman's proximity to it in an emergency, and his state of mind in assessing the degree of danger posed by the emergency.

1.2.4 Summary and Conclusions - There are enough amply-sized points for emergency egress by the pilots and crew of this helicopter. There is no evidence of any problem areas associated with emergency egress and the individual's protective clothing and equipment worn during flight.

2. Current Problems -

2.1 Personal Equipment -

2.1.1 Operational Gloves - The fire resistant gloves currently worn by the helo crewman offer very little thermal protection against the cold. Since all of the crewman's manual tasks are conducted in the rear section of the helo, with the rear loading ramp open, they are exposed to ambient weather and prop wash; winter cold compounds the problem. When handling wet equipment (e.g. cable floats, otters, etc.) the gloves become wet and slimy after a period of time. In addition, the current gloves offer little or no protection against pinching, abrasion or crushing which the crewman might accidentally sustain in handling the heavy equipment.

2.1.2 Pre-Flight Gloves - Adequate pre-flight inspection of helicopters requires the actual physical contact of various parts of the aircraft and rotor system. Many of these parts require frequent greasing and manual checking which results in excessive soiling of the flight gloves, thus rendering them unusable for their primary function. Excessive usage rates of flight gloves can no doubt result because of the harsh wear imposed upon them.

2.1.3 Face Protection - During recovery operations the MCM equipment is retracted into the helo by the cables of hydraulic winches. As the equipment (floats, otters, etc.) reaches the rear platform it is subjected to prop wash from the rotor blades which cause the equipment to gyrate violently about the axis of the cable to which it is tethered. The crewman must reach out to pick up each piece of equipment and disconnect it before the cable passes over the guide rollers. During this operation, the crewmember is subjected to the potential hazard of being hit in the face or body by the gyrating equipment. The current SPH-3 helmet offers no face protection in these circumstances.

2.1.4 Anti-Exposure Protection - The currently prescribed constant wear CWU-33/P anti-exposure suit provides the intended protection against exposure but all MCM crewmen are unanimous in the complaint that the suit severely restricts upper torso mobility. This mobility is essential to the conduct of the MCM crewmen's physical duties. This problem has reached such proportions that some of the MCM personnel have been granted permission to temporarily wear a two-piece skin divers wet suit obtained through open purchase. Although this suit provides greater mobility, it does not have the internal air flow distribution system of the CWU-33/P. Thus, the gain in mobility is offset by the loss of cooling capability to dissipate body heat.

2.1.5 Knee Protection - The duties of the MCM crewmen during streaming and recovery operation, often require them to function with one knee on the deck (for balance and stability) while handling and connecting the heavy equipment. As a result of this, the knees of their flight clothing are subjected to the abrasiveness of the decks and the anti-skid pads. In addition to this, the MCM crewman's knees are subjected to impact with the equipment.

2.2 Accessory Equipment -

2.2.1 Multi-Place Life Raft - Present multi-place life rafts do not meet the requirements for acceptable egress during ditching. Due to the soft-container packing method for multi-place life rafts, the rafts do not lend themselves to compact storage aboard present helicopters, nor are they conducive to manual ejection via emergency escape hatches.

2.3 Aircraft Equipment -

2.3.1 ICS Connection and Cable System - The current ICS connectors are easily connected, however, they can be easily disconnected accidentally by snagging and pulling, especially when the crewmen are moving about in the crowded interior of the helo while lifting and handling equipment. Loss of communication due to accidental disconnection during operations causes unnecessary problems and potential hazard.

2.3.2 Heating and Ventilation Systems- The aft section of the CH-53 helicopter does not offer any heating or ventilating air to the crewmen. In cold weather operations, heat would be an obvious asset to the crewman. Lack of ventilation air precludes the proper utilization of the air distribution network in the CWU-33/P anti-exposure suit or in any other suit of future design.

2.3.3 Pilot/Co-pilot/Crewman's Seats- Pilot, co-pilot and crewman's seats exhibit a number of serious inadequacies. They lack structural integrity for potentially survivable crash conditions. They offer only marginal seat comfort and body support for long flight missions. The seat restraint is also inadequate for limiting crash loads and controlling the motion of the occupants. In addition, there is little or no commonality of seats or seat components from aircraft to aircraft.

3. Equipment Requirements/Recommended Design Approaches-

3.1 Personal Equipment -

3.1.1 Operational Gloves - A requirement exists for an improved flight glove for the MCM crewman that would afford better thermal protection against the cold and protection against physical pressure and abrasion. The glove must have a maximum of flexibility in the fingers, since this is required in executing certain critical tasks, e.g., arming and connecting the cutter body and fin to the winch cable by means of small levers and pins. The glove should be designed to protect against below zero temperatures, chill factors and dampness.

The technical approach should include the observance of the MCM crewman in the performance of his duties to determine whether the glove design will need reinforced areas or whether a glove of uniform construction is adequate. A survey of industrial gloves should be made in the interest of expediency and economy and with the thought of adapting an existing glove to meet the requirement.

If no potentially suitable commercial glove is found available then the development of an entirely new glove would be necessary.

3.1.2 Pre-Flight Gloves - There is a requirement for a set of pre-flight gloves that will permit the hand maneuvers required in pre-flight inspection of aircraft, and protect the hands from minor injuries. The glove should be durable and readily cleanable.

