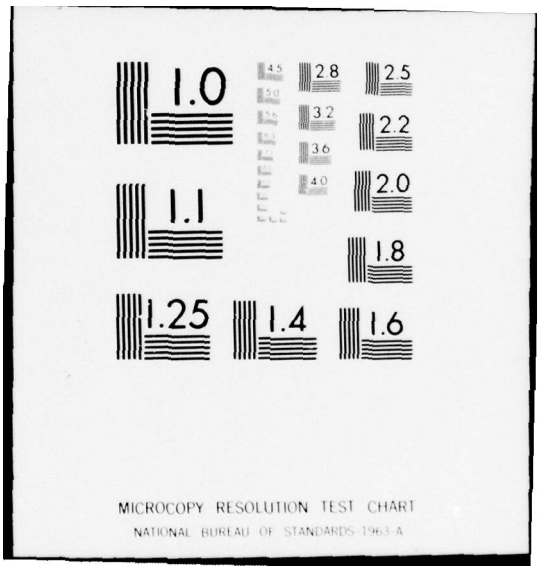
AD-A037 439 ARMY AVIATION CENTER FORT RUCKER ALA F/G 13/13
OPERATIONAL TEST II (OT II) OF EMERGENCY REPAIR SHELTER FOR THE--ETC(U)
SEP 74

UNCLASSIFIED NL

| OF |
ADA037439

END

DATE
FILMED
4-77


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

UNCLASSIFIED

FINAL REPORT OF TEST

OPERATIONAL TEST II (OT II)
OF
EMERGENCY REPAIR SHELTER
FOR THE
CH-47 HELICOPTER

Test And Evaluation Division
Deputy For Developments
United States Army Aviation Center
Fort Rucker, Alabama 36360

26 SEPTEMBER 1974

UNCLASSIFIED

UNCLASSIFIED

RDTE PROJECT NO 1J664713DL40
ACN 17846

OPERATIONAL TEST II (OT II)
OF
EMERGENCY REPAIR SHELTER FOR
THE
CH-47 () HELICOPTER DURING TEMPERATE CLIMATIC CONDITIONS
AND
ARTIC SIMULATION TESTS
CDOG PARAGRAPH 169N(6)

FINAL REPORT

CPT LOEL A. EWART

September 1974

UNCLASSIFIED

DEPARTMENT OF THE ARMY
HEADQUARTERS UNITED STATES ARMY AVIATION CENTER AND FORT RUCKER
FORT RUCKER, ALABAMA 36360

ATZQ-D-MT

21 OCT 1974

SUBJECT: Final Report of Test, Operational Test II (OT II) of Emergency Repair Shelter for the CH-47 Helicopter, CDOG Paragraph 169N(6)

Commander
U.S. Army Training and Doctrine Command
ATTN: ATCD-FT
Fort Monroe, Virginia 23651

1. References.

a. Department of the Army Approved Material Need (MN) for an Emergency Repair Shelter for the CH-47 Helicopter, dated 19 June 72 with CN 1, dated 7 February 73.

b. Letter, ATCD-FT-O, HQ TRADOC, 5 Jun 74, "Interim Guidance for Operational Testing".

c. "Draft Coordinated Test Program (CTP) for Emergency Repair Shelter for the CH-47 Helicopter" undated U.S. Army Natick Laboratories.

d. Outline Test Plan for Operational Test II (OT II) 10 Sep 73, revised 8 Apr 74, U.S. Army Aviation School.

2. The U.S. Army Aviation Center conducted the Operational Test II (OT II) to determine whether the emergency repair shelter for the CH-47 helicopter meets the requirements of the approved material need (MN) during temperate and simulated Arctic conditions. The OT II was performed in conjunction with the Developmental Test II (DT II) conducted by the Aviation Test Board as a combined OT/DT II test. Test data was gathered by the Aviation Test Board for Joint OT/DT II use. Four shelters were tested from Nov 73 thru Jun 74.

3. Although the subject shelter fulfills the basic requirements of the DA approved MN, the Aviation Center forwards the following judgemental conclusions. (Reference b, precludes inclusion of judgemental conclusions in the test report).

ATZQ-D-MT 21 OCT 1974

SUBJECT: Final Report of Test, Operational Test II (OT II) of Emergency Repair Shelter for the CH-47 Helicopter, CDOG Paragraph 169N(6)

a. An Emergency requiring the use of the shelter for repairs was never clearly defined in the Material Need Document. What constitutes a field site emergency repair can only be based upon the experience level of the Maintenance Officer/Technician for that given aircraft emergency to determine if a minor fix or major repair is necessary.

b. An emergency repair requiring a shelter must be based primarily on the type of repair and weather conditions. Time required to locate and complete repairs on the downed helicopter are additional factors. If total time in an area is a factor in aircraft/crew safety, then the repair shelter would not be used due to the additional time required for erecting and striking the shelter.

c. To effectively use the emergency repair shelter, a lighting set, and during cold weather, a heating unit is required for maintenance operations. This is an additional transport burden on the recovery aircraft.

d. Normally the climatic conditions which would require an emergency repair shelter make erecting the shelter a near hazard. Winds above 20 knots are especially dangerous to the mechanics on top of the helicopter trying to install the shelter top section. It must be acknowledged that work on the CH-47 pylon area is inherently dangerous and numerous accidents involving personnel falling from the pylons have occurred.

4. Conclusions. This type of shelter would be more advantageous at a fixed base location where hangar space is limited or non-existent. For use as an emergency repair shelter, it is lacking in those areas necessary for fast erection and striking, lighting and heating. A consensus of maintenance personnel is that the shelter would rarely be used as an emergency repair shelter, but would have application as a fixed base shelter.

5. Recommendations.

a. That the words "emergency repair shelter" be changed to "maintenance repair shelter".

b. That the shelter be issued as a supplementary shelter on an "as required" basis, not force issued to units.

c. The shelter be issued as a set, one complete forward pylon and one complete aft pylon shelter.

FOR THE COMMANDER:

Christopher E. Sodder

1 Incl
as

CHRISTOPHER E. SODDER
Captain, AGC
Assistant Adjutant General

CF:
CDR, TRADOC, ATTN: ATCD-FT

ATZQ-D-MT
SUBJECT: Final Report of Test, Operational Test II (OT II) of Emergency Repair Shelter for the CH-47 Helicopter, CDOG Paragraph 169N(6)

CF: (continued)
CDR, TRADOC, ATTN: ATCD-C
CDR, TRADOC, ATTN: ATCD-O
CDR, TRADOC, ATTN: ATTS
CDR, TRADOC, ATTN: ATCD-FT; CDR, OTEA IN TURN
CDR, USA Log Eval Agency, ATTN: LEA-ME
HQ, Department of the Army, ATTN: DAMA-AR
HQ, Department of the Army, ATTN: DAMO-FD
CDR, USAMC, ATTN: AMCRP
CDR, USA Natick Laboratories, ATTN: AMXRE-GRQ
CDR, Defense Documentation Center for Scientific and Technical Information
ATTN: Document Service Center Cameron Station
CDR, USA Avn Systems Cmd, ATTN: AMSAV-SI
CDR, USA Avn Test Board, ATTN: STEBG-MT-RA
CMDT, USA Transportation School, ATTN: ATST-CTD-DT

INDEX OF CONTENTS

Section I Introduction

Section II Details of Test

Section III Test Results

Section IV Appendix

DISPOSITION INSTRUCTIONS

Destroy this report when it is no longer needed. Do not return it to the originator.

DISCLAIMER

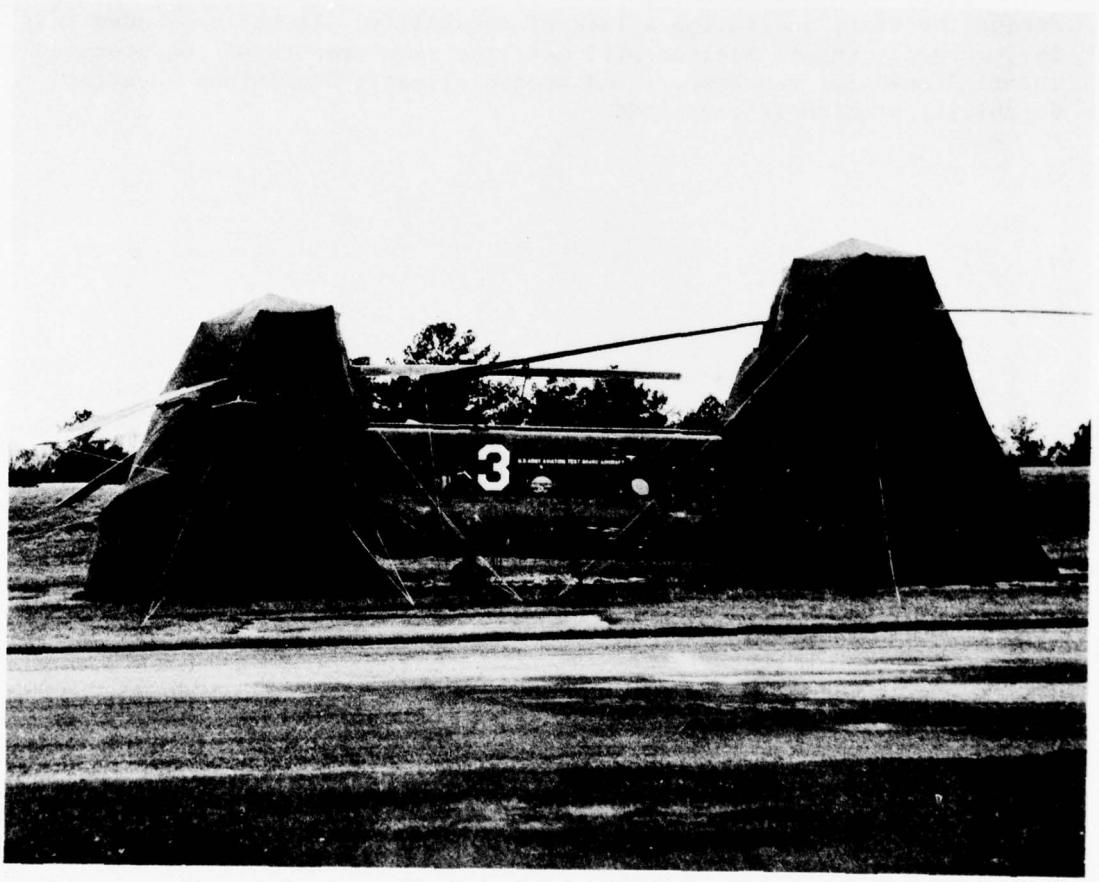
The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents issued and approved by the Department of the Army. The use of trade names in this report does not constitute an official endorsement or approval of the use of such commerical hardware or software. This report may not be cited for purposes of advertisement.

ABSTRACT

The U.S. Army Aviation Center conducted the Operational Test II (OTII) to determine whether the emergency repair shelter for the CH-47 helicopter meets the requirements of the approved material need (MN) during temperate and simulated Arctic conditions. Four shelters were tested from November 1973 through June 1974 at Fort Rucker, Alabama; Appalachicola, FL and in the McKinley Climatic Laboratory at Eglin Air Force Base, FL. Several zippers on the sidewall of the shelter failed during the test, indicating a lack of durability. It was concluded that the emergency repair shelter will meet the requirements of the approved material need for temperature and Arctic climatic conditions when the durability problem is corrected.

Letter on file

FRONTISPIECE



Emergency shelter erected over both the forward and aft pylons of the CH-47 helicopter

1.0. EXECUTIVE SUMMARY.

1.1. TEST DATES AND LOCATIONS.

a. Emergency repair shelter test - 1 Nov 73-30June 74

b. Climatic Hangar Test - 1-30 Nov 73

c. Blackout Test - 12 Jun 74

d. Wind Test - 1-30 Nov 73; 18, 19 Jun 74

1.2. SUMMARY OF TEST OBJECTIVE.

To determine whether the Emergency Repair Shelter and its associated maintenance package meet the military utility and operational effectiveness of the approved material need during temperate and simulated Arctic conditions.

1.3. DESCRIPTION OF SYSTEM/ITEM.

The shelter is made of a lightweight water-and-wind-resistant fabric with fire retardant characteristics and is supported by a frame which attaches to the rotor head. It is collapsible and easily erected. It incloses the major components of the helicopter when erected on each rotor head. The shelter has heat retention qualities and provides protection to maintenance personnel from both subzero temperatures and wind-chill. It is equipped with a duct to accept heat from an external source while preventing exhaust gases of the external heat source from entering the shelter. Ventilation openings are incorporated. The complete shelter weighs 398 pounds.

1.4. TEST DESCRIPTION.

The U.S. Army Aviation Center conducted the Operational Test II (OT II) in conjunction with the Developmental Test II (DT II) performed by the Aviation Test Board as a combined OT/DT II Test. Test data was gathered by the USAAVNTBD for joint OT/DT II use.

1.4.1. Objectives were derived from the Department of the Army Approved Materiel Need (Engineering Development) (MN (ED)) (SDR) for Emergency Repair Shelter for the CH-47 (Reference, Para 36) Helicopter and Military Standard (MIL-STD) 1472A, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities". Criteria for operational/maintenance evaluation were derived from the MN(ED), MIL-STD-1472A, AR 70-10, AR 71-6, AR 750-1.

1.5. SUMMARY OF PRINCIPLE TEST RESULTS.

A meeting was held at the U.S. Army Aviation Test Board (USAAVNTBD) on 26-28 February 1974 for review of equipment performance reports (EPR's) and maintenance manual changes resulting from test of the shelter. As a result of the meeting and evaluation of all EPR's requiring action, the U.S. Army Natick Laboratories modified the shelter to incorporate design improvements recommended by the different agencies. These changes were evaluated and the results are indicated in this report. A point-by-point comparison of the test results with the criteria is contained in Appendix K.

a. Initial Inspection. The four shelters received for test were serviceable.

b. Durability. One objective was met and one was partially met.

(1) The zippers in the intermediate shelter wall were damaged after the freezing rain test; this was considered a deficiency because the shelter could not be closed and would not retain heat. The modified shelter had a flap cover over the zipper to help prevent water from entering the zipper and freezing; however, the modified shelter was not tested in freezing rain. (Para 2.4.1.1.)

(2) After 12 erecting/striking cycles, all the rib frames in the top shelter section were bent at top and bottom attachment points. One top attachment rib frame was broken. This was considered a shortcoming. U.S. Army Natick Laboratory modified the rib frame. However, only four cycles were accomplished prior to test completion. Therefore, the durability of the modified rib frame was not determined. (Para 2.4.1.1.3,d).

c. Functional Suitability. Objectives were met after modification of the shelter with the exception of shelter weight requirements.

(1) The original shelter had insufficient working space, particularly around the combining transmission and engine transmission areas, and was modified to provide sufficient space for maintenance operations. However, the number one engine cannot be removed using the maintenance davit due to insufficient space between the helicopter and the shelter wall to lower the engine to the stand (shortcoming). (Para 2.4.1.2.3.,a).

(2) Blackout provisions were adequate after outside flaps were added to cover the zippers. (Para 2.4.1.2.3,b)

(3) The overall weight of the shelter exceeded the MN(ED) requirement by 98 pounds with the heaviest package exceeding the MN(ED) requirement by 21 pounds (shortcoming) (Para 2.4.1.2.3,c)

d. Effects of Weather. The objectives were met.