The approach to the glove solution may be by means of a durable stretch knit overglove designed to snugly fit over the flight glove with a minimum addition of bulk to the hand.

The solution may also be achieved by a new utility glove that is durable, cleanable and economical in cost. A glove design requiring as few sizes as possible would be a decided advantage.

3.1.3 Face Protection - Because of the hazards to the MCM crewman's face during the performance of his duties there is a requirement to provide him with face protection.

This could be achieved by modifying the protective helmet with the addition of a protective face bar (similar to that found on a football helmet). The face bar could be a quick attachable type worn only when required.

A sturdier visor that can withstand greater impact forces would also be an approach to the problem.

3.1.4 Anti-Exposure Protection - In view of the problems associated with the wearing of the CWU-33/P anti-exposure suit, and the highly physical nature of the MCM crewman's duties, it is required that anti-exposure protection be provided in a manner that is acceptable to the MCM crewman from an operational standpoint. If the protection is accomplished by means of a garment, then the garment shall permit the necessary mobility and also means for dissipating body heat buildup. If this can't be achieved because of lack of a satisfactory suit design approach or lack of suitable means to bring ventilation to the suit, then anti-exposure protection must be accomplished by a supplementary system.

3.1.5 Knee Protection - There is a requirement to provide flexible knee pads, which the MCM crewman can easily attach and detach over his flight clothes, to protect his knees and clothing from effects of deck abrasion and impact with equipment.

The technical approach can initially begin with a survey of industrial or sporting goods equipment and if need be modify or completely redesign the available equipment to meet the specific needs of the crewman.

3.1.6 Helmet Assembly - There is a general requirement for an overall improved helmet design. The required helmet should (1) incorporate ambient noise attenuation that is superior to current SPH-3 levels of performance; (2) be of lesser weight and thus induce less fatigue to the wearer; (3) be constructed of higher strength per weight material; (4) incorporate a non-protruding "mike" technique of voice transmission having a higher signal to noise ratio; (5) permit earphone adjustment for optimum fit to various head contours; (6) incorporate a visor system having both clear and tinted capabilities; and (7) have improved peripheral vision.

3.1.7 Life Preserver - There is a requirement to develop a constant wear preserver which, in the stowed or uninflated condition, imposes a minimum of encumberance to the wearer and permits the wearer to perform the in-flight role to which he has been assigned. The preserver shall offer buoyancy consistent with the weight of the equipment worn by the crewman and should be compatible with the wearer's total configuration, work function, and assigned seating. The preserver shall not require helmet removal in order to prepare the preserver for inflation. The buoyancy of the preserver shall be so distributed as to place the user in a properly angled face-up position in the water.

3.2 Accessory Equipment

3.2.1 Multi-Place Life Rafts - A requirement exists to provide a multi-place life raft (a MK-7 in the case of the H-53 series) that is packed in a rigid container designed to accommodate the raft and the desired emergency equipment, and is capable of easy removal through the emergency escape hatch of the aircraft.

Determine from Safety Center data and through recommendations received from other sources, a list of the minimum required accessory equipment to be packaged with the raft in a container system. The container system design should then be based upon stowage techniques in the aircraft and the ease with which the system can be removed from the aircraft during an emergency egress.

3.3 Aircraft Equipment -

3.3.1 ICS Connection and Cable System - There is a requirement for a quick, reliable and more secure connector that will prevent accidental separation from the ICS and yet permit rapid disconnection for emergencies. In addition, a requirement exists for a simple and reliable method of controlling cable slack behind the crewman so that he can draw extra cable when needed and automatically retract the cable when not needed.

The solution to the connector separation may be found by designing a modification of the current hardware that will increase the separation force sufficiently to preclude inadvertant disconnection and yet permit an unencumbered manual separation when desired.

The retraction system can be devised along the lines of commercially available systems now in use with vacuum cleaner line cords and other such devices. It would naturally be necessary to determine the economic and logistic impact of introducing such a system.

3.3.2 Heating and Ventilation Systems - There is a requirement to provide ventilation air to the crewman's wet suit in order to reduce the body heat buildup that occurs during the handling and connection of the heavy equipment for streaming and recovery operations. If anti-exposure protection is to be achieved through the use of a garment that required ventilation during the in-flight phase, then a vent air system is an extremely important requirement. In addition, it is equally as important to provide a well regulated warm air system for those periods of the year when the crewmen perform their MCM duties in a cold ambient environment.

3.3.3 Pilot/Co-pilot/Crewman's Seats - There is a strong requirement to improve the crashworthiness of the pilot, co-pilot and crewmen's seat systems.

This can be achieved through the use of new structural materials such as honeycomb aluminum to reduce weight and improve structural strength; the addition of a negative G strap to reduce submarining; the provisions of an inflatable body and head support; and the improvement of the structural strength of the aircraft floor and seat-floor interface track.

There is also a requirement to improve the comfort of the seat which can be approached by contouring the seat cushion, adding lumbar support; improving ventilation to the seat cushioning, providing an adjustable headrest and incorporating vibration isolators.

Logistic support of seat structures and components can be greatly enhanced by standardizing designs among various aircraft.

3.3.4 Crewman Safety Belt - A requirement exists for a redesign of the locking assembly of the crewman's safety belt which would prevent it from being accidentally disengaged and yet enable it to be quickly released when an emergency arises.