(1) The shelter withstood winds at 40 knots for 3 consecutive hours. The pitot tube on the CH-47 punctured the shelter. A pitot tube cover with a blunt end was provided for the test of the modified shelter, and prevented puncturing of the shelter during high winds. (Para 2.4.1.3.2,c).

(2) Freezing rain and ice accumulation on the shelter caused the zipper to come apart from the slider prior to the modification. (Para 2.4.1.3.2,c)

e. Transportability. Objectives were met. The shelter was satisfactorily transported by 3/4 ton and 2½ ton cargo trucks, and internally and externally by UH-1 helicopter. (Para 2.4.1.4.3,a).

f. Installation and Removal. Objectives were met after modification of the shelter.

(1) There were no difficulties encountered while erecting and striking the shelter. No problems are anticipated during field operation in a temperate and Arctic enviornment. (Para 2.4.1.5.3)

(2) Shelter modifications corrected the problem areas found during early test stage. The vent opening for the external heat source was enlarged to accept the external heater, the ties straps were lengthened to secure the vent to the heater, and placard was stenciled on the APU exhaust cone clamp to reduce the possibility of incorrect installation.

(3) It can be stated with 90-percent confidence that the probability that a crew of four men can erect the shelter within 1.5 hours is 96 percent, and the probability that a crew of four men can strike the shelter in 1.5 hours is 99.9 percent. The erecting and striking time criterion was met.(MN(ED)) (Para 2.4.1.5.3.)

g. Safety. The objectives were met with the exception of the vent for the helicopter onboard heater. The shelter did not provide an exhaust vent for the onboard heater. This is considered a shortcoming because of the hazard created by the exhaust fumes retained in the shelter. (Para 2.4.2.1.3.).

h. Training. The objective was met. The detailed instructions in the publications after numerous word changes is sufficient to allow a four man crew to install and remove the shelter without formal instruction. (Para 2.4.3.1.3.)

i. Maintainability. Objectives were met. The mean time to repair (MTTR) was 0.18 hour at organizational level. Repair was not required at direct and general support levels during the test. The ratio of maintenance man-hours to operating hours was 0.0005. (Para 2.4.4.1.4.)

j. Reliability. The objective was met. Test results indicated that with 80-percent confidence, the MTBF of the shelter is between 565 and 20,844 hours, inclusive. The point estimate exceeds the minimum acceptable level of 800 hours; therefore, the reliability was achieved. (Para 2.4.4.2.3.)

k. Repair kits. Objectives were met. Test personnel recommended the addition of several items to the repair kits. The repair kit with the modified shelter included the recommended items (Para 2.4.4.3.3.)

l. Maintenance Operations, Human Factors. The objectives were met. The original shelter did not provide sufficient space around the combining transmission and engine areas, making entrance and exit and performance of duties difficult. After modification of the shelter, the work space was considered adequate. (Para 2.4.4.4.3.).

m. Equipment Publications. The objective was partially met. Several changes were required for adequate operation and maintenance instructions for the shelter. The suggested changes were provided to U.S. Army Aviation Systems Command. (Para 2.4.4.5.3.).

n. Shelter Maintenance Safety. The objective was met. There were no hazards observed to personnel while maintaining the shelter. (Para 2.4.4.6.3.).

o. Special Tools and Shelter Storage Requirement.

(1) The Tools and Test Equipment objective was met. Additional tools and equipment, other than those contained in the repair kit, were not required to maintain the shelter. (Para 2.4.5.1.4.).

(2) The shelter requires 25.9 cu ft of inside space for storage. (Para 2.4.5.2.4.)

p. Test against the OT I Shortcomings and Deficiencies. No OT I was conducted on the repair shelter.

q. Deficiencies and Shortcomings. (Appexdix J.2)

(1) Deficiency. Several zippers failed on the side shelter walls during the test because the zipper pulled and tore apart under stress.

(2) Shortcomings.

When lowering the No. 1 engine to the engine stand, the shelter wall has to be opened for the davit to swing out properly. There is insufficient space inside the shelter between the helicopter and shelter wall to accommodate the engine stand without opening the shelter wall.

All rib frames were bent at the top and bottom points where they attach to the center pole. One top attachment point was broken.

The shelter did not provide an exhaust vent for operation of the onboard heater.

The maintenance shelter exceeded the MN(ED) weight requirements.

2.0. DETAILS OF OPERATIONAL TEST.

2.1. INTRODUCTION.

Since the advent of the helicopter into the military inventory, there has not been a standard lightweight, portable repair shelter developed for use in the field under adverse environmental conditions. The aviation maintenance shelters described in paragraph 1639 of the Combat Developments Objective Guide (CDOG), though adequate for their intended purpose, do not suffice when an aircraft must, in the interest of safety, land in a remote area for emergency repairs to a malfunctioning system.

The development of an adequate emergency repair shelter will lessen the logistical support burden for the CH-47 ( ) helicopter by eliminating the need for costly evacuation to direct support (DS)/general support (GS) facilities to accomplish emergency repair that could have been performed on site had adequate shelter been available.

2.1.1. Purpose.

The shelter is designed to provide weather protection to a mechanic performing emergency field repairs to the CH-47 ( ) helicopter in climatic environments 1 through 8 as contained in Army Regulation (AR) 70-38. It facilitates performance of maintenance and inspection when fixed or semi-permanent facilities are not adequate or available.

2.1.2. Background.

The U.S. Army Combat Developments Command (USACDC) in 1972, established a new concept for an emergency repair shelter for the

CH-47 helicopter by detailing a material need (MN) document. The emergency repair shelter was designed and fabricated by Natick Laboratories, MA, under U. S. Army Materiel Command's in-house program to meet the MN requirement for an emergency repair shelter. The U. S. Army Test and Evaluation Command (TECOM) was tasked by the Army Materiel Command (AMC) to conduct a development test II (DT II) in June 1973. TECOM directed the Aviation Test Board, Fort Rucker, AL to conduct the service phase of the DT II. During this period, HQ, TRADOC directed the Aviation Center to conduct the Operational Test II as the user. By agreement of TRADOC and AMC, the DT/OT II test was combined for better utilization of materiel and personnel. The combined DT/OT II test began in November 1973 and ended June 1974. While the Aviation Center did not conduct the Arctic Portion of the OT test, the DT II Arctic Test results were used in this report. Arctic test results were used in this report to compare methodology and assure validity of test results derived from the climatic hangar tests at Eglin AFB, Florida.

2.1.3. Objectives.

To determine whether the CH-47 ( ) Emergency Repair Shelter and its associated maintenance package meet the requirements for military utility and operational effectiveness as stated in the MN document.

2.1.4. Tactical Context.

The tactical setting was typical of a field emergency repair site. Personnel were the minimum number required to perform emergency repairs in a field situation.

2.1.5. Limitations and Assumptions.

Removal of the rotor heads and main transmissions were not attempted. All component part removal/replacement and repair work was assumed to be that of a tactical emergency nature.

2.2. SYSTEM DESCRIPTION.

The shelter is designed to provide weather protection to a mechanic performing emergency field repairs to the CH-47 ( ) helicopter in climatic environments 1 through 8 and contained in AR 70-38. It facilitates performance of maintenance and inspection when fixed or semi-permanent facilities are not adequate or available. The shelter is made of a lightweight water- and wind-resistant fabric with fire retardant characteristics and is supported by a frame which attaches to the rotor blade. It is collapsible and easily erected. It incloses the major components of the helicopter when erected on each rotor head. The shelter has heat-retention

qualities and provides protection to maintenance personnel from both subzero temperatures and wind chill. It is equipped with a duct to accept heat from an external source while preventing exhaust gases of the external heat source from entering the shelter. Ventilation openings are incorporated. The complete shelter weighs 398 lbs.

2.3. TEST METHODOLOGY/DESIGN

2.3.1 Test Conditions.

The shelter was installed on the forward and aft main rotor heads in both temperate and simulated Arctic conditions. Four CH-47 helicopter repairmen (MOS 67U20) were utilized during all erecting and striking operations. All failures, problem areas and reaction times were recorded for all activities to include unpacking, assembly, erection, striking, assembly of components, and packing during the temperate and simulated Arctic conditions. The shelter was erected and struck a total of 59 times on the forward and aft rotor heads in a simulated tactical environment.

2.3.2. Dendritic Structure - Table A.

TEST RESULTS.

The mandatory physical performance and RAM characteristics for the emergency repair shelter as stated in the DA approved materiel need document are the primary requirements for the conduct of operational test (OT II).

2.4.1. Operational Suitability.

Objective: The shelter must have heat retention qualities and provide protection to mechanics from subzero temperatures and wind-chill. It must be lightweight, collapsible and easily erected without the use of special tools or removal of protective gloves or mittens. The shelter must be tailored to inclose major exterior components of the helicopter, i.e., engines, rear rotor head and rear pylon. By repositioning, the shelter must be capable of inclosing the front rotor head and pylon to provide protection to a mechanic working on the exterior. The shelter will be introduced into an area of operations by airlift, air drop, or surface transportation. (MN (ED) Para 2c)

2.4.1.1. Durability.

2.4.1.1.1. Criteria.

a. Shelter fabric: lightweight, water resistant, wind resistant.....and impervious to fluid damage, i.e., hydraulic fluid, fuel, grease and oil (MN(ED), para 2c(1)).

b. Reinforcement must be provided at stress areas. (MN(ED), para 2c(2)).

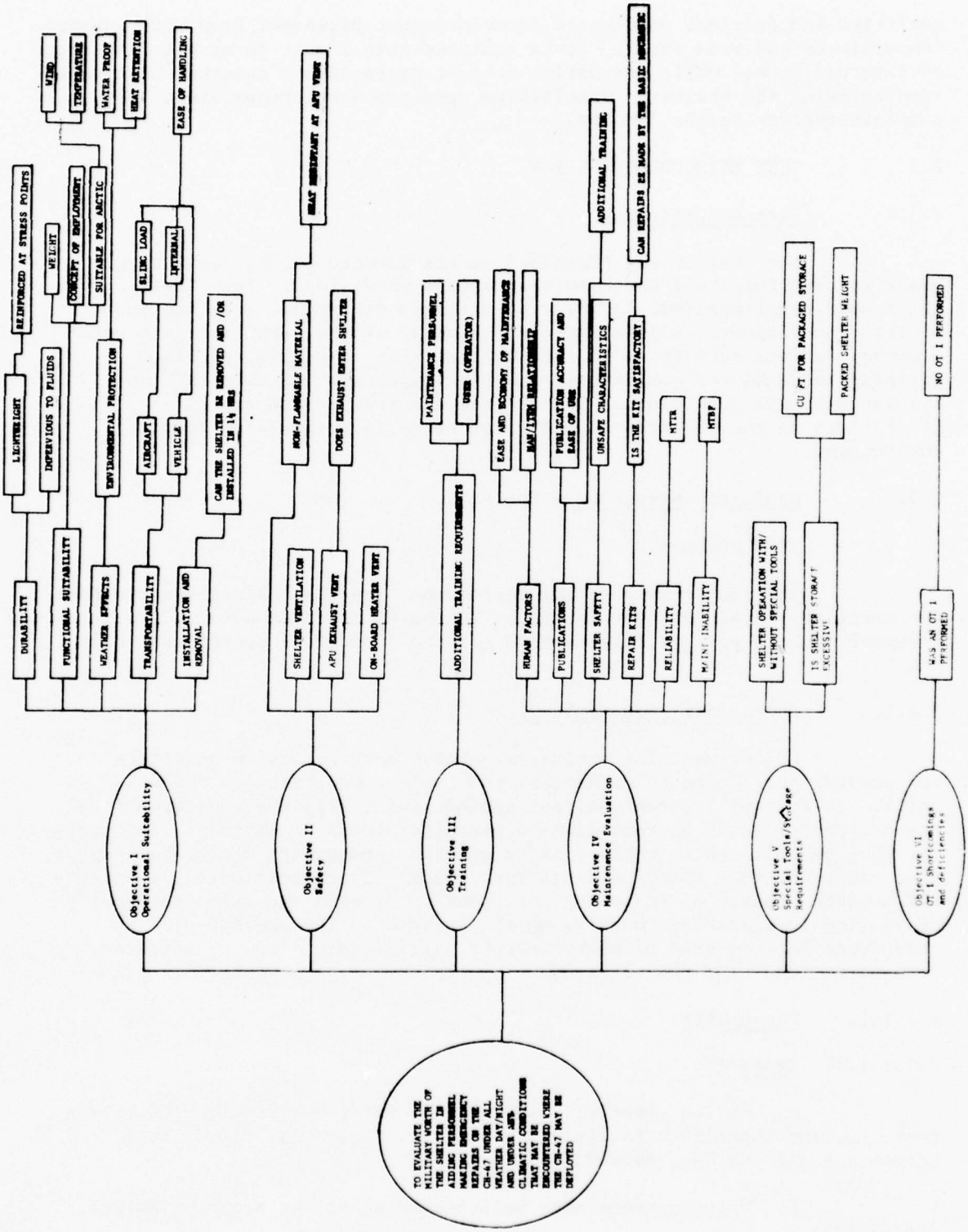


TABLE A - DENDRITIC STRUCTURE

2.4.1.1.2. Method.

a. The shelter was examined periodically during the test for evidence of hydraulic fluid, fuel, grease or oil on the shelter's fabric or other components.

b. Stress areas of the shelter were examined to determine if reinforcements had been incorporated. The shelter's fabric and other components were examined periodically for damage caused by normal wear (i.e., effects of wind or other actions that caused rubbing or slipping between components, or repeated actions that caused excessive stress to fabric seams). Any damage and cause of damage that occurred during erecting, use, or disassembling of the shelter were recorded.

c. During the operational suitability test, the shelter was exposed to 40 knot winds continuously for 3 hours.

d. The erecting/striking operations during the climatic laboratory test were conducted under the following conditions:

(1) Condition I - Temperature from $0^{o}F$ to $-25^{o}F$. The shelter was erected and struck six times on the forward rotor head. The shelter was exposed to 10-, 20-, and 30-knot winds after erection.

(2) Condition II - Temperature from $-25^{o}F$ to $-45^{o}F$. The shelter was erected and struck three times on each rotor head. The shelter was exposed to 10-, 20-, and 30-knot winds after erection.

(3) Condition III - Temperature $-45^{o}F$ to $-65^{o}F$. The shelter was erected and struck two times on each rotor head. The shelter was exposed to 10-, 20-, and 30-knot winds after erection.

(4) Condition IV - Temperature of $-65^{o}F$ or below. The shelter was erected and struck once on each rotor head. The shelter was exposed to 10-, 20-, and 30-knot winds after erection.

2.4.1.1.3. Results.

a. The shelter fabric was lightweight, water-resistant, and wind-resistant. During the rain test, water leaked around the zipper seams, but did not leak into the work area. After modification (i.e., incorporation of flaps over the zippers), no leakage was noted around the zippers during a 1/2 inch rainfall. The top shelter section tore under heavy wind at the shelter frame to fabric attachment point along the seam area. (Appendix I, Fig 11).

b. Fabric stress areas such as guy rope tiedown attachment points were provided with reinforcements. These reinforcements were durable during winds up to 40 knots.

c. The zipper on the intermediate shelter wall containing the APU and heater sleeves came apart above the slider (Appendix I, Fig 1). This damage occurred at 0°F and after the frezzing rain test (5 hours) which included approximately 1/4 inch ice accumulation on the shelter. The zippers on the other three shelter walls either pulled out or came apart above the slider when erecting the same shelter at -65°F.

d. After 12 erecting/striking cycles, all rib frames were bent at the top and bottom points where they attach to the center pole. One top attachment rib frame was broken (Appendix I, Fig 2). This necessitated the frame to be modified for additional strength.

e. There was no damage due to hydraulic fluid, fuel, grease, or oil leakages on the shelter.

2.4.1.2. Functional Suitability.

2.4.1.2.1. Criteria.

a. The shelter must.....permit maximum acessibility to all pylon components. The frame must also provide a minimum of four feet above the rotorhead to permit, as nearly as practicable, unrestricted use of the maintenance davit outside the shelter, (MN (ED) Para 2c(3)).

b. The shelter must be capable of being blacked out to the extent that the light from a standard two cell flashlight may not be seen from a distance of 1000 meters when the light source is a minimum distance of 2 feet from the inside wall of the shelter (MN (ED) Para 2c(17)).

c. Total weight of the shelter to include fabric, mast, anchor ropes, guy ropes and fasteners must not exceed 300 pounds with the heaviest component not weighing more than 50 lbs. (MN (ED) Para 2c(18)).

d. The shelter must provide openings for positioning around the rotor blades. Openings must be of sufficient size to allow for blade removal (MN (ED) Para 2c(4)).

e. The shelter must have a means of closing (Velcro) the vertical portion of the shelter that extends below the rotor blades. (MN (ED) Para 2c(5)).

f. The shelter when mounted over the pylon areas must be configured to conform to the shape of the fuselage of the helicopter at a sufficient distance from the point of attachment of the maintenance davit to the fuselage to permit operation of the davit outside the shelter. (Appendix I, Fig 3). This opening must be equipped with a restraining device to permit tightening around the fuselage. (MN (ED) Para 2c(10)).

2.4.1.2.2. Method.

a. The clearance of the shelter above the rotor head was measured while using the maintenance davit for removal of major components to include an engine, transmission assembly, combining transmission, and one rotor blade from each rotor head.

b. To determine the blackout capability, project personnel visually observed the shelter from several different angles at a distance of 1,000 meters during the hours of darkness. A standard two-cell flashlight placed 2 feet from inside the shelter wall was used as a light source.

c. Shelter component items were individually packaged, weighed and measured. The four component units were weighed and measured.

d. The shelters were erected on both rotor heads with all rotor blades installed. Visual inspection was made for provisions for openings.

e. The means of closing the vertical portion that extends below the rotor blades was checked for adequacy.

f. The shelter was erected with the maintenance davit installed. The shelter was tightened around the fuselage with the maintenance davit installed.

2.4.1.2.3. Results.

a. The shelter provided the specified 4-foot clearance above the rotor head. However, when the shelter was erected over the aft rotor, the following restrictions were noted where the shelter covered the combining transmission and engine transmission areas:

(1) Entrance to the shelter in the vicinity of the combining transmission was restricted, especially for personnel wearing arctic clothing (Appendix I, Fig 4).

(2) The pylon leading edge hinge fairings struck the shelter walls when opening.

(3) Inadequate workspace and protection were provided to mechanics performing maintenance in the following areas:

a. Combining transmission

b. Oil coolers

c. Engine driveshaft

d. Engine transmission

(4) Use of the maintenance davit was restricted. An opening was not provided in the shelter for the maintenance davit cable. USANLABS modified the shelter to provide additional workspace around the aft pylon. The modified shelter provided an entrance for the davit cable and adequate workspace for all operations except for the lowering of No. 1 engine to the maintenance stand. The shelter wall had to be opened to allow the davit to swing out properly to lower the No. 1 engine and permit access to the engine stand because there is insufficient space inside the shelter.

b. During the blackout tests, the light from a standard two-cell flashlight inside the shelter was visible around the zipper seams at a distance of 1,000 meters. After flaps were added over the zippers, blackout provisions were adequate.

c. The shelter consisted of four packages. Their weights and volumes were:

Package	Weight (LBS)	Dimensions	Volume (CU FT)
Shelter side walls	141	3'5"x1'5"x2'5"	11.7
Repair kit	26	1'4"x1'4"x8"	1.2
Anchor, tiedown ropes, etc.	160	3'3"x1'3"x1'2"	4.9
Top, shelter section	71	6'5"x1'4"x11"	8.1
TOTAL	398		25.9

d. Rotor blades were removed to determine if the openings were sufficient. The openings provided were sufficient to remove or install main rotor blades. Openings provided for positioning the shelter around the rotor blades were satisfactory (Appendix I, Fig 5). While the shelter leaked water around the blade openings, it did not present a problem with maintenance.

e. Zippers were provided to close the vertical portion of the shelter that extends below the blades. This method of closure was satisfactory.

f. The shelter conforms to the shape of the helicopter fuselage when mounted over the pylon areas.

The maintenance davit was installed satisfactorily outside the shelter when erected on the aft pylon. The shelter was satisfactorily tightened around the fuselage with the maintenance davit installed.

g. The following components may be removed, replaced or repaired with the shelter installed:

(1) Main rotor blades

(2) Combining transmission

(3) Oil coolers

(4) Engine drive shaft

(5) Engine transmission

(6) Engines (note para 4.2.1.2.3.a)

(7) Aft M/R transmission

(8) Aft M/R transmission drive shaft

2.4.1.3. Effects in weather.

2.4.1.3.1. Criteria.

a. The shelter must have a lightweight telescopic frame to support the shelter against the environmental conditions described herein.....(MN (ED) Para 2c(3)).

b. The shelter, by repositioning, must afford equal protection to a mechanic working on both rotor heads and pylons. (Appendix I, Fig 6). (MN (ED) Para 2c(15)).

c. The shelter must be capable of withstanding winds up to 40 knots when erected. (MN(ED) Para 2c(20)).

2.4.1.3.2. Method.

a. The shelter's frame structure was observed during use to determine its ability to support the shelter against environmental conditions encountered. Any damage noted was recorded. Weather information was obtained daily.

b. Observations were made during the simulated arctic and temperate conditions with shelter erected on both the aft and forward pylon areas to determine if equal environmental protection was provided.

c. The shelter was subjected to winds up to 40 knots for 3 hours using a wind machine.

2.4.1.3.3. Results.

a. The shelter frame was lightweight and telescopic and capable of supporting the shelter during the environmental conditions described.

b. Equal environmental protection was afforded mechanics working on both the aft and forward pylon areas during rain, ice, snow, sun, and wind conditions.

c. The shelter withstood winds of 40 knots for 3 consecutive hours. The shelter wall on the forward pylon was punctured by the pitot tube and pitot tube cover during the wind test. A pitot tube cover with a blunt end was furnished with the modified shelter. This cover prevented puncturing of the shelter in 40-knot winds. The zipper on the intermediate shelter wall containing the APU and heater sleeve came apart above the slider during the freezing rain test.

2.4.1.4. Transportability.

1.3.1.3.1. Criteria.

a. Packaged configuration of the shelter must be such that it can be transported internally in a utility helicopter (MN(ED), para 2c(19)).

b. This shelter shall be transportable by organizational cargo vehicles and Army aircraft including sling load. (MN(ED), para 3o).

2.4.1.4.2. Method.

a. The shelter in its packaged configuration was:

(1) Loaded into the cargo compartment of a UH-1H helicopter, transported, and unloaded.

(2) Transported as a sling load by a UH-1H helicopter.

(3) Loaded into the cargo beds of 3/4-ton and 2 1/2-ton cargo trucks, transported, and unloaded.

b. The number of packages transported and the dimensions, volume, and weight of each were recorded.

c. The number of personnel, time, and equipment required for each loading/unloading operation was recorded.

2.4.1.4.3. Results.

a. The shelter was satisfactorily loaded into, transported by, and unloaded from the UH-1H helicopter, 3/4 ton cargo truck, and 2 1/2 ton cargo truck. The shelter was also satisfactorily transported as a sling load by UH-1H helicopter using a cargo net.

b. The shelter consisted of four packages. Their weights and volumes were:

Package	Weight (lb)	Dimensions	Volume (Cu Ft)
Shelter side walls	141	3'5"x1'5"x2'5"	11.7
Repair kit	26	1'4"x1'4"x8"	1.2
Anchor, tiedown ropes, etc.	160	3'3"x1'3"x1'2"	4.9
Top, shelter section	71	6'5"x1'4"x11"	8.1
TOTAL	398		25.9

c. Two men were required to handle, load, and unload the shelter. Each loading and unloading operation required approximately 5 minutes (10 man-minutes). No equipment was required.

2.4.1.5. Installation/Removal.

2.4.1.5.1. Criteria.

The reaction times for operation in climatic categories 1 through 8, AR 70-38, with personnel wearing appropriate environmental clothing are:

a. Unpacking, assembly of components and erecting the shelter shall not exceed 1½ hours for four men. (MN(ED) Para 2f(1)).

b. Striking the shelter, disassembly of components and packing shall not exceed 1½ hours for four men. (MN(ED) Para 2f(2)).

2.4.1.5.2. Method.

The shelter was installed on the forward and aft rotor heads in both temperate and simulated arctic conditions. Four CH-47 ( ) helicopter repairmen (military occupational specialty, MOS 67U2F) were utilized during all erecting and striking operations. Reaction times were recorded for all activities to include unpacking, assembly, erection, striking, assembly of components, and packing during the temperate and simulated arctic conditions.

2.4.1.5.3. Results.

Four men erected and struck the shelter a total of 59 times on both the forward and aft rotor heads in temperate and simulated arctic conditions.

a. An average of 1 hour and 13 minutes (elapsed time) was required to unpack, assembly components, and erect the shelter.

b. An average of 59 minutes (elapsed time) was required to strike, disassemble components, and pack the shelter.

c. No special tools or equipment is required for shelter installation or removal.

2.4.2. SAFETY.

2.4.2.1. Consideration of health and safety criteria in accordance with MIL STD 1472A.

1.4.2.1.1. Criteria.

a. The shelter must be equipped with a vent to accept an external heat source and designed, or provided instructions, to prevent the exhaust gases from the external heat source from being drawn into the tent. (MN(ED) Para 2c(6)).

b. The shelter must be equipped with a ventilation flap. (MN(ED) Para 2c(7)). (Appendix I, Fig 10).

c. Two air intake openings must be positioned to coincide with the two integral air inlets located on the right rear of the helicopter approximately seven feet up from the bottom of the fuselage. (MN(ED) Para 2c(8)).

d. The rear of the shelter must be equpped with an exhaust vent to accommodate the exhaust port of the auxiliary power unit located on the rear of the aft pylon approximately seven feet eight inches above the lowest point of the fuselage. (Appendix I, Fug 7). This exhaust vent should be approximately 1&½ times the diameter of the APU exhaust and should be equipped with mating fasteners that can be affixed to the helicopter to secure the vent in position. Non-flammable material will be used around the immediate area of the APU exhaust (MN(ED) Para 2c(9)).

e. The shelter.....and provide vent for onboard heater intake and exhaust located in vicinity of station #120 starboard side of aircraft. (MN(ED) Para 2c(15)).

f. There shall be no inherent health hazard in the materials used for the tent (MN(ED Para 3g(1)).

g. Design and construction of the tent shall impose no safety risk for erecting, using and striking the tent. (MN(ED) Para 3g(2)).

h. Shelter to be made of fire resistant material or treated for flameproofing (MN(ED) Para 3g(3)).

2.4.2.1.2. Method.

a. The shelter was equipped with a vent to accept an external heat source. An attempt was made to fit the duct of the external heater (Federal stock number (FSN) 4520-223-3221) to the shelter vent. The vent opening on the shelter had to be enlarged 2 inches in diameter to accommodate the external heater. The tie straps had to be lengthened 6 inches to secure the heater ducting to the shelter vent opening. The external heater was operated, using instructions provided to determine if exhaust gases were drawn into the shelter. A Mine Safety Apparatus Universal Tent Kit with carbon monoxide indicator tubes was used to test for carbon monoxide.

b. The shelter was inspected for provision of the required ventilation flaps, and their location and adequacy were evaluated.

c. The shelter was inspected for provision of the required air intake openings and their location and adequacy were evaluated.

d. The exhaust cone provided with the shelter was attached on the helicopter auxiliary power unit. The cone was then inserted in the vent opening. The vents were then inspected to determine if fasteners were adequate.

e. The shelter was inspected for provision of the required intake and exhaust vents for the helicopter onboard heater.

f. All components of the shelter were inspected with special attention given to the materials used for manufacture to determine health hazards.

g. Special attention was given to the adequacy of safety features provided in the shelter. Hazardous conditions experienced by personnel using the shelter were recorded. Warning and instruction placards pertaining to the shelter were inspected for adequacy and location. Hazards were classified in accordance with paragraph 3.14 of MIL-STD 882.

h. Shelter material around aircraft APU exhaust was monitored while APU was operational.

2.4.2.1.3. Results.

a. The exhuast gases from the external heat source were not drawn into the shelter.

b. The shelter was equpped with two ventilation flaps located at the top of the shelter. Ventilation was adequate.

c. The two air intake openings were not installed on the right rear portion of the shelter.

d. The rear of the shelter was equipped with an exhaust vent that accommodated the exhaust cone when attached to the APU. The vent was located on the rear of the aft pylon 7 feet 8 inches above the lowest point of the fuselage. The exhaust vent was 1 1/2 times the diameter of the APU exhaust. The exhaust vent was equipped with mating fasteners that could be affixed to the exhaust cone. The APU exhuast cone clamp could be installed incorrectly. A placard "THIS SIDE TO APU" was stenciled on the clamp to lessen this possibility. The shelter was modified with non-flammable material around the APU exhaust vent.

e. The shelter did not provide an intake and exhaust vent for the helicopter onboard heater.

f. No inherent health hazard was found in the materials used for the shelter.

g. The top section of the shelter was difficult to handle and position in winds up to 20 knots.

h. The shelter material around the APU exhaust charred and melted but did not burn. This area was modified with nonflammable heat resistant material around the APU exhaust vent (Appendix I, Fig 8).

2.4.3. TRAINING.

2.4.3.1. Objective: To determine the extent of required instruction to erect, operate, strike and repair the shelter.

2.4.3.1.1. Criteria.

Equipment publications shall be written in a manner so that operational and repair procedures will be logical, clear and concise.

2.4.3.1.2. Method.

a. A four man maintenance team, using the instruction manual erected and removed the shelter on the forward and aft main rotor heads.

b. Operations performed were monitored and observed to determine whether the instructions were adequate and whether the sequence of operation was properly detailed to preclude the need for formal training in shelter operational and repair procedures.

2.4.3.1.3. Results.

Numberous minor word changes to the draft manuals were recommended to enhance clarity, especially to the erecting and striking procedures for the shelter. No formal instruction was necessary. With the changes added, the manual was satisfactory.

2.4.4. MAINTENANCE EVALUATION.

2.4.4.1. Maintainability.

To determine the maintenance/maintainability characteristics of the shelter.

2.4.4.1.2. Criteria.

a. The mean time to repair (MTTR) shall not exceed:

Organization level	2 hours
Direct support level	8 hours
General support level	8 hours

(MN(ED), para 5(c)).

b. The ratio of maintenance (MR) man-hours to operating hours shall not exceed 0.01. (MN(ED), para 5(d)).