CARGO AND TROOP TRANSPORT (HEAVY ASSAULT)

Aircraft Types: CH-53 A/D
Crew: Pilot/Co-pilot; Enlisted Crew Chief and other crewmen

1. Mission Profile - The primary objective of heavy assault ship operations is to effect rapid delivery of men and material (cargo) to a combat zone. With respect to cargo delivery and pickup, two methods are employed:

(a) External. Cargo is carried in slings or nets attached to the bottom of the helo by means of a cargo hook. This is identical to vertical replenishment conducted by the CH-46 aircraft as discussed elsewhere.

(b) Internal. Cargo is carried internally within the cabin of the helo. The cargo comprises two types; motor vehicles such as jeeps and mules, and pallet loads such as bulk cargo which has been packaged and secured to loading platforms.

In certain instances, external and internal loading is combined by employing cargo delivery in the external mode and simultaneously utilizing the interior of the helo for carrying troops.

1.1 Inflight Phase -

1.1.1 Pilot/Co-pilot - Prior to take-off, the pilot and co-pilot conduct a pre-flight inspection of the physical condition of the aircraft in accordance with NATOPS requirements. This includes checking the fuselage of the aircraft, the hydraulic system, the engines, the transmission, and other aircraft functional systems. During final preparation for flight, the pilot and co-pilot must perform a number of physical tasks which involve attaching the protective devices to their person. These tasks include donning the survival vest (combat or non-combat configured), the life preserver, and the protective helmet; connecting the helmet to the interior communications system (ICS); connecting the aircraft vent hose to the anti-exposure suit (when worn); and securing themselves to their respective seats via the seat harness assembly, and donning flight gloves. For the duration of the flight, the pilot and co-pilot remain seated in their respective seats and perform their assigned flight duties, which involve the exercise of intellective and psychomotor skills rather than distinct physical work.

1.1.2 Enlisted Crewmen - Prior to take-off, the crewmen of the heavy assault aircraft will be involved in the applicable cargo loading operations:

(a) Internal Cargo (Motor Vehicles). Motor vehicles to be delivered are driven into the interior of the helo by the rear loading ramp. The helo crewman guides the driver(s) through the helo interior to the tie-down points. After the engine and brakes are secured by the driver, the helicopter crewmembers tie down each vehicle with tie-down straps and ratchet hooks which are adjusted for maximum tightness to prevent the vehicle from shifting when the helicopter is in flight.

(b) Internal Cargo (Pallet Loads). Pallet loads of cargo are brought into the interior of the helo from the rear loading ramp. The pallet(s) are then drawn in by hydraulic winches over the deck track rollers by the helicopter crewmen. Each pallet is secured at the nearest tie-down points with tie-down straps and ratchet hooks which are adjusted for maximum tightness to prevent the load from shifting while the helicopter is in flight.

The Crew Chief checks the cargo tie-down equipment and ensures that it is securely fastened in place prior to flight. The cargo winches and cables are checked for proper functioning, as well as the rear loading ramp. After this has been completed and reported to the pilot, the crewmembers don their life preservers and helmets, secure themselves to their seats with a lap belt and wait for take-off.

1.2 Egress Phase.

1.2.1 Egress Points. The CH-53 A/D, regardless of mission, are configured with ten evacuation exits; five on the port side and five on the starboard side. The port side exits are arranged as follows:

One pilot's compartment window/door

One personnel door, which is the normal mode of aircraft ingress and egress

Three window ports, all aft of the personnel door; i.e., one amidship over the sponson, and two in the after section of the helo.

The starboard side exits are arranged as follows:

One pilot's compartment window/door

Four window ports all aft of the window; i.e., one in the forward section, one amidship over the sponson, and two in the after section of the helo.

1.2.2 Normal Egress Procedures. Pilots and crew enter and leave the aircraft through the personnel door on the port side. There are no known problems associated with this procedure, unless the latching mechanism of the door malfunctions.

1.2.3 Emergency Egress Procedures

a. Pilot and Co-pilot. A number of options are open to them. The quickest and closest escape route would be through the adjacent pilot's window/door to his side. If this is not possible, egress may be accomplished through any of the seven window ports. A final option for the pilots would be through the rear compartment ramp, if it is lowered. This is the least preferable, due to the fact that the pilot must climb out of his seat and take caution to avoid getting snagged on the various protruding surfaces within the length of the helo. This is especially true if the interior of the helo is carrying internal fuel tanks or bulk cargo.

b. Crewmembers. The crew composition and size will vary according to the mission and other requirements. In any case, the crewmen do not have any fixed seated positions, for the conduct of a mission. The crewmen do have assigned stations (locations) at which they perform their mission duties; however, this is done while standing or in a prone position (vertical replenishment).

Despite this apparent latitude of freedom, there are potential problem areas that can arise under certain conditions in the Cargo Transport Mission.

In certain cases, the interior of the helo is filled to varying degrees with fuel tanks, bulk cargo, tie-down cables, etc.; all of which impede the free flow of the crewman's movement. In order to reach a different location within the interior of the helo, the crewman must climb on or step over the various cargo or equipment pieces.