2.4.4.1.3. Method.

The following was recorded during maintenance actions on the shelters: (Appendix L, Part 1).

a. Scheduled and unscheduled actions for each maintenance level.

b. Total man-hours expended.

c. Number of personnel utilized, by MOS.

d. Total downtime in clock hours.

e. Total erected hours.

f. Number of chargeable failures.

g. Administrative and supply downtime.

2.4.4.1.4. Results.

a. A total of zero (0) scheduled maintenance man-hours was expended.

b. A total of 1.1 unscheduled maintenance man-hours was expended.

c. A total of 1.1 clock-hours was expended for corrective maintenance.

d. A total of eight corrective maintenance actions were required during the test; however, two were performed at USANLABS and no repair times were available.

e. Four personnel were utilized:

MOS	Grade	CH-47 Experience
67U2F	E-6	8 years
67U2F	E-6	6 years
67U2F	E-5	4 years
67U2F	E-4	2 years

f. A total of 2.3 clock-hours of downtime was accumulated.

g. A total of 2,199 erected hours was obtained on the shelter.

h. The MTTR was:

0.18 hours Organizational (Based on six corrective maintenance actions performed by the USAAVNTBD.)

0 hours Direct Support

0 hours General Support

i. The ratio of maintenance man-hours to operating hours (MR) was 0.0005.

j. Achieved availability (A_a) was 0.9995.

k. A maintenance analysis chart is contained in Appendix L.

2.4.4.2. Reliability.

2.4.4.2.1. Criteria.

a. The mission MTBF for the shelter shall not be less than 800 erected hours. For purpose of computing MTBF, a mission stopping failure is defined as any malfunction which the crew cannot remedy by adjustment, repair or replacement using controls, on equipment tools and parts, within 15 minutes which causes or may cause degradation of performance capability of the shelter below designated performance levels, serious damage to the shelter by continued operations, or serious personnel safety hazards. (MN(ED) Para 2g(1)).

b. Mission duration will range from one day to 14 days depending upon the operational mission of the using unit. The shelter shall be suitable for use 6 hours per day for 14 days with organizational maintenance only (MN(ED) Para 2g(3)).

2.4.4.2.2. Method.

a. The shelters were tested by performing a mission which consisted of erecting, use for a specified time in performing typical maintenance functions, disassembly, and transport. The shelters were erected on both sod and concrete surfaces and in both the climatic laboratory and natural environment. The duration of missions and the number of times each mission was performed are listed in Table B.

b. A record was kept of the total erected hours, the number of missions attempted, the number of missions that failed, the cumulative erected hours at which each failure occurred, and a description of each failure and the corrective action taken.

2.4.4.2.3. Results.

a. A total of 2,199 hours was accumulated with the shelter in the erected state.

b. A total of 59 missions were attempted during the test, and two mission failures occurred. The first failure occurred at 102 cumulative erected hours. The zipper on the intermediate shelter wall which contained the APU and heater sleeves came apart during shelter striking at an ambient temperature of 0^{o}F. This occurred after a freezing rain test of 5 hours duration during which approximately 1/4 inch of ice accumulated on the shelter. The entire rear wall of the shelter was replaced due to the broken zipper. (Appendix I, Fig 9).

c. The other mission failure occurred at 174 cumulative erected hours. This failure consisted of simultaneous zipper failures on the other three walls of the shelter and was discovered during operations at -65^{o}F. Ice accumulation was still present from the earlier freezing rain test. This shelter is the same one that suffered the earlier zipper failure. It had been installed over the aft rotor head during the test. The entire shelter was returned to USANLABS, and a new shelter was subjected to the test.

d. Although two mission failures occurred during the test, the second failure was not considered chargeable for reliability analysis purposes. It is believed that the second set of zipper failures occurred due to failure to dry the shelter, in accordance with instructions, prior to re-erecting it. The shelter was not dried properly because it was necessary that testing in the climatic laboratory at that time continue due to other tests being conducted concurrently.

e. For statistical analysis purposes, the exponential distribution was hypothesized. With only one chargeable mission failure occurring, the test results were insufficient to challenge this hypothesis; therefore, based on one chargeable mission failure in 2,199 erected hours, a point estimate of the mission MTBF is 2,199 hours. It may be stated with 80-percent confidence that the MTBF is between 565 and 20,844 hours, inclusive. Since the point estimate exceeds the minimum acceptable level of 800 hours, it is concluded that the required reliability was achieved.

TABLE B.

Mission Hours	No. of Missions Scheduled	No. of Missions Accomplished	Scheduled Hours	Accomplished Hours
6	21	21	126	126
24	20	18*	480	480
48	10	10	480	480
72	5	5	360	360
120	1	1	120	120
240	1	1	240	240
336	1	1	336	336
	59	57	2142	2142
				57**
				2199

*Two mission failures.

**Accumulated during modification and demonstration.

2.4.4.3. Repair Kits.

2.4.4.3.1. Criteria.

a. Organizational maintenance: Systematic inspection, care and service to maintain the shelter in serviceable condition. Repair of the shelter and components will be accomplished by an unskilled individual within the capabilities furnished by components and material available in a repair kit. Repair will be simple and easy to accomplish and will not exceed a maximum of 2 hours to accomplish. Depending upon design and construction of the shelter, simple component part replacement may be made. Repair kits with instructions and supplies will be furnished with each shelter. Precautionary instructions should be included in repair kits regarding any hazardous materials to be used...(MN(ED), para 5(a)).

b. Direct Support/General Support Maintenance: The level of maintenance performed on the shelter is the same at General Support as at Direct Support. Selection of DS or GS is based on workload and proximity. Maintenance support will include: overhaul of the shelter body; replacement of Velcro fasteners; replacement of snap fasteners; repair/replace guy ropes and tie ropes; and other major repairs. Determination will be made on economical repair or need for item replacement. Repair units will be forwarded to supply for subsequent reissue. Non-repairable or uneconomically repairable items will be subject to disposal. Repair or renovation will be capable of completion within 8 hours of active work effort. No new or unusual maintenance requirements will be imposed. (MN(ED), para 5 b).

2.4.4.3.2. Method.

a. The parts provided for the proposed repair parts kit were inventoried prior to test commencement.

b. All repair parts used during the test were recorded as follows: nomenclature, FSN, related maintenance action, sequence number, maintenance level prescribed and recommended, part life, if replacement was scheduled or unscheduled, and the reason for replacement at all echelons of maintenance. Repair parts were compared with parts replaced for determining their interchangeability, compatibility, and ease of installation and adjustment. Parts were examined to determine whether they could be replaced by parts presently in the logistical system. Unskilled personnel were utilized to perform maintenance on the shelter.

2.4.4.3.3. Results.

a. A list of repair parts provided in repair kits is included in Appendix K. All parts listed were included in the repair kit except individual sized patches.

b. The following problems were noted while using the maintenance repair kit provided with each shelter:

(1) The adhesive provided with the kit required excessive time to cure (48 hours) and had no adhesive characteristics at temperatures of $-25^{o}F$ to $-65^{o}F$.

(2) The needle in the repair kit was too large for the fabric and thread.

(3) The sewing palm was very stiff, and could not be adjusted to different hand sizes.

(4) The different patch sizes called for in the maintenance kit were not included in two of the four repair kits. However, five yards of patching material was included in each kit, thereby negating the requirement for individual size patches to be included in each repair kit.

(5) The sheath for the shears should be sewn into the kit to avoid loss or detachment.

c. The following items were required but not furnished with the repair kit:

(1) Hook, spring snap which holds the guy ropes to the shelter (6 each).

(2) Throw-away brushes to apply adhesive (12 each).

(3) Zipper runners (12 each).

(4) Webbing for connecting rings.

(5) A metal end in the sheath to house the shears.

(6) Bolts, base plate (4 each).

(7) Cover with blunt end to cover the pitot tube.

2.4.4.4. Maintenance Operations, Human Factors.

2.4.4.4.1. Criteria.

a. The design shall adhere to the essential principles of human factors engineering and the man/item relationship must be adequate for effective maintenance operations. The design of the shelter shall include consideration of factors that affect human performance. (AR 71-6, App D; AR 70-10, para 1-5k; AMCP 706-134, Chap 4, 9, 12, 17, and 31; and MIL-STD-1472A).

b. Adequate space for man, his equipment, and free volume for the movements he is required to perform during operation and maintenance tasks under both normal and emergency conditions. (MIL-STD1472A, para 4.4(d)).

c. Design features to assure rapidity, safety, ease and economy of maintenance in normal, adverse, and emergency maintenance environments. (MIL-STD-1472A, para 4.4(m)).

2.4.4.4.2. Method.

a. All maintenance of the shelter was observed and any physical discomfort experienced by the maintenance personnel that was conducive to error, injury, or delay was recorded.

b. An inspection of the shelter was conducted during the initial erection to determine whether conditions existed that would render the shelter unsuitable for test personnel to utilize.

c. Human performance reliability was evaluated in terms of frequency and consequence of human errors committed while packaging, erecting, using, and striking the shelter. The following test functions were evaluated to include the consequence of the errors and the conditions under which they occurred:

(1) Operability. The adequacy of the man/item combination to perform in conformance with requirements, including, but not limited to, shelter components and procedures required for:

a. Item setup.

b. Connection with other components.

c. Operational checkout.

d. Adjustments and tightening.

e. Ingress and egress.

f. Performance of required function.

g. Accommodation of shelter and operator to various operating conditions.

h. Adequacy of instructional documents and labels.

(2) Maintainability. The effectiveness of the man/item relationship during the performance of maintenance, including, but not limited to, the components and procedures required for:

a. Ease of operations.

b. Detection of malfunctions.

c. Removal, repair, and replacement of components.

d. Adequacy of instructional documents and labels.

(3) Transportability. The human factors aspects which pertain to transporting the shelter, including, but not limited to, the testing of components and procedures for:

a. Preparation of the shelter for transport (packing, removal of projections, and fastening down of loose elements).

b. Attaching of cables, hooks, etc., to shelter.

c. Pushing, sliding, hoisting, or lifting the shelter.

d. Typing down or securing the shelter in the carrier vehicle.

e. Adequacy of instructions and labels.

(4) Erectability. The adequacy of the shelter for assembly under field conditions, including, but not limited to, the shelter components and procedures required for:

a. Pre-erection alignment of parts.

b. Assembly of components.

c. Sealing of joints.

d. Testing of shelter integrity after erection.

e. Disassembly of shelter after use.

f. Adequacy of instructions, diagrams, and labels.

2.4.4.4.3. Results.

a. There were no physical discomforts to the mechanics performing maintenance on the shelter.

b. The shelter inspection did reveal one condition that did render the shelter unsuitable for personnel to use. Working

space was not sufficient around combining transmission and engine areas which resulted in shelter modifications to allow adequate working space. (Appendix I, Fig 10).

c. The following are results of significant findings of test functions that were evaluated:

(1) Operability.

a. Item setup - satisfactory.

b. Connection with components - satisfactory.

c. Operational checkout - satisfactory.

d. Adjustment and tightening - satisfactory.

e. Ingress and egress - satisfactory.

f. Performance of required function - satisfactory after modification of the shelter. (Subtest 2.4.1.).

g. Accomodation of shelter and operator to various operational conditions - satisfactory after modification of the shelter.

h. Adequacy of instructional documents and labels - not completely satisfactory. Revisions to the operating instructions were required.

(2) Maintainability.

a. Ease of maintenance - satisfactory; however, only limited organizational maintenance was accomplished. (Subtest 2.4.4.).

b. Detection of malfunctions - satisfactory.

c. Removal, repair, and replacement of components. Removal and replacement of components were satisfactory. Repair, such as patching, was not difficult; however, the adhesive provided required 48 hours of dry weather conditions to properly cure. A cold weather contact adhesive that would cure in less time would enhance this repair action.

d. Adequacy of instructions and labels - not satisfactory. Revisions to instructions were required (Para 2.4.4.5.).

(3) Transportability.

a. Preparation of the shelter for transport (packaging, removal of projections, and fastening down of loose elements) - satisfactory.

b. Attachment of cables, hooks, etc., to shelter - satisfactory.

c. Pushing, sliding, hoisting, or lifting the shelter - satisfactory.

d. Adequacy of instructions and lables - satisfactory.

e. Tieing down or securing the shelter in the carrier vehicle - satisfactory.

(4) Erectability.

a. Pre-erection alignment of parts - satisfactory.

b. Assembly of components - satisfactory.

c. Sealing of joints - satisfactory.

d. Testing of shelter integrity after erection - satisfactory.

e. Disassembly of shelter after use - satisfactory.

f. Adequacy of instructions, diagrams, and labels - not satisfactory. Instructions and diagrams required revision.

2.4.4.5. Equipment Publications.

2.4.4.5.1. Criteria. The equipment publications contained in the maintenance test package shall be complete, accurate, easy to ready, consistent in nomenclature, simple to follow, and adequate to complete both scheduled and unscheduled maintenance operations and parts acquisition at all levels of maintenance..... ....(AR 750-1, para 2-9, 2-23 and 2-26).

2.4.4.5.2. Method.

a. The maintenance instructions contained in the maintenance package were reviewed for simplicity, clarity, and completeness. Terminology and nomenclature were evaluated for conformity. An evaluation of the adequacy of personnel and equipment safety instructions was made. Diagrams and illustrations were examined for accuracy and completeness. Inadequacies in the publications were reported.

b. Maintenance operations performed were monitored and observed to determine whether the instructions were adequate and whether the sequence of operation was properly detailed for the level of training possessed by appropriate maintenance personnel.

c. Maintenance package literature charts were prepared.

2.4.4.5.3. Results.

a. Numerous minor wording changes to the draft manuals were recommended to enhance clarity, especially pertaining to the erecting and striking procedures for the shelter. An informal In-Process Review was held at the USAAVNTBD on 26-28 Feb 74. At this time all recommended changes from test agencies, as well as the test sponsor, were reviewed, consolidated, and provided to the US Army Aviation Systems Command representative for revision of the manuals.

b. The maintenance package literature chart is contained in Appendix L, Page 10.

2.4.4.6. Shelter Maintenance Safety.

2.4.4.6.1. Criteria. Unsafe characteristics involving maintenance of the shelter will be identified.

2.4.4.6.2. Method. Safety aspects of shelter maintenance were evaluated throughout the test.

2.4.4.6.3. Results. There were no hazards observed while personnel were maintaining the shelter.

2.4.5. SPECIAL TOOLS AND SHELTER STORAGE REQUIREMENTS.

2.4.5.1. Tools and Test Equipment.

2.4.5.1.1. Objective. To determine whether the tools and equipment authorized in the using unit are sufficient to maintain the shelter.

2.4.5.1.2. Criteria. Additional tools or special equipment for maintaining the shelter will not be required.

2.4.5.1.3. Method. The shelter was maintained using tools and equipment available to the testing unit.

2.4.5.1.4. Results.

a. Additional tools and equipment, other than those contained in the repair kit were not required to maintain the shelter. (Appendix K, Part 3) (Para 2.4.5.1.)

b. The tools and test equipment chart is contained in Appendix L, Part 3.

2.4.5.2. Shelter Storage.

2.4.5.2.1. Objective to determine the cubic feet of storage space requirement.

2.4.5.2.2. Criteria. The burden of extra storage space will not be excessive.

2.4.5.2.3. Method. Each shelter package was weighed and measured to determine total weight and volume.

2.4.5.2.4. Results. The shelter consisted of four packages. Their weight and volumes were:

PACKAGE	WEIGHT (LB)	DIMENSIONS	VOLUME (CU FT)
Shelter Side Walls	141	3'5"x1'5"x2'5"	11.7
Repair Kit	26	1'4"x1'4"x8"	1.2
Anchor, Tiedown, Ropes	160	3'3"x1'3"x1'2"	4.9
Top, shelter section	71	6'5"x1'4"x11"	8.1
TOTAL	398		25.9

The shelter will require 25.9 cubic feet of inside storage space.

2.4.6. TESTING FOR OT I SHORTCOMINGS AND DEFICIENCIES

No OT I was performed on the shelter.

3. References.

a. Army Regulation 70-38, "Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions, " 5 May 1969.

b. "Department of the Army Approved Materiel Need (Engineering Development) (MN (ED)) (SDR) for Emergency Repair Shelter for the CH-47 Helicopter, CDOG Paragraph 169n(16)," 19 June 1972, with Change 1, 7 February 1973.

c. "Draft Coordinated Test Program (CTP) for Emergency Repair Shelter for the CH-47 Helicopter," undated U.S. Army Natick Laboratories.

d. Outline Test Plan for Operational Test II (OT II) 10 Sep 73, revised 8 Apr 74, U.S. Army Aviation School.

e. Final Report, "Methodology Investigation, Simulation Testing of Emergency Repair Shelter," TECOM Project No. 9-CO-00E-000-015, U.S. Army Aviation Test Board, June 1974.

f. Army Regulation 71-6, "Type Classification/Reclassification of Army Materiel," 20 November 1969.

g. Army Regulation 70-10, "Test and Evaluation During Development and Acquisition of Materiel," July 1971.

h. Army Regulation 750-1, "Army Materiel Maintenance Concepts and Policies" May 1972.

i. Military Standard 882, "System Safety Program for Systems and Associated Subsystems and Equipment" Requirement for" 15 July 1969.

j. Military Standard 1472A, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities," 15 May 1970.

k. U.S. Army Test and Evaluation Command R gulation 750-15, "Maintenance of Supplies and Equipment," 1 December 1969.

l. Letter, Interim Guidance for Operational Testing, 5 June 1974, TRADOC.

4. GLOSSARY OF TERMS AND ABBREVIATIONS.

a. A_a - Achieved availability

b. ACN - Action control number

c. APP - Appendix(es)

d. APU - Auxiliary power unit

e. AR - Army Regulation

f. CTP - Coordinated Test Program

g. OTP - Outline Test Plan

h. OT II - Operational Test II

i. Cu ft - Cubic foot (feet)

j. D.S. - Direct support

k. EPR - Equipment performance report

l. F - Fahrenheit

m. Fig - Figure

n. GS - General support

o. lb - Pound

p. MIL-STD - Military Standard

q. MN(ED) - Material Need (Engineering development)

r. MOS - Military occupational speciality

s. MR - Maintenance ratio

t. MTBF - Mean time between failure

u. MTP - Material test procedures

v. MTTR - Mean time to repair

w. No - Number

x. Para - Paragraph

y. RDTE - Research, development, test, and evaluation

z. Ref - Reference

aa. SDR - small development requirement

bb. USANLABS - US Army Natick Laboratories

SECTION IV APPENDICES

5. Appendices

   A. OTP

   B. Troops, support and resources required

   C. Schedule of major test events

   D. Environment factors

   E. Test date tabulations

   F. Pre-test training

   G. Test Budget and actual cost

   I. Photographs

   J. Test findings

      1. Test criteria

      2. Deficiencies and shortcomings

   K. Repair Kit Contents

   L. Maintenance Evaluation

      Part 1. Maintenance analysis

      Part 2. Parts analysis

      Part 3. Special Tools and Test Equipment

   M. Distribution List

A. OUTLINE TEST PLAN (OTP)

DATE: 10 Sep 73

REVISED: 8 Apr 74

TEST TITLE: Emergency Repair Shelter for the CH-47 Helicopter Operational Test II

TEST TYPE: Operational Test II (OT II)

TEST PROPONENT: The U. S. Army Training and Doctrine Command (TRADOC).

TEST SUPPORT UNIT: The U. S. Army Aviation Center (USAAVNC).

TEST ACTIVITY: Test and Evaluation Division, Deputy for Developments, U. S. Army Aviation Center will conduct a combined OT II/DT II with the U. S. Army Aviation Test Board.

TEST UNIT: No TOE unit, per se, will be utilized during OT II. Personnel will consist of the same personnel being utilized in the ST Phase of DT II.

DA STAFF PROPONENT: DAFD-AV.

TEST LOCATION: U. S. Army Aviation Test Board, Fort Rucker, Alabama.

TEST DATES: Oct 73 through March 74.

1. REFERENCES:

a. DA Approved Materiel Need (Engineering Development) (MN(ED)) (SDR) for Emergency Repair Shelter for the CH-47 Helicopter CDOG Paragraph 169n(16)

b. AR 70-10 (DRAFT)

c. AR 71-6 Oct 72

2. PURPOSE: To evaluate the military worth of the shelter in aiding personnel making emergency repairs on the CH-47 under all weather, day/night and under any climatic conditions that may be encountered where the CH-47 may be deployed.

3. OBJECTIVES:

a. Objective 1: To determine the operational suitability of the shelter.

1.1: To determine what emergency repairs can be conducted utilizing the shelter.

1.2: To determine if any special tools or equipment are required to erect the shelter.

1.3: To obtain data for reliability and maintainability characteristics.

b. Objective 2: To determine training and safety requirements.

c. Objective 3: To estimate the additional burden placed on a using organization in terms of special tools and storage requirements.

4. SCOPE AND TACTICAL CONTEXT:

a. Scope: OT II will determine if the emergency repair shelter is adequate to perform emergency repairs on the CH-47. Test results will be used to determine if the system fulfills the purpose and operational characteristics of the DA Approved (MN(ED)).

b. Tactical Context: The tactical setting for OT will be typical of an emergency field repair site. Personnel will be the minimum number required to perform emergency repairs in a field situation. The methodology used is to be determined.

5. TEST RESOURCE REQUIREMENTS:

a. Test Directorate:

(1) Personnel Requirements:

Position	Grade	Qualification	Number	Inclusive Dates	Source
Deputy Test Director	LTC/MAJ	CH-47 Qual Aviator	1	2-4Q74	USAAVNS T & E Br
Evaluator	MAJ/CPT WO/GS	"	1		"

(2) Special Equipment Requirement. No requirement in addition to DT II requirements.

b. Player Participants. No requirement for this test.

c. Test Facilities/Base Operations Support. None required.

d. Items to be Tested. No requirement in addition to DT II requirements.

e. Data Collection, Processing, and Analysis. No requirement in addition to DT II requirements.

f. Ammunition, Missiles, and Pyrotechnics. None.

g. Other Resource Requirements. No requirement in addition to DT II requirements. No POL requirements in addition to those for DT II.

6. TEST MILESTONES:

a.	Outline Test Plan OT II	Sep 73
b.	Detailed Test Plan DT II/OT II	Sep 73
c.	Start DT II/OT II Testing	Oct 73
d.	Complete DT II/OT II Testing	May 74
e.	Final OT II Report of Test	Jul 74
f.	IPR	Oct 74

7. COST SUMMARY:

	FY 76
OMA	0*
RDTE	0
PEMA	0
TOTAL	$0,000

* Since this test is to be conducted at the USAAVNTBD, Ft Rucker, AL, there will be no cost for conduct of OT.

8. POINTS OF CONTACT:

Agency	Mailing Address	Location	Autovon
Natick Labs (Mr. Donald B. Shaw)	General Equipment and Packaging Laboratory Natick, MA 01760	Natick Laboratories Natick, MA	995-2523
USAMC (Mr. Dave Hillman)	USATECOM Avn Test Directorate	St. Louis, MO	870-5102/4971
USAAVNTBD (Mr. Paul Brand)	President US Army Avn Test Bd ATTN: STEBG-PO-O Ft Rucker, AL 36360	Ft Rucker, AL	558-6112/4418

Agency	Mailing Address	Location	Autovon
USAAVNS (CPT Loel Ewart)	USAAVNS Deputy for Developments D435 Fort Rucker, AL 36360	Ft Rucker, AL	558-2405/5805
TRADOC LTC Haaland	TRADOC ATTN: ATCD-CM Ft Monroe, VA 23351	Ft Monroe, VA	680-4243

TEST COST ESTIMATE

DATE PREPARED: 16 Nov 73

TEST CH-47 Emergency Repair Shelter OT II OTP DATED: 9 Oct 73

TEST LOCATION: Fort Rucker, Alabama

Fund requirements reflected below provide for direct costs to conduct the test. Estimates are based upon and provide funds to support only those resource requirements stated in paragraph 5 of the associated Outline Test Plan.

CATEGORY OF COST	APPN	FY 75	FY	FY
1. TEST DIRECTORATE	OMA	0		
2. PLAYER PARTICIPANTS	OMA	0		
3. BASE OPERATIONS SUPPORT/TEST FACILITIES	OMA	0		
4. * SUPPORT OF ITEMS TO BE TESTED.		0		
(IF APPLICABLE).				
5. TEST DATA COLLECTION/ANALYSIS				
a. Purchase of Instrumentation/Equip		0		
b. Other (Equip Rental, Contract Spt)	OMA	0		
6. OTHER COSTS				
a. Pretest Training	OMA	0		
*b. Simulators, Targets & Special Equip		0		
c. Contract Studies of Tech Support	OMA	0		
d. Photographic Support	OMA	0		
*e. Other		0		
7. TOTALS				
a. OMA		0		
b. RDTE		0		
c. PA		0		
d. GRAND TOTAL		0		

B. Troops, Support and Resources Required.

NONE

C. Schedule of Major Test Events.

EVENT	DATE
1. Climatic Hangar Test	1-30 Nov 73
2. Wind Test	1-30 Nov 73; 18,19, Jun 74
3. Blackout Test	12 Jun 74
4. Striking and erecting	1 Nov 73 - 30 Jun 74

D. Environment Factors.

NONE

E. Test Date Tabulations.

NOT APPLICABLE

F. Pre-Test Training.

NONE REQUIRED

G. Test Budget and Actual Cost

Elements	OMA (in thousands $) Test Budget	Actual Cost
(1) Test Directorate	1.61	0
(2) Player participants, operations, and maintenance	2.52	0
TOTAL	4.13	

H. Instrumentation Employed.

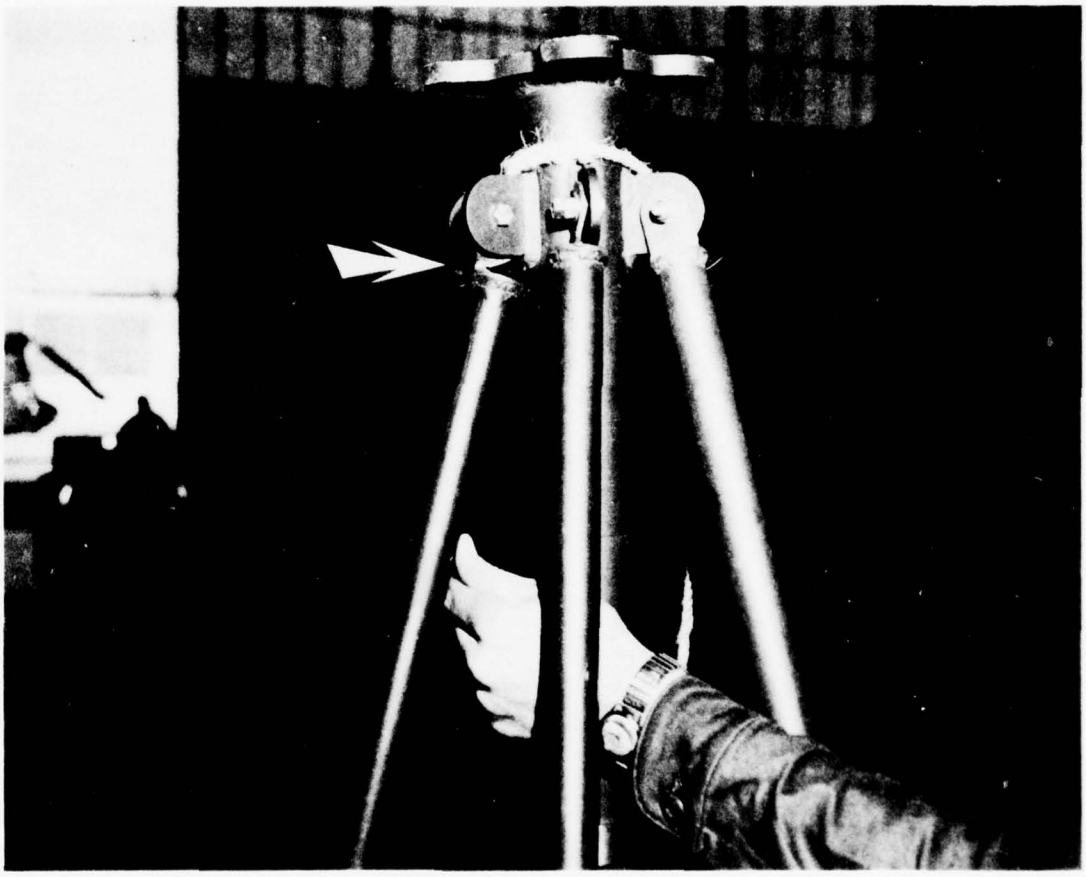
1. Wind machine - wind measuring device (windspeed)
2. Temperature probes
3. McKinley Climatic Laboratory (Eglin AFB, FL)
4. Stop watch
5. Weighing scales
6. Tape measuring device (in feet)
7. Blackout test - flashlights