In such cases, he is subjected to such hazards as snags, fouling, entrapment, cuts, tears and lacerations. All of these can impede/injure him in his attempts to effect a rapid emergency egress.

The emergency egress open to the crew in the order of expressed verbal preference are as follows:

(1) Escape through the personnel door on the port side

(2) Escape through the rear ramp if it is in the down position

(3) If the ramp is in the up position, the final option open to the crewman would be through any of the seven window ports.

It should be emphasized that the final selection of one of the above routes will depend on the crewman's proximity to it in an emergency, and his state of mind in assessing the degree of danger posed by the emergency.

1.2.4 Summary and Conclusions. There are enough amply-sized points for emergency egress by the pilots and crew of this helicopter. There is no evidence of any problem areas associated with emergency egress and the individual's protective clothing and equipment worn during flight.

2. Current Problems.

2.1 Personal Equipment -

2.1.1 Pre-Flight Gloves - Adequate pre-flight of helos requires the actual physical contact of various parts of the aircraft and rotor system. Many of these parts require frequent greasing and result in excessive soiling of flight gloves, thus rendering them unusable for their primary function. Pilots are now providing their own "second" set of gloves which are not intended for pre-flight.

2.1.2 Operational Gloves - The current fire-resistant flight gloves worn by the helo crewman offer very little thermal protection against pinching, abrasion or crushing which the crewman might accidentally sustain in handling heavy cargo.

2.1.3 Body Armor - The current body armor worn by the assault ship crewman is extremely bulky and subjects him to a high degree of body heat buildup, particularly in tropical climate. The body armor would be worn by the crewman while being stationed at an interior machine gun mount. The body armor when worn in conjunction with other personal equipment results in a very cumbersome assembly of poorly integrated devices.

2.2 Accessory Equipment -

2.2.1 Multi-Place Life Raft - Present multi-place life rafts do not meet the requirements for acceptable egress during ditching. Due to the soft-container packing method for multi-place life rafts, the rafts do not lend themselves to compact storage aboard present helicopters, nor are they conducive to manual ejection via emergency escape hatches.

2.3 Aircraft Equipment -

2.3.1 ICS (Interior Communication System). The long cables which connect the helo crewman to the ICS are frequently subjected to snagging and fouling due to the fact that there is no mechanism for controlling payout and slack. As a consequence of this, the crewman must continually pick up and move the cable as he moves about the interior and exterior of the helicopter while performing his duties.

2.3.2 Heating and Ventilation Systems - The aft section of the CH-53 helicopter does not offer any heating or ventilating air to the crewman. In cold weather operations, heat would be an obvious asset to the crewman. Lack of ventilation air precludes the proper utilization of the air distribution network in the CWU-33/P anti-exposure suit or in any other suit of future design.

2.3.3 Pilot/Co-pilot/Crewman's Seats - Pilot, co-pilot and crewman's seats exhibit a number of serious inadequacies. They lack structural integrity for potentially survivable crash conditions. They offer only marginal seat comfort and body support for long flight missions. The seat restraint is also inadequate for limiting crash loads and controlling the motion of the occupants. In addition, there is little or no commonality in seats or seat components from aircraft to aircraft.

2.3.4 Troop Seats - Troop seats and their restraint systems are found not to be crashworthy. The total restraint is inadequate by virtue of the lack of upper torso restraint. The crashworthiness of the seat system is further compromised by the poor attachment of the basic seat to the floor.

3. Equipment Requirements/Recommended Design Approaches -

3.1 Personal Equipment -

3.1.1 Pre-Flight Gloves - There is a requirement for a set of pre-flight gloves that will permit hand dexterity pertinent to pre-flight inspection of aircraft, and protect the hands from minor injuries. The glove should be durable and readily cleanable.

The approach to the glove solution may be by means of a durable stretch knit over-glove designed to snugly fit over the flight glove with a minimum addition of bulk to the hand.

The solution may also be achieved by a new utility glove that is durable, cleanable, and economical in cost. A glove design requiring as few sizes as possible would be a decided advantage.

3.1.2 Operational Gloves - A requirement exists for an improved flight glove for the assault-ship crewman that would afford better thermal protection during cold weather operations and protection against physical pressure and abrasion without sacrificing finger and palm mobility.

A survey of industrial gloves should be made in the interest of expediency and economy and with the thought of adapting an existing glove to meet the requirement. If no commercial glove is found to be potentially suitable, then the development of an entirely new glove would be necessary.

3.1.3 Body Armor - A requirement exists for a lightweight and cooler body armor for the assault-ship crewman which would provide adequate protection against gun fire, but would not unduly restrict his mobility while performing his gunnery or cargo transport duties. The body armor should integrate with other personal survival equipment worn by the crewman.

3.1.4 Helmet Assembly - There is a general requirement for an overall improved helmet design. The required helmet should (1) incorporate ambient noise attenuation that is superior to current SPH-3 levels of performance; (2) be of lesser weight and thus induce less fatigue to the wearer; (3) be constructed of higher strength per weight material (4) incorporate a non-protruding "mike" technique of voice transmission having a higher signal to noise ratio; (5) permit earphone adjustment for optimum fit to various head contours; (6) incorporate a visor system having both clear and tinted capabilities and (7) have improved peripheral vision.