I Photo

ZIPPER FAILURE ON ICE FROZEN SHELTER

Figure 1

I Photo



SHELTER TOP RIB FRAME BROKEN ATTACHMENT POINT

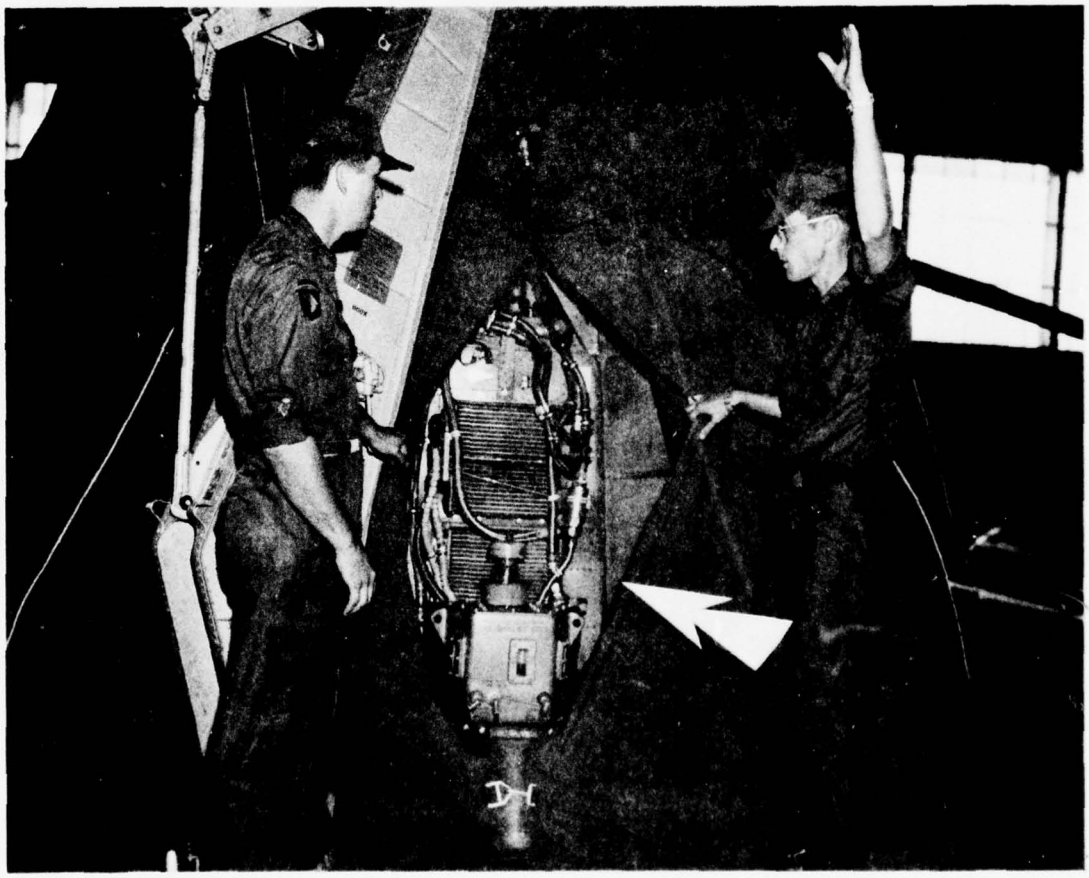
Figure 2

I Photo

CLOSE FIT OF SHELTER TO AIRFRAME

Figure 3

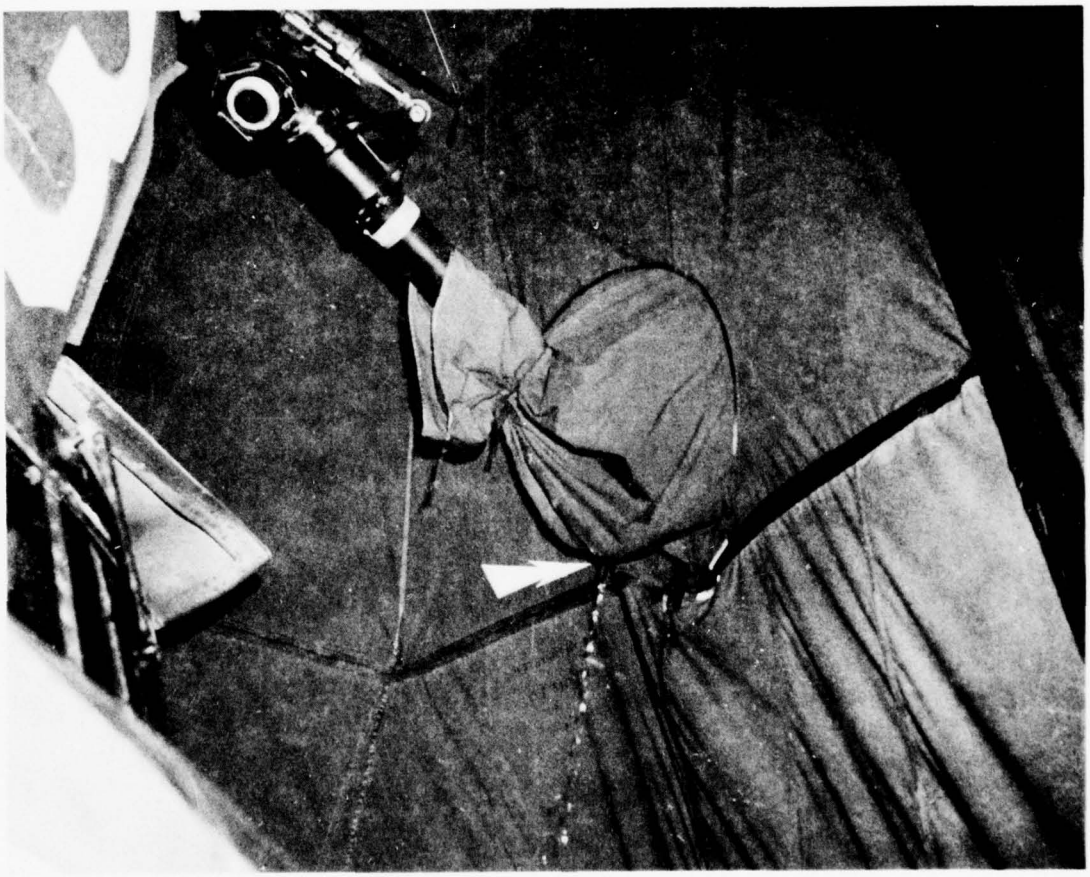
I Photo



UNMODIFIED AFT SHELTER AT MIDCASE AREA

Figure 4

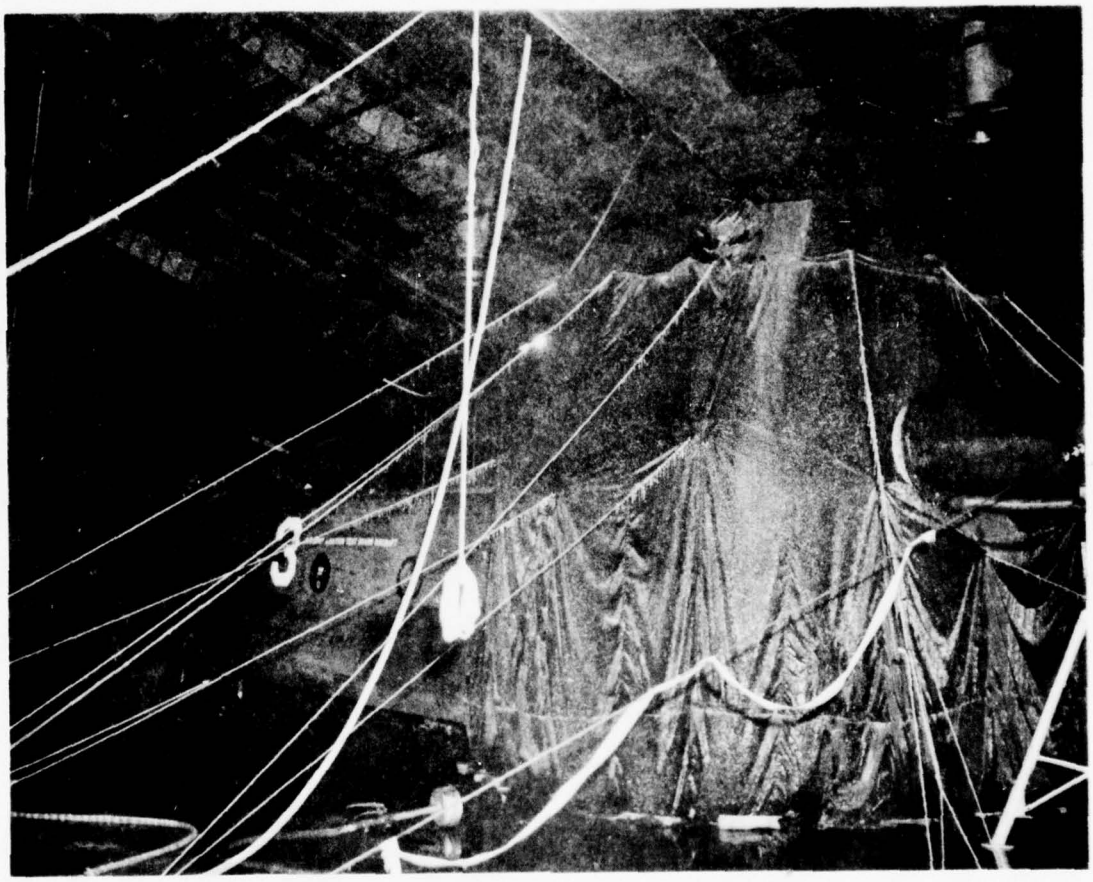
I Photo



WATER LEAK AROUND BLADE OPENINGS

Figure 5

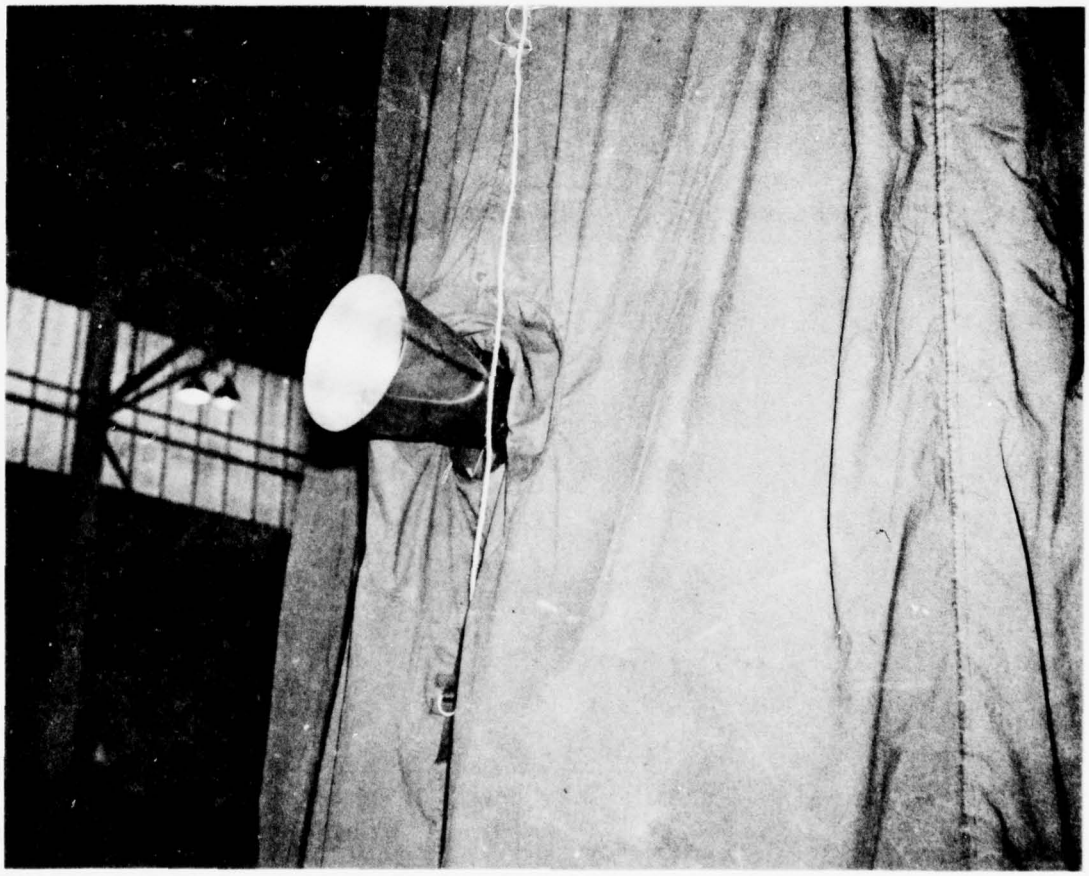
I Photo



ICE TEST OF FRONT AND REAR SHELTERS

Figure 6

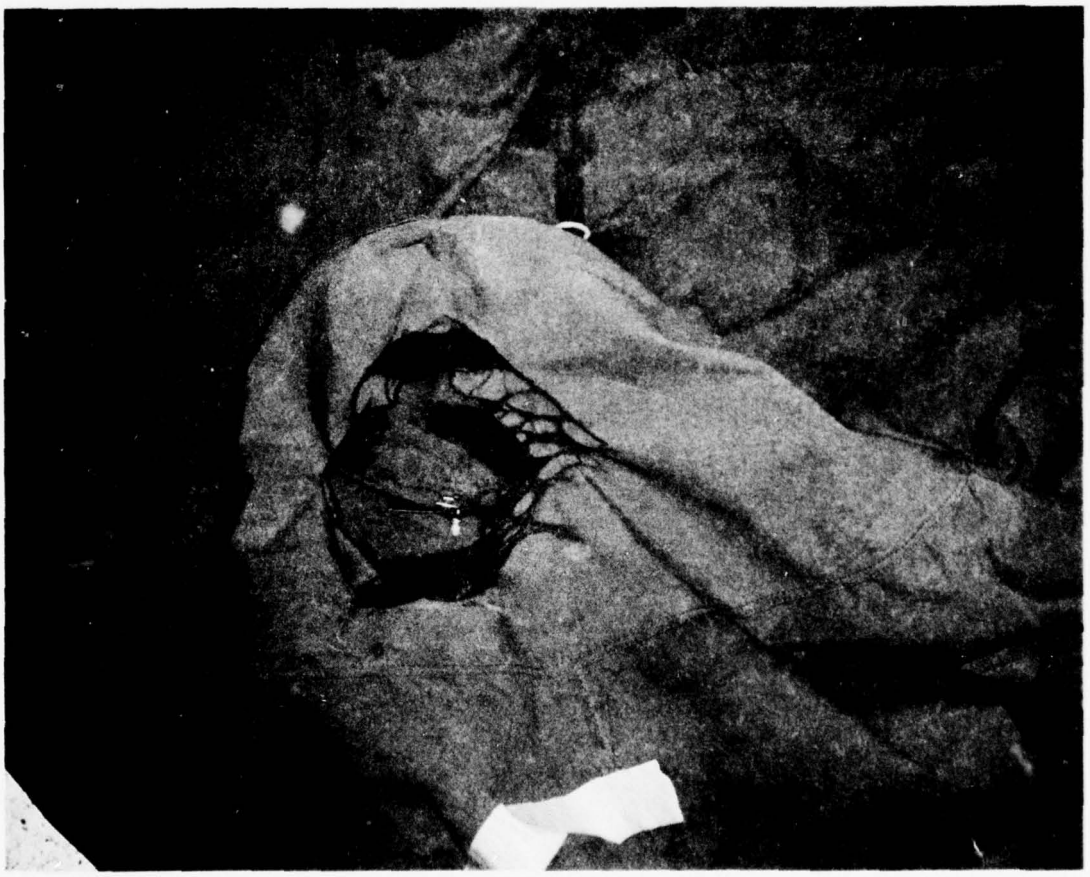
I Photo



APU EXHAUST THROUGH AFT TENT WALL

Figure 7

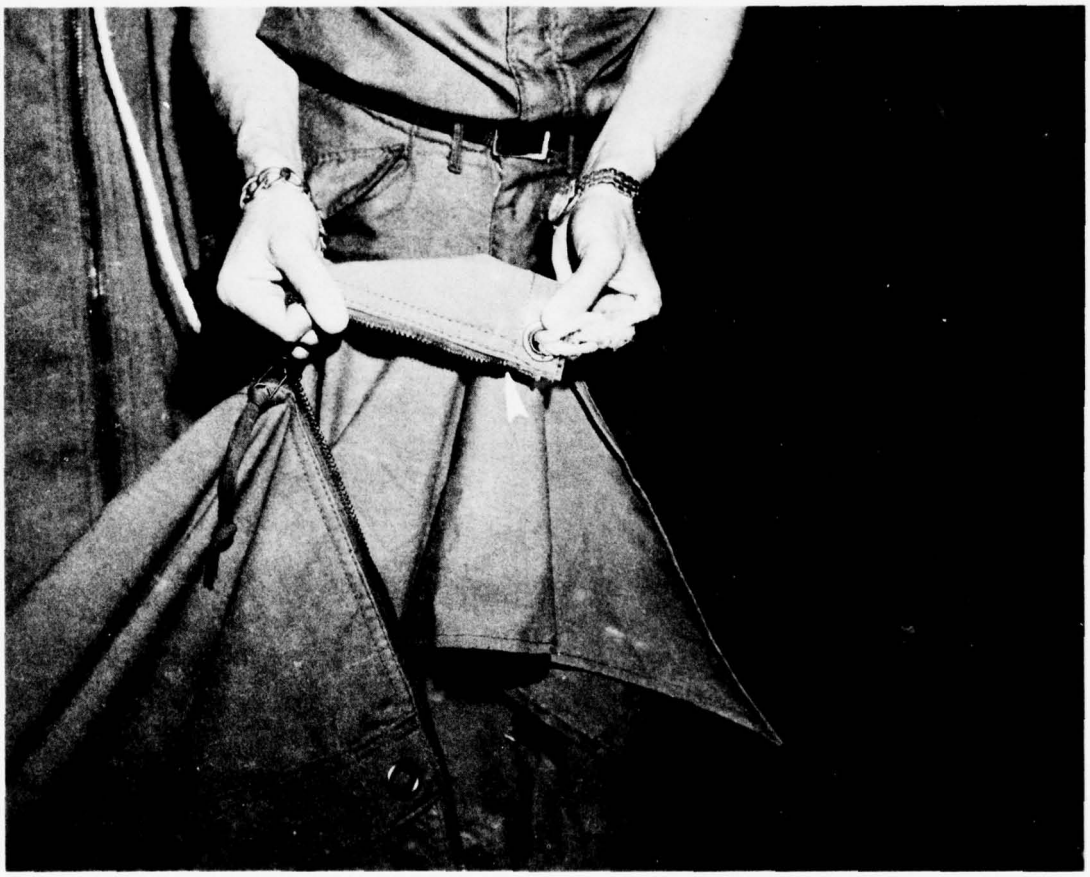
I Photo



CHARRED CANVAS AROUND APU EXHAUST

Figure 8

I Photo



CANVAS ZIPPER FAILURES

Figure 9

I Photo

MODIFIED REAR SHELTER

Figure 10

I Photo

SHELTER TOP FRAME CANVAS RIPPED AT SEAM

Figure 11

J. TEST FINDINGS

1. TEST CRITERIA

ITEM	SOURCE	CRITERIA	APPLICABLE SUBTEST PARA	REMARKS
1	MN(ED) para 2c(1)	Shelter fabric (shall be) lightweight, water-resistant, . . . and impervious to fluid damage, i.e., hydraulic fluid, fuel, grease and oil.	2.4.1.1	MET: See paragraph 2.4.1.1.3, a, e
2	MN(ED, para 2c(2)	Reinforcement must be provided at stress areas.	2.4.1.1	NOT MET: Top shelter section tore at seam. Zipper and top shelter frame failed during test. See paragraph 2.4.1.1.3, a, c
3	MN(ED), para 2c(3)	The shelter must have a lightweight, telescopic frame to support the shelter against the environmental conditions described herein. . .	2.4.1.3	MET: See paragraph 2.4.1.3.3, a, c
4	MN(ED), para 2c(3)	The shelter. . . must permit maximum accessibility to all pylon components. The frame must also provide a minimum of 4 feet above the rotor head to permit, as nearly as practicable, unrestricted use of the maintenance davit outside the shelter.	2.4.1.2	MET: See paragraph 2.4.1.2.3, a, g
5	MN(ED), para 2c(4)	. . . (Shelter) openings must be of sufficient size to allow for blade removal.	2.4.1.2	MET: See paragraph 2.4.1.2.3, d, e
6	MN(ED), para 2c(4)	The shelter must provide openings for positioning around the rotor blades. . .	2.4.1.2	MET: See paragraph 2.4.1.2.3, d
7	MN(ED), para 2c(5)	The shelter must have a means of closing the vertical portion of the shelter that extends below the rotor blades.	2.4.1.2	MET: See paragraph 2.4.1.2.3, e

ITEM	SOURCE	CRITERIA	APPLICABLE SUBTEST PARA	REMARKS
8	MN(ED), para 2c (6)	The shelter must be equipped with a vent to accept an external heat source and designed, or provided instructions, to prevent the exhaust gases from the external heat source from being drawn into the tent.	2.4.2.1.	MET: See paragraphs 2.4.2.1.2, a and 2.4.2.1.3, a.
9	MN(ED), para 2c(7)	The shelter must be equipped with a ventilation flap.	2.4.2.1.	MET: See paragraph 2.4.2.1.3, b
10	MN(ED), para 2c(9)	Two air intake openings must be positioned to coincide with the two integral air inlets located on the right rear of the helicopter approximately seven feet up from the bottom of the fuselage.	2.4.2.1.	NOT MET: See paragraph 2.4.2.1.3, c
11	MN(ED), para 2c(9)	The rear of the shelter must be equipped with an exhaust vent to accommodate the exhaust port of the auxiliary power unit located on the rear of the aft pylon approximately 7 feet 8 inches above the lowest point of the fuselage. This exhaust vent should be approximately 1 ½ times the diameter of the APU exhaust and should be equipped with mating fasteners that can be affixed to the helicopter to secure the vent in position. Non-flammable material must be used around the immediate area of the APU exhaust.	2.4.2.1.	MET: See paragraph 2.4.2.1.3, d
12	MN(ED), para 2c(10)	The shelter, when mounted over the pylon areas, must be configured to conform to the shape of the fuselage of the helicopter at a sufficient distance forward of the point of attachment of the maintenance davit to the fuselage to permit operation of the davit. This opening must be equipped with a restraining device to permit tightening around the fuselage.	2.4.1.2.	MET: See paragraph 2.4.1.2.3, f

ITEM	SOURCE	CRITERIA	APPLICABLE SUBTEST PARA	REMARKS
15.	MN(ED) para 2c(15)	The shelter, by repositioning, must afford equal protection to a mechanic working on the forward and aft rotor heads and pylons.	2.4.1.3.	MET: See paragraph 2.4.1.3.3, b
16.	MN(ED), para 2c(15)	The shelter . . . . .and provide vent for the on-board heater, intake, and exhaust located in the vicinity of station #120.	2.4.2.1.	NOT MET: See paragraph 2.4.2.1.3, e
17.	MN(ED), para 2c(17)	The shelter must be capable of being blacked out to the extent that the light from a standard two-cell flashlight may not be seen from a distance of 1,000 meters when the light source is a minimum distance of 2 feet from inside wall of the shelter.		MET: See paragraph 4.2.1.2.3, b
18.	MN(ED), para 2c(18)	Total weight of the shelter to include fabric, mast, anchor ropes, guy ropes, and fasteners must not exceed 300 lbs. with the heaviest component not weighing more than 50 lbs.	2.4.1.2.	NOT MET: See paragraph 2.4.1.2.3, c
19.	MN(ED), para 2c(19)	Packaged configuration of the shelter must be such that it can be transported internally in a utility helicopter.	2.4.1.4.	MET: See paragraph 2.4.1.4.3, a
20.	MN(ED), para 2c(20)	The shelter must be capable of withstanding winds up to 40 knots when erected.	2.4.1.1.	MET: See paragraph 2.4.1.1.3,b and 2.4.1.3.3, c

ITEM	SOURCE	CRITERIA	APPLICABLE SUBTEST PARA	REMARKS
		The reaction times for operation in (temperate) climatic categories . . . with personnel wearing appropriate environmental clothing are:		
21.	MN(ED), para 2f(1)	Unpaking, assembly of components, and erecting the shelter shall not exceed 1½ hours for four men.	2.4.1.5.	MET; See paragraph 2.4.1.5.3, a
22.	MN(ED), para 2f(2)	Striking the shelter, assembly of components and packing shall not exceed 1½ hours for four men.	2.4.1.5.	MET: See paragraph 2.4.1.5.3, b
23.	MN(ED), para 2g(1)	The MTBF for the shelter shall not be less than 800 erected hours. The specified MTBF is 1,600 erected hours.	2.4.4.2.	MET: See paragraph 2.4.4.2.3, d
24.	MN(ED), para 2g(3) Draft CTP	The shelter shall be suitable for use 6 hours per day for 14 days with organizational maintenance only.	2.4.4.2.	MET: See paragraph 2.4.4.2.3, d
25.	MN(ED), para 2h	Operational ready rate or combat ready rate must be 99%.	2.4.4.2.	MET: See paragraph 2.4.4.2.3, d and 2.4.4.1.4, j
26.	MN(ED), para 3g(1)	There shall be no inherent health hazzards in the materials used for the tent.	2.4.2.1.	MET: See paragraph 2.4.2.1.3, f
27.	MN(ED), para 3g(2)	Design and construction of the tent shall impose no safety risk for erecting, using, and striking the tent.	2.4.2.1.	MET: See paragraph 2.4.2.1.3, g (partially)