3.1.5 Anti-Exposure Protection - In view of the problems associated with the wearing of the CWU-33/P anti-exposure suit, and the highly physical nature of certain crewman's duties, it is required that anti-exposure protection be provided in a manner that is acceptable to the crewman from an operational standpoint. If the protection is accomplished by means of a garment, then the garment shall permit the necessary mobility and means for dissipating body heat buildup. If this can't be achieved because lack of a satisfactory suit design approach or lack of suitable means to bring ventilation to the suit, then anti-exposure protection must be accomplished by a supplementary system.

3.1.6 Life Preserver - There is a requirement to develop a constant wear preserver which, in the stowed or uninflated condition, imposes a minimum of encumberance to the wearer and permits the wearer to perform the inflight role to which he has been assigned. The preserver shall offer buoyancy consistent with the weight of the equipment worn by the personnel and should be compatible with the wearer's total configuration, work function, and assigned seating. The preserver shall not require helmet removal in order to prepare the preserver for inflation. The buoyancy of the preserver shall be so distributed as to place the user in a properly angled face-up position in the water.

3.1.7 Knee Protection - There is a requirement to provide flexible knee pads, that the crewman can easily attach and detach over his flight clothes, to protect his knees and clothing from effects of deck abrasion and impact with equipment.

The technical approach can initially begin with a survey of industrial or sporting goods equipment and if need be modify or completely redesign the available equipment to meet the specific needs of the crewman.

3.2 Accessory Equipment -

3.2.1 Multi-Place Life Raft - A requirement exists to provide a multi-place life raft (a MK-7 in the case of the H-53 series) that is packed in a rigid container designed to accommodate the raft and the desired emergency equipment, and is capable of easy removal through the emergency escape hatch of the aircraft.

A list of the minimum required accessory equipment to be packaged with the raft in a container system should be determined from Safety Center data and through recommendations received from other sources. The container system design should then be based upon stowage techniques in the aircraft and the ease with which the system can be removed or ejected from the aircraft during an emergency egress.

3.3 Aircraft Equipment -

3.3.1 ICS (Interior Communication System) A requirement exists for a simple and reliable method of controlling cable slack behind the crewmen so that he can draw extra cable when needed and automatically retract the cable when not needed.

The retraction system can be devised along the lines of commercially available systems involving electrical power cords, pneumatic hose lines, etc.

3.3.2 Heating and Ventilation Systems - There is a requirement to provide ventilation air to the crewman's wet suit in order to reduce the body heat buildup that occurs during the handling of cargo and the performance of other duties on the assault-ship. If anti-exposure protection is to be achieved through the use of a garment that requires ventilation during the in-flight phase, then a vent air system is an extremely important requirement. In addition, it is equally as important to provide a well regulated warm air system for those periods of the year when the crewman performs their transport duties in a cold ambient environment.

3.3.3 Pilot/Co-pilot/Crewman's Seats - There is a strong requirement to improve the crashworthiness of the pilot, co-pilot and crewman's seat systems.

This can be achieved through the use of new structural materials such as honeycomb aluminum to reduce weight and improve structural strength, the addition of a negative G strap to reduce submarining; the provision of an inflatable body and head support; and the improvement of the structural strength of the aircraft floor and seat-floor interface.

There is also a requirement to improve the comfort of the seat which can be approached by contouring the seat cushion, adding lumbar support, improving ventilation to the seat cushioning, providing an adjustable headrest and incorporating vibration isolators.

Logistic support of seat structures and components can be greatly enhanced by standardizing designs among various aircraft.

3.3.4 Troop Seats - A requirement exists for a redesign of the locking assembly of the crewman's safety belt which would prevent if from being accidentally disengaged and yet enable it to be quickly released when an emergency arises.

GUNFIRE SUPPORT (GUNSHIP)

Aircraft Types: AH-IJ, AH-IG
Crew: Pilot/Co-pilot

1. Mission Profile - The primary objective of the gunfire support mission is to provide aerial gunfire suppression on tactical targets in support of ground operations e.g. combat engagements, rescue operations, etc. The gunship, with its high performance and ability to hover, coupled with a "Gatling gun" type machine gun and externally mounted rocket pods, makes an excellent gunfire platform. The secondary missions of the aircraft revolve around visual reconnaissance including strike assessment and forward air control.

1.1 Inflight Phase -

1.1.1 Pilot/Co-pilot - Prior to take-off, the pilot and co-pilot conduct a pre-flight inspection of the physical condition of the aircraft in accordance with NATOPS requirements. This includes checking the fuselage of the aircraft, the hydraulic system, the engines, the transmission, and other aircraft functional systems. During final preparation for flight, the pilot and co-pilot must perform a number of physical tasks which involve attaching the protective devices to their person. These tasks include donning the survival vest (combat or non-combat configured), the life preserver, and the protective helmet; connecting the helmet to the interior communications system (ICS); connecting the aircraft vent hose to the anti-exposure suit (when worn); and securing themselves to their respective seats via the seat harness assembly, and donning flight gloves. For the duration of the flight, the pilot and co-pilot remain seated in their respective seats and perform their assigned flight duties, which involve the exercise of intellective and psychomotor skills rather than distinct physical work. This includes flying the helo, which has dual controls, and delivering suppressive fire by means of the forward-mounted, three barrel, 20 MM cannon or the air-to-ground rockets which are mounted in dual pods on the left and right sides of the helo. Either the pilot or the co-pilot may fire the above armament.