28.	MN(ED), para 3g(3)	Shelter to be made of fire resistant material or treated for flame proofing.	2.4.2.1.	MET: See paragraph 2.4.2.1.3, h

ITEM	SOURCE	CRITERIA	APPLICABLE SUBTEST PARA	REMARKS
29.	MN(ED), para 3o	This shelter shall be transportable by organizational cargo vehicles and Army aircraft including sling load.	2.4.1.4	MET: See paragraph 2.4.1.4.3, a
30.	MN(ED), para 5a	Organizational maintenance: Systematic inspection, care, and service to maintain the shelter in serviceable condition. Repair of the shelter and components will be accomplished by an unskilled individual within the capabilities furnished by components and material available in a repair kit. Repair will be simple and easy to accomplish and will not exceed a maximum of two hours to accomplish. Depending upon design and construction of the shelter, simple component part replacement may be made. Repair kits with instructions and supplies will be furnished with each shelter. Precautionary instructions should be included in repair kits regarding any hazardous materials to be used....	2.4.4.3	MET: See paragraph 2.4.4.3.3 a and paragraph 2.4.4.3, c(2)

ITEM	SOURCE	CRITERIA	APPLICABLE SUBTEST PARA	REMARKS
31.	MN(ED), para 5b	Direct Support/General Support Maintenance: the level of maintenance performed on the shelter is the same at G/S as at D/S. Selection of D/S or G/S is based on workload and proximity. Maintenance support will include: overhaul of the shelter body; replacement of Velcro fasteners; replacement of snap fasteners; repair/replace guy ropes and tie ropes; and other major repairs. Determination will be made on economical repair or need for item replacement. Repaired units will be forwarded to supply for subsequent re-issue. Nonrepairable or uneconomically repairable items will be subject to disposal. Repair or renovation will be capable of completion within 8 hours of active work effort. No new or unusual maintenance requirements will be imposed.	2.4.4.3.	MET: See paragraph 2.4.4.3.1, a, b and 2.4.4.3.3, a, b
32.	MN(ED), para 5c	The mean time to repair (MTTR) shall not exceed: Organizational level - 2 hours; DS level - 8 hours; GS level - 8 hours.	2.4.4.1.	MET: See paragraph 2.4.4.1.4, a, b, c, h
33.	MN(ED) para 5d	The ratio of maintenance (MR) man-hours to operating hours shall not exceed 0.01.	2.4.4.1	MET: See paragraph 2.4.4.1.4, i
34.	AR 71-6, app D; AR 70-10, para 1-5k; MIL-STD-1472A	The design shall adhere to the essential principles of human factors engineering and the man-item relationship must be adequate for effective maintenance operations.	2.4.4.4	MET: See paragraph 2.4.4.4.3

ITEM	SOURCE	CRITERIA	APPLICABLE SUBTEST PARA	REMARKS
35	AR 750-1 para 2-9, 2-23, and 2-26; AMCR 750-15, para 23	The equipment publications contained in the maintenance test package shall be complete, accurate, easy to read, consistent in nomenclature, simple to follow, and adequate to complete both scheduled and unscheduled maintenance operations and parts acquisition at all levels of maintenance. (The design of the shelter shall include consideration of human engineering factors that effect human performance including:)	2.4.4.5	Partially met. Numerous minor wording changes to the draft manuals were recommended to enhance clarity. See paragraph 2.4.4.5.3, a
36	MIL-STD-1472A, para 4.4(d)	Adequate space for man, his equipment, and free volume for the movements he is required to perform during operation and maintenance tasks under both normal and emergency conditions.	2.4.4.4	MET: See paragraph 2.4.4.4.3, a, b
37	MIL-STD 1472A, para 4.4(m)	Design features to assure rapidity, safety, ease and economy of maintenance in normal, adverse and emergency maintenance environments.	2.4.4.4	MET: See paragraph 2.4.4.4.3, c
38	USAAVNTBD	Additional tools or special equipment for maintaining the shelter will not be required.	2.4.5.1	MET: See paragraph 2.4.5.1.4, a
39	USAAVNTBD	Unsafe characteristics involving maintenance of the shelter will be identified.	2.4.4.4	MET: See paragraph 2.4.4.4.3
40	OTP OT II	The burden of extra storage space will not be excessive.	2.4.5.2	MET: See paragraph 2.4.5.2.4
41	OTP OT II	Testing for OT I shortcomings and deficiencies.	2.4.6	N/A: See paragraph 2.4.6

2. DEFICIENCIES AND SHORTCOMINGS

a. DEFICIENCY

Deficiency	Suggested Corrective Action	Remarks
Several zippers failed on the side wall shelter during test due to the zippers pulling apart under stress. (Para 2.4.1.1)	Larger zipper would help prevent the zipper from pulling apart under stress, and flap cover would prevent water from entering the zipper and freezing.	Flap covers have been installed.

b. SHORTCOMINGS

Shortcomings	Suggested Corrective Action	Remarks
1. When lowering the No. 1 engine to the engine stand, the shelter wall has to be opened for the davit to swing out properly. There is insufficient space inside the shelter between the helicopter and shelter wall for the engine stand without opening the shelter wall. (Para 2.4.1.2)	The right shelter wall could be enlarged 3 feet for proper clearance in lowering engine and for engine stand space.	
2. The rib frame bent at the top and bottom points where it attaches to the center pole on the shelter top. (Para 2.4.1.1.3, d)		Modifications were made to strengthen the frame. Four erecting and striking operations were made without any difficulties.
3. An exhaust vent for the helicopter's onboard heater was not provided on the shelter. (Para 2.4.2.1)	An exhaust vent should be added for the onboard shelter.	
4. The total weight of the repair shelter exceeded the MN requirements by 98 lbs. with the heaviest package weighing 71 lbs.	Reduce the total weight of the shelter and individual packages to meet the MN requirements.	

c. CORRECTED DEFICIENCIES AND SHORTCOMINGS

Deficiency/Shortcoming	Corrective Action	Remarks
1. The work area around the combining transmission and engine transmission was restricted. (Para 2.4.1.2.3)	The shelter was modified with an add-on shelter to satisfy this requirement. Design drawings have been revised accordingly.	
2. The shelter external heater duct opening was too small for installing the external heater ducting. The tie straps were too short. (Para 2.4.2.1.2)	Heater duct sleeves were enlarged to accept the 12-inch diameter air hose. The tie straps were lengthened so that the sleeves could adequately be tied.	
3. An opening was not provided for maintenance davit cable into the shelter without opening the shelter wall. (Para 2.4.1.2.3)	The shelter was modified to provide an entrance for the maintenance davit cable into the shelter for removal of an engine. The design drawings will be revised accordingly.	

k. Repair Kit Contents
(Subtest 2.4.4.3)