1.2 Egress Phase -

1.2.1 Egress Points - The AH-IJ, regardless of mission, is configured with twin independent canopies; one for the pilot and one for the co-pilot (or gunner), who comprise the entire crew complement.

1.2.2 Normal Egress Procedures - The pilot/co-pilot (or gunner) enter and exit the aircraft by manually unlatching and raising their respective independent canopies. They secure themselves to their seats and manually lower and latch their canopy prior to take-off.

1.2.3 Emergency Egress Procedures - In the event of an emergency, requiring rapid exit from the aircraft, the pilots may make their exit as described above, or they may each activate a linear explosive system to cut the windows from the canopy support structure for their respective canopy windows.

Ground crewmembers can also effect this by reaching in the nose access door to the air/fire mechanism, rotating the handle 90 degrees and pulling.

1.2.4 Summary and Conclusions - This aircraft has adequate provisions for emergency egress by the pilot/co-pilot; however, there is one condition which creates a serious problem.

Whenever the pilot/co-pilot wears body armor, it is exceedingly difficult to get in and out of the aircraft. The design of the aircraft makes it necessary to climb up the side of the aircraft, over the cockpit edge and down into the seat. This entire procedure resembles the approach a jet fighter pilot must use to gain access to his aircraft cockpit. This requires a high degree of upper torso mobility and significant physical exertion. Body armor seriously impedes this activity.

In the event of an emergency requiring rapid emergency egress either manually or explosively activated, it is practically impossible to get out fast. To underscore this fact, the pilots of this aircraft do not wear body armor when conducting their mission.

2. Current Problems -

2.1 Personal Equipment -

2.1.1 Pre-Flight Gloves - Adequate pre-flight of helos requires the actual physical contact with various parts of the aircraft and rotor system. Many of these parts require frequent greasing and result in excessive soiling of flight gloves, thus rendering them unusable for their primary function. Pilots are not providing their own "second" set of gloves which are not intended for pre-flight.

2.1.2 Body Armor - The current body armor employed by the pilot/co-pilot is extremely bulky and uncomfortable. It is extremely incompatable with other personal equipment such as preserver and survival vest and produces a high degree of body-heat buildup, particularly in tropical climate. The cumbersome assembly of body armor and other personal equipment is entirely unsatisfactory.

2.2 Accessory Equipment - No problems stated.

2.3 Aircraft Equipment -

2.3.1 Ventilating Air System - The AH-1G and AH-1J helicopters lack systems that provide ventilating air to the pilot and co-pilot, and this precludes the proper utilization of the air distribution network within the CWU-33/P anti-exposure suit or any other suit of future design incorporating ventilation capability. Without vent air provisions, the pilots are subjected to high body-heat buildup.

2.3.2 Pilot/Co-pilot Armored Seat - The pilot and co-pilot seats exhibit a number of serious inadequacies. They lack structural integrity for potentially survivable crash conditions. They offer only marginal seat comfort and body support for long flight missions. The seats have adequate ballistic protection but restrict rapid egress. In addition, there is little or no commonality of seats or seat components from aircraft to aircraft.

3. Equipment Requirements/Recommended Design Approaches -

3.1 Personal Equipment -

3.1.1 Pre-Flight Gloves - There is a requirement for a set of pre-flight gloves that will permit hand dexterity pertinent to pre-flight inspection of aircraft, and protect the hands from minor injuries. The glove should be durable and readily cleanable.

The approach to the glove solution may be by means of a durable stretch knit over-glove designed to snugly fit over the flight glove with a minimum addition of bulk to the hand.

The solution may also be achieved by a new utility glove that is durable, cleanable, and economical in cost. A glove design requiring as few sizes as possible would be a decided advantage.

3.1.2 Body Armor - A requirement exists for lighterweight and cooler body armor, for the pilot and co-pilot, that would provide adequate protection against gun fire, but would not unduly restrict his inflight performance nor his egress and survival capability. The body armor should integrate with the pilot's other personal equipment and induce a minimum of discomfort and heat buildup.

3.1.3 Helmet Assembly - There is a general requirement for an overall improved helmet design. The required helmet should (1) incorporate ambient noise attenuation that is superior to current SPH-3 levels of performance; (2) be of lesser weight and thus induce less fatigue to the wearer; (3) be constructed of higher strength per weight material; (4) incorporate a non-protruding "mike" technique of voice transmission having a higher signal to noise ratio; (5) permit earphone adjustment for optimum fit to various head contours; (6) incorporate a visor system having both clear and tinted capabilities; and (7) have improved peripheral vision.

3.2 Accessory Equipment - No requirements established.

3.3 Aircraft Equipment -

3.3.1 Ventilating Air System - There is a requirement to provide ventilation air to the crewman's anti-exposure suit in order to reduce the body heat buildup that occurs during the performance of his duties. If anti-exposure protection is to be achieved through the use of a garment that requires ventilation during the inflight phase, then a vent air system is an extremely important requirement.

3.3.2 Pilot/Co-pilot Armored Seat - There is a significant requirement to improve the crashworthiness of the pilot/co-pilot seat systems. This can be achieved by an energy-attenuating frame support for the armored bucket, improved side panels, ballistic head protection using transparent armor, improved body restraint using inflatables, and increased structural capacity to the floor and track.

There is also a requirement to improve the comfort of the seat, which can be approached by contouring the seat cushion, adding lumbar support, improving ventilation to the cushioning, providing an adjustable headrest and incorporating vibration isolators.

Logistic support of seat structures and components can be greatly enhanced by standardizing designs among various aircraft.

MISCELLANEOUS

The following random requirements have been expressed by a limited number of helicopter personnel with regard to desireable modifications and innovations, principally to aircraft. These recommendations are listed for the record, as possible areas for future program support:

1. Pyrotechnic systems for the rapid release of windows or hatches to facilitate emergency egress.

2. Redesign or modification of the SH-3 sonar console in order that it be crashworthy.

3. Provide a low altitude (less than 40 ft.) aural or visual warning systems to the crewmen of the SH-3 ASW mission to act as a back-up to the pilots' system.

4. Incorporate relief-tube capabilities in AH-1, SH-2, etc. aircraft.

5. Investigate and improve the cargo tie-down capabilities of the SH-3 in performing a utility mission. This is to include improvements in deck stressing and buckle attachment points.

6. Integrate the controls for activating the ICS, hover trim and hoist control so that the SAR crewman in the SH-3 may have one hand free to guide the hoist cable.

CONCLUSION

As stated earlier, under Rationale, for the purposes of this study and the technical programs to follow, the helicopter system is considered to be an interplay of three major sub-systems; personal equipment, accessory equipment, and aircraft equipment. This is illustrated simply in Figure 1.

Starting with this concept, the variations in helicopter missions were examined and defined. It appears that helicopters perform in six definable mission areas which should adequately cover the protection requirements of all other helicopter personnel/aircraft. The six include the mission of gun support as performed by the gunship AH-IJ; search and rescue as typically performed by the SH-3; cargo and troop transport conducted with a CH-53; anti-submarine warfare performed by an SH-3; vertical replenishment as usually accomplished by a CH-46; and mine countermeasures as performed by a CH-53.

The study then proceeded to examine the operational profile of each of the six missions and the related problems which occur during the mission. From the statements of problems, a list of requirements evolved and these will be the basis for establishing engineering development programs.

Figure 2 illustrates diagramatically, the approach by which the requirements for each of the mission areas within each of the equipment sub-systems (personal,accessory, and aircraft) were grouped in order to determine the degree of commonality of these requirements.

Tables 1,2, and 3 are expansions of the three triangular portions of Figure 2, and show by titles, the distribution of requirements and their commonality among the various missions/aircraft.

A cursory review of Table 1,2, and 3 indicates that the mission hazards (listed in Table 4) requiring most corrective action are heat loss (operational gloves, anti-exposure protection, heating system); heat stress (ventilation air); body impact (helmet assembly, pilot-copilot seat; troop seat, crewman's seat); noise (helmet assembly); projectiles (body armor); fire/burns; and drowning (life preserver, multi-place raft, escape hatch markings).