CONTENTS	QUANTITY
Beeswax, Technical	½ Pound
Cloth, Duck, Cotton, OD, 12.29 ounce, FWWMR, 29 in.	5 Yards
Brommet, Metallic, Black Chemical Finish, Rolled Tim W/Washer, Spur Type, No. 4 (In Bag)	75 Each
Grommet, Metallic, Black Chemical Finish, Rolled Rim W/Washer, Spur Type, No. 5 (In Bag)	75 Each
Mallet, Rawhide, 2 3/4-Inch Face	1 Each
Manual, TM-10-633, Canvas Repair Kit	1 Each
Palm, Sewing	1 Each
Patch, Tent, 3-Inch	150 Each
Patch, Tent, 4 3/8-Inch	50 Each
Patch, Tent, 6½-Inch	25 Each
Punch and Die, Inserting, Spur Grommet No. 4 (In Bag)	1 Set
Punch and Die, Inserting, Spur Grommet No. 5 (In Bag)	1 Set
Rings, Connecting, Round, Galvanized, ½-Inch (In Bag)	50 Each
Rings, Connecting, Round, Galvanized, 3/4-Inch (In Bag)	25 Each
Rings, Connecting, Round, Galvanized 1-Inch (In Bag)	10 Each
Sling, Carrying, Bag and Case	1 Each
Slip, Tent Line, Magnesium Casting	10 Each
Twine, Cotton, Wrapping, 5-Ply, ½ Pound Ball, MRT	2 Each
Thread, Polyester, Type I or II, Class 1, Size FF	1 Pound
Adhesive, Liquid, Butyl, Tent Patching	6 Pints
Needle, Sailmaker's, No. 17	12 Each

CONTENTS	QUANTITY
Brush, Wire, Steel, Scratch	1 Each
Cutter, Grommet Hold, No. 4	1 Each
Awl, Sadler's Sewing, Automatic, 4½-Inch Handle	1 Each
Cutter, Grommet Hold, No. 5	1 Each
Shears, Bent Trimmers, Length Overall, 10 Inches	1 Each

MAINTENANCE EVALUATION

Part 1. Instructions for Maintenance Analysis Chart (Para 2.4.4.1)

COLUMN

1 — Group and Sequence Numbers. Functional group number as indicated in the maintenance allocation chart (or TB 750-93-1) of the assembly or subassembly. The sequence number of the maintenance operation is in parentheses below the group number.

2 — Component and Related Operations. Component and related operations as indicated in the maintenance allocation chart. Operations assigned to depot-level maintenance are not shown normally.

3 — Maintenance Level, Prescribed. The maintenance level prescribed by the maintenance allocation chart is indicated using the following code: "C" - Operator/Crew; "O" - Organizational; "F" - Direct Support; "H" - General Support.

4 — Maintenance Level, Recommended. Use the code letters "C", "O", "F", or "H" to indicate the maintenance level recommended by the test agency.

5 — TM Instructions, Adequate. An "X" in this column indicates the TM instructions covering this maintenance task or action are adequate.

6 — TM Instructions, Inadequate. When the TM instructions are considered inadequate, insert the test agency equipment performance report (EPR) number (if appropriate) which transmitted the DA Form 2028.

7 & 8 — Active Maintenance Time. Clock hours and man-hours required for the maintenance operation to the nearest tenth of an hour. If the operation was not actually performed but was reviewed, the estimated active maintenance time is indicated by using the prefix "E". (Unusual differences in maintenance times for the same operation should be explained in the body of the test report.)

9 — Number of Men. Number of men utilized for maintenance function.

COLUMN

10 System Life. The number of operational hours (essential) and miles, rounds, events, etc., as required in the test plan, accumulated during the test before the malfunction or scheduled service occurred. (Under the life figure, enter in parentheses the sequence number for which that particulat operation was last performed followed by the appropriate life unit, i.e., "M", "H", "R", etc.) An "S" will be placed in this column if the operation was performed on a sampling basis and not because of an actual maintenance action.

11 Reason Performed. The symbol "Unsched" will be entered in this column if this operation was performed as a result of unscheduled maintenance. If the operation was performed and recorded as a required portion of a scheduled maintenance service, the symbol "Sched" will be used. If the operation was performed only to verify procedures or tool requirements, not to correct a malfunction, the symbol "Sim" will be entered.

NOTE. Separate maintenance and reliability analysis charts will be used to record simulated maintenance actions.

12 Remarks. When an EPR is related to a maintenance operation, the EPR number is entered. The notation "Failure" indicates operations performed as a result of a failure. If the operation was not performed as a result of using the sampling technique authorized by AR 750-6, one of the following remarks, as appropriate, is entered:

a. Reviewed - not performed.

b. Neither reviewed nor performed due to lack of TM's or other reasons.

c. Other, as appropriate.

MAINTENANCE ANALYSIS CHART (Material Test Div SOP)	PROJECT NO. 1J664713DL40	NOMENCLATURE Emergency Repair Shelter for CH-47( ) Helicopter	IDENTIFICATION NO.

ITEM NO.	COMPONENT AND RELATED OPERATIONS	MAINTENANCE LEVEL C - OPERATOR/CREW O - ORG F - DIRECT H - GENERAL		TM INSTRUCTIONS		ACTIVE MAINTENANCE TIME		NUMBER OF MEN	SYSTEM USE H - HOURS M - MILES R - ROUNDS	REASON PERFORMED	REMARKS
		PRESP	RECM	ADQT	PAMPHLET	CLOCK HOURS	MAN HOURS				
1	2	3	4	5	6	7	8	9	10	11	12
(01)	Patched shelter side wall.	O	O	X		0.2	0.2	1	N/A	Unsch	
(02)	Patched damage caused during wind test by pitot tube.	O	O	X		0.3	0.3	1	N/A	Unsch	EPR KF-8 submitted.
(03)	Patched small hole in shelter wall.	O	O	X		0.2	0.2	1	N/A	Unsch	
(04)	Replaced guy line.	O	O	X		0.1	0.1	1	N/A	Unsch	
(05)	Patched hole in shelter wall.	O	O	X		0.2	0.2	1	N/A	Unsch	
(06)	Replaced charred APU vent.*	F	F	-	-	-	-	-	N/A	Unsch	EPR KF-3 submitted.
(07)	Modified shelter to gain access to the combining gear.*	F	F	-	-	-	-	-	N/A	Sch	EPR KF-11 submitted.
(08)	Replaced grommet.	O	O	X		0.1	0.1	1	N/A	Unsch	

*Accomplished by USANLA3S.

EDG-MT Form 12, 1 Feb 74 Replaces EDG Form 1020, 10 Apr 73 which will be used until the supply is exhausted

Part 2. Instructions for Parts Analysis Chart
(para 2.4.4.5)

General. The parts analysis chart provides for a listing of the parts used in maintaining the test item. Parts will be grouped on this chart by functional group and in Federal stock number (FSN) numerical order within each group.

COLUMN

1 Group and Sequence Number. Parts usage by maintenance operation is indicated by a cross-reference to the group number and sequence number from column 1 of the maintenance analysis chart.

2 Federal Stock Number. Record the FSN, technical service part number, manufacturer's part number, or drawing number in this order of preference.

3 Noun Nomenclature. As listed in the parts manual.

4 Maintenance Level, Prescribed. The maintenance level prescribed by the parts list under review. Use the code: "C" - Operator/Crew; "O" - Organizational; "F" - Direct Support; "H" - General Support.

5 Maintenance Level, Recommended. The code symbols "C", "O", "F", or "H" indicate the maintenance level recommended by the test agency.

6 Part Life. The number of operating hours (essential) and miles, rounds, events, etc., as required by the test plan, accumulated by this part. This is Actual Part Life and should agree with the part life reported on the EPR. Each entry in this column is followed by the appropriate life unit symbol; i.e., "H", "M", "R", etc.

7 Reason Used. The symbol "Unsched" will be entered in this column if this part was used as a result of unscheduled maintenance. If the part was replaced as a required action of scheduled maintenance, the symbol "Sched" will be entered. If the part was used as a "time change component", the symbol "TCC" will be entered. If the part was consumed to verify procedures or tools, not to correct a malfunction, the symbol "Sim" will be entered.

COLUMN	
8	Remarks. If an EPR is related to the part used, the EPR reference number will be inserted in this column. When the part was replaced to correct a failure, as defined in TECOM Regulation 750-15, it will be indicated by inserting the word "Failure" in this column.

PARTS ANALYSIS CHART (Materiel Test Division SOP)	PROJECT NO 1J664713DL40	NOMENCLATURE Emergency Repair Shelter for CH-47( ) Helicopter				IDENTIFICATION
GP NO (SEQ NO)	FEDERAL STOCK NUMBER	NOUN NOMENCLATURE	MAINTENANCE LEVEL C-OPERATOR/CREW O-ORGANIZATION F-DIRECT H-GENERAL		PART LIFE H-HOURS M-MILES R-ROUNDS	REASON USED	REMARKS
			PRESB	RECM			
1	2	3	4	5	6	7	8
(03)	81349	Grommet	O	O	N/A	Unsched	
(04)	8340-205-2759	Slip, Rope, Guy Line	O	O	N/A	Unsched	
(04)	72785	Hook, Spring Snap	O	O	N/A	Unsched	
(05)	Unknown	Fabric (Patching Material)	O	O	N/A	Unsched	

STEAP-MT Form 10, 1 Feb 74 Replaces EIG Form 1018, 23 Jun 70 which will be used until the supply is exhausted

Part 3. Instructions for Special Tool and Test Equipment Chart (Para 2.4.5)

COLUMN

1 — Nomenclature or Description. Enter the nomenclature as shown in the manual or if none, enter nour nomenclature and brief description of item. (Enter in parentheses the number of like items received, such as (2 Ea.).).

2 — Federal Stock Number or Part Number. Enter one of the following--Federal Stock number, part number or drawing number, in this order.

3 — Maintenance Level, Prescribed. Maintenance level authorized the special tool as prescribed by the technical publication.

4 — Maintenance Level, Recommended. Indicate the maintenance level to be authorized the special tool as recommended by test agency. If the tool is not required, enter "None".

5 — Date Received. Enter the date the special tool or test equipment was received (Example: 6/69). Enter "Not Rec" if the special tool or test equipment was not received.

6 — Evaluation, Adequate. Enter an "X" if the tool was adequate for use by the mechanics and for its intended purpose at the maintenance level recommended in column 4. Make no comment on tools marked "None" in column 4.

7 — Evaluation, Inadequate. Enter an "X" if the special tool was found to be inadequate for its intended use. Make no comment on tools marked "None" in column 4.

8 — Required (ROR) Yes or No. A "Yes" in this column indicates the special tool or test equipment is required at the maintenance level indicated in column 4. A "No" in this column indicates the special tool or test equipment is not required. This column should be marked "No" when "None" is marked in column 4.

COLUMN	
9	Listed in Technical Manual. Enter the number of the technical publication for the test item in which the special tool or test equipment is listed.
10	Remarks. If an EPR is related to the special tool, the EPR number will be entered. If the special tool or test equipment was used only to verify the need for the item, this will be indicated. When it has been determined that a special tool is not required, indicate the tool from the common tool set and the set number which will perform the required maintenance function.

SPECIAL TOOLS & TEST EQUIPMENT CHART (Material Test Div 5020)	PROJECT NUMBER 1J664713DL40			NOMENCLATURE Emergency Repair Shelter for CH-47( ) Helicopter					
NOMENCLATURE OR DESCRIPTION	FSN OR PART NO	MAINT LEVEL C-OP/CREW O-ORG F-DIRECT H-GENERAL		DATE RECEIVED	EVALUATION		ROR YES OR NO	TECHNICAL MANUAL IN WHICH LISTED	REMARKS
		FREQ	RECM		ADQT	INADQT			
1	2	3	4	5	6	7	8	9	10
No special tools or equipment required other than those in the repair kit.									

STEBG-MT Form 11, 1 Feb 74 Replaces EBG Form 1019, 23 Jun 70 which will be used until the supply is exhausted.

Part 4. Instructions for Maintenance Package Literature Chart
(para 2.4.3.1.3)

COLUMN	
1	Number. Enter Army's or manufacturer's publication or draft manual number.
2	Quantity. Number of copies received. Insert "0" if none were supplied. Use chapter 9, AR 310-3, as a guide to determine those publications that should accompany the test item. Publications contained in the maintenance test package should cover operations and functions through general support maintenance and should specify the categories involved.
3	Title. Complete title.
4	Date Received - Literature. Enter date publication was received.
5	Date Received - Materiel. Enter date test item or materiel was received.
6 & 7	Evaluation - Adequate or Inadequate. Insert an "X" in the appropriate block. Minor errors noted on DA Form 2028 are not sufficient reasons to term a publication inadequate.
8	Form 2028 - Date Forwarded. Insert EPR number (if appropriate) and date DA Form 2028 was forwarded.
9	Remarks. In addition to other appropriate remarks, if manuscript was not evaluated, explain why.

MAINTENANCE PACKAGE LITERATURE CHART

PROJ NO: 1J664713DL40

NOMENCLATURE: Emergency Repair Shelter for CH-47( ) Helicopter

MANUSCRIPT			DATE RECEIVED		EVALUATION		FORM 2028		REMARKS
NUMBER	QTY	TITLE	LIT	MATERIEL	ADQT	INADQT	DATE	FORWARDED	
1	2	3	4	5	6	7	8		9
DTM 10-8340-223-23	4	Organizational and Direct Support Maintenance Manual including Repair Parts and Special Tools list. Shelter, Emergency Repair CH-47 Helicopter FSN 8340-000-0000	Oct 73	Oct 73		X			Suggested changes were given to the Sponsor during an informal in-progress review held 25 February 1974. EPR KF-16.

STEPG-MT Form 13, 1 Feb 74 Replaces EBG Form 1021, 23 Jun 70 which will be used until the supply is exhausted

M. DISTRIBUTION LIST

ADDRESSEE	FINAL REPORTS
1. Commander US Army Training and Doctrine Command ATTN: ATCD-FT ATTN: ATCD-C ATTN: ATCD-O ATTN: ATTS Fort Monroe, VA 23651	4
2. THRU: Commander US Army Training and Doctrine Command ATTN: ATCD-FT Fort Monroe, VA 23651 TO: Commander US Army OTEA Fort Belvoir, VA 22060	1
3. Commander US Army Logistics Evaluation Agency ATTN: LEA-ME New Cumberland Army Depot New Cumberland, Pennsylvania 17070	1
4. Headquarters Department of the Army ATTN: DAMA-AR Washington D. C. 20310	1
5. Headquarters Department of the Army ATTN: DAMO-FD Washington D. C. 20310	1
6. Commander US Army Material Command ATTN: AMCRP 5001 Eisenhower Avenue Alexandria, VA 22333	1
7. Commander US Army Natick Laboratories ATTN: AMXRE-GRQ Natick, Massachusetts 01760	1

ADDRESSEE	FINAL REPORT
8. Commander Defense Documentation Center for Scientific and Technical Information ATTN: Document Service Center Cameron Station Alexandria, VA 22314	1
9. Commander US Army Aviation Systems Command ATTN: AMSAV-SI P.O. Box 209 St. Louis, Missouri 63166	1
10. Commander US Army Aviation Test Board ATTN: STEBG-MT-RA Fort Rucker, AL 36360	1
11. Commandant US Army Transportation School ATTN: ATST-CTD-DT Fort Eustis, VA 23604	1