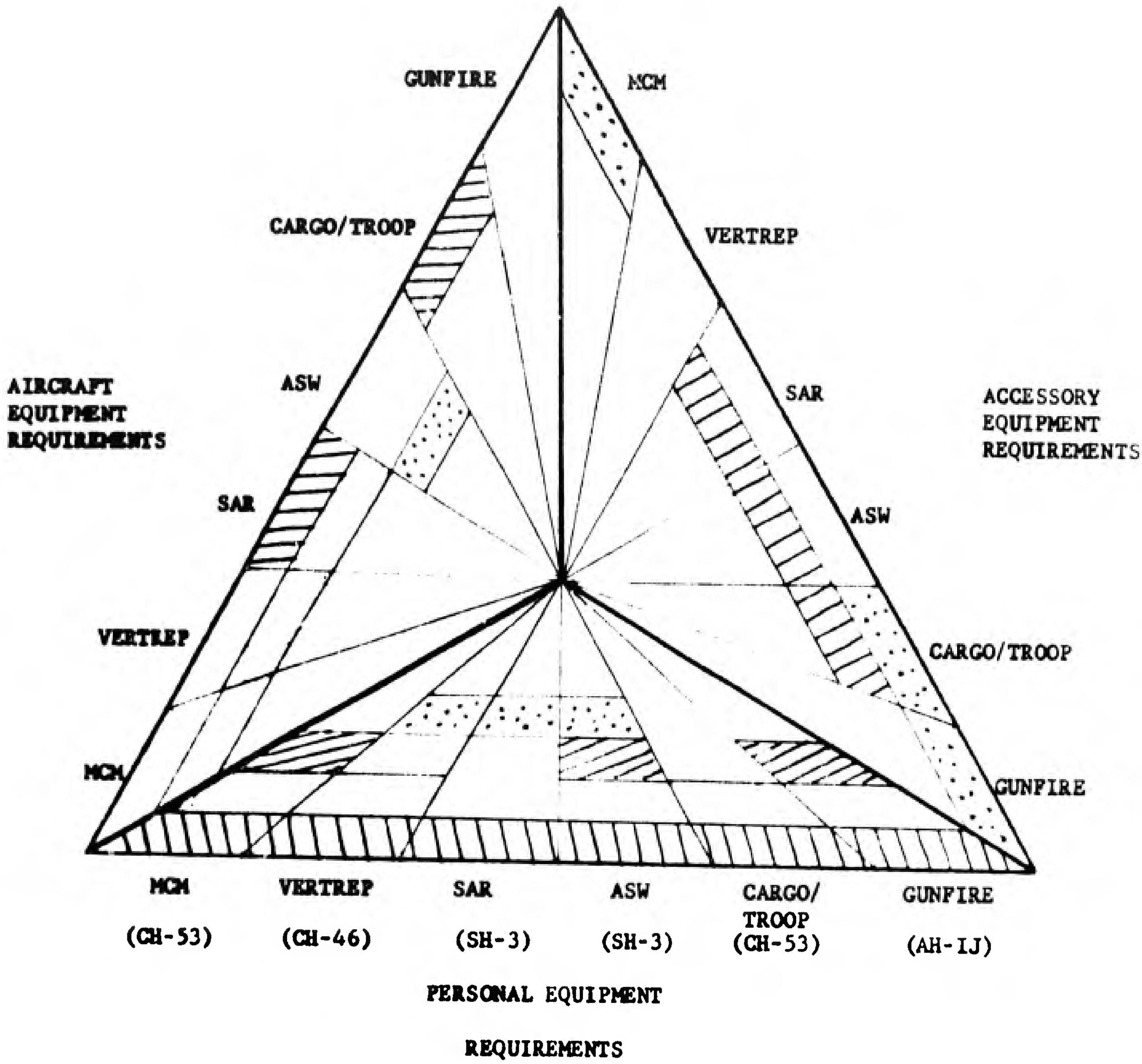

Figure 2 HELICOPTER SYSTEM (Requirements Commonality)

Table 1. PERSONAL EQUIPMENT REQUIREMENTS

MCM (CH-53)	VERTREP (CH-46)	SAR (SH-3)	ASW (SH-3)	CARGO/TROOP (CH-53)	GUNFIRE (AH-IJ)
PRE-FLIGHT GLOVES	XX	XX	XX	XX	XX
OPERATIONAL GLOVES	XX	XX	XX	XX	
FACE PROTECTION					
	EYE PROTECTION	XX	XX	XX	
ANTI-EXPOSURE PROTECTION	XX	XX	XX	XX	XX
LIFE PRESERVER	XX	XX	XX	XX	
HELMET ASSEMBLY	XX	XX	XX	XX	XX
		BODY ARMOR		XX	XX
KNEE PROTECTION	XX	XX		XX	
	SURV. EQUIP. STOWAGE				
	XX	RESCUE SWIMMERS SUIT			
	XX	RESCUE SWIMMERS CONFIGURATION			

Table 2. **ACCESSORY EQUIPMENT REQUIREMENTS**

MCM (CH-53)	VERTREP (CH-46)	SAR(SH-3)	ASW (SH-3)	CARGO/TROOP CH-53)	GUNFIRE (AH-IJ)
MULTI-PLACE RAFT	XX	XX	XX	XX	
	DECK PAD			XX	
		RESCUE LITTER			
			VENT HOSE		
	X	SIGNAL DEVICE			

Table 3. AIRCkAFT EQUIPMENT REQUIREMENTS

MCM (CH-53)	VERTREP (CH-46)	SAk (SH-3)	ASW (SH-3)	CARGO/TROOP (CH-53)	GUNFIRE (AH-IJ)
ICS CONNECTOR & CABLE SYSTEM	XX		XX	XX	
AMBIENT HEATING SYSTEM	XX		XX	XX	
VENTILATION AIR	XX		XX	XX	XX
CREWMAN SAFETY BELT	XX	XX	XX	XX	
	ESCAPE HATCH MARKINGS	XX	XX	XX	
PILOT/COPILOT SEATS	XX	XX	XX	XX	XX
	TROOP SEAT			XX	
XX	XX	CRASH LOCATOR	XX SONAR DOME SEATING	XX	XX
CREWMAN SEAT		XX	XX	XX	

HAZARD DEFINITION

	1. High Altitude	- 7000 ft. max.
*	2. Heat Loss	- ground level at pre-flight temperature $0-20^{\circ}$ F wind chill factor (40 knots)-18° F - in water emergency water temp. $28^{\circ}-32^{\circ}$ F air temp. $0^{\circ}-20^{\circ}$ F wind velocity 15-20 mph
*	3. Heat Stress	- $110^{\circ}-115^{\circ}$ F ambient
	4. Acceleration	- not applicable
*	5. Body Impact	- 40 G crash
	6. Vibration	- not significant
	7. Weightlessness	- not applicable
	8. Radiation	- not applicable
	9. Toxicity	- not defined
*	10. Noise	- 100 db
*	11. Projectiles	- 30 caliber armor piercing 100 yds and 0° obliquity.
*	12. Fire/Burns	- 3 sec. immersion in a gasoline flame
	13. Body Injury	- see specific mission profile
	14. Equipment Wear or Polution	- see specific mission profile
	15. Discomfort Stress	- see specific mission profile
*	16. Drowning & Entanglement	- hampered egress; inoperative flotation; inaccessible flotation
	17. Emotional Stress	- motion sickness
	18. Physical Stress & illness	- combat injury; work injury

* Protection to be improved by ADO 45-67 engineering programs.