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CHEMICAL PROTECTIVE SUIT ENVIRONMENTAL PROTECTION AGENCY

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Development of a modular hazardous environmental protective ensemble, for Environmental Protection Agency Personnel involved in the clean up of hazardous materials spills. It contains all the components necessary to isolate the user from a toxic environment. It's modular design provides the user the option to select different combinations of components in the ensemble to best accomplish his mission tasks over a climatic range of −17.8°C (−0.04°F to 100.4°F). Body cooling, needed for operating in hot environments is accomplished by the use of a modular liquid-cooled cap/vest.

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LIQUID-COOLED
HEAT BALANCE
ACCLIMATIZE
INDUSTRIAL HEALTH AND SAFETY.

PREFACE

This report details the design concept of the Hazardous Environmental Protection (HEP) Ensemble as developed by the US Army Natick R&D Laboratories (NLABS) in agreement with the Environmental Protection Agency (EPA). Four major work tasks were accomplished:

1. Identification of hazardous material.

2. Identification of needs.

3. Conduction of state-of-the-art review.

4. Definition of proposed protective suit system design concept and building of prototypes.

Thanks are due to the EPA Project Officer, Dr. Joseph P. Lafornara, for the technical guidance and support given to this program. These Laboratories also wish to express thanks to Ira Wilder, Frank Freestone, and their staff at the Industrial Environmental Research Laboratory, Edison, NJ for their cooperation and support.

We also wish to acknowledge the good work performed by ILC Dover for the fabrication of the first eleven prototype suits delivered under contract DAAK60–77–C-0045.

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CHEMICAL PROTECTIVE SUIT ENVIRONMENTAL PROTECTION AGENCY

INTRODUCTION

In July 1976 the Environmental Protection Agency (EPA) of Edison, New Jersey, entered into an interagency agreement with the U.S. Army Natick Research and Development Command, Natick, Massachusetts. The objective of this agreement was to develop a protective clothing system for the EPA Spill Response Personnel. To accomplish this objective the program was divided into the following four major work tasks:

1. Identify hazardous material (definition of the spill threat).

2. Identify needs (develop operational mission profile for EPA Spill Response Personnel and personal safety equipment required.

3. Conduct state-of-the-art review of commercial and Government available protective clothing systems.

4. Define the proposed protective suit system design concept and build prototypes.

Accordingly, this report discusses the state of the art for microclimate protective clothing and describes the design concept of the Hazardous Environmental Protective (HEP) Ensemble.

LITERATURE STUDY AND STATE OF THE ART

A. Statement of the Problem

It is estimated that approximately two billion tons of hazardous chemicals are manufactured each year. The distribution of these chemicals from one industrial site to another imposes a serious hazard upon people and the environment. The probability of accidental release of these hazardous chemicals to the environment is obviously increased through the many steps of handling, before the final utilization of the chemicals. Experience has shown that hazardous material spills, during transport, can vary from one gallon to several thousand gallons. During these spills a serious problem confronts EPA Spill Response Personnel in that the spill can involve a variety of materials of unknown and/or toxic nature. The hazard may be in the form of solid, liquid, vapor, or aerosals which may affect the handler directly or indirectly through a contaminated object. The location of such spills can be anywhere: in cities, open country, or remote areas where access can be a problem for getting spill response personnel to the site rapidly. To minimize this danger to the public and to the total environment, it is important that the spill material be contained in its most concentrated form as quickly as possible.

To meet this task, it is necessary that EPA Response Personnel be able to react to the emergency quickly and that they be adequately protected against the toxic environment at the incident site. The problem providing these individuals with personal protection is complicated by the fact that they are required, at least on occasion, to be present at "ground-zero" of the spill to obtain first-hand information in order to act. To render these

individuals invulnerable to the hazards at "ground-zero", their entire skin surface must be covered with impermeable material.

The Protective Clothing System presently used by EPA Hazardous Spill Response Personnel consists of a permeable high temperature nylon, "Nomex",* and a breathing apparatus. Such a permeable protective system is inadequate for meeting the mission requirements.

B. Significance of Hot Environments on the Wearing of Sealed Suits

Modern industry, like modern warfare, creates many situations where impermeable protective clothing must be worn as a barrier against various hazards. It is not difficult to realize that this form of protection will build up heat stress especially during periods of activity, yet it is desirable that the wearer should remain cool and reasonably comfortable when operating in the higher temperature ranges. It is also desirable to prevent penetration of moisture and toxic agents from the outside of the garment while permitting the transmission and escape of moisture vapor from the inside of the garment.

Consider a man suited in an impermeable garment when the ambient temperature is above the temperature of his body. As long as the air surrounding his skin can take up moisture, he can maintain thermal balance by sweating. But the volume of air within the sealed suit is small, approximately 28.3 liters (1 cu ft), which would be saturated in a very few minutes. At this point, all means of heat loss would be blocked. He would gain, rather than lose heat, and though his body would pour out sweat, it would merely run from his skin as liquid. So his body temperature would rise, and if no relief were provided, heat stroke and collapse would follow.

An effective means of dealing with this stressful possibility is to introduce controlled microclimate. Figure 1 shows microclimate controlled suit. Figure 2 shows plots of rectal and skin temperature as a function of time for individuals wearing unventilated and ventilated (controlled microclimate) impermeable protective clothing. It is readily seen in Figure 2 that men suited in unventilated protective clothing are only able to tolerate a moderate work load for 30 to 40 minutes, before skin temperature has converged on rectal temperature. Under these circumstances, the heat regulating mechanisms for these individuals have failed, and heat illness will follow shortly. On the other hand, for those individuals wearing the controlled microclimate system, their skin temperature parallels rectal temperature after two hours of operation. These individuals were able to remove heat from their body, and consequently their tolerances to do moderate work at these conditions were extended from 30 minutes to over two hours. Important facts about these results are that the average age for these men was 21 years, and before testing, they were acclimatized to the environment conditions of the test.

There is little point in protecting the man against a toxic environment if he is to be rendered operationally ineffective by the protection. The protective clothing, therefore, must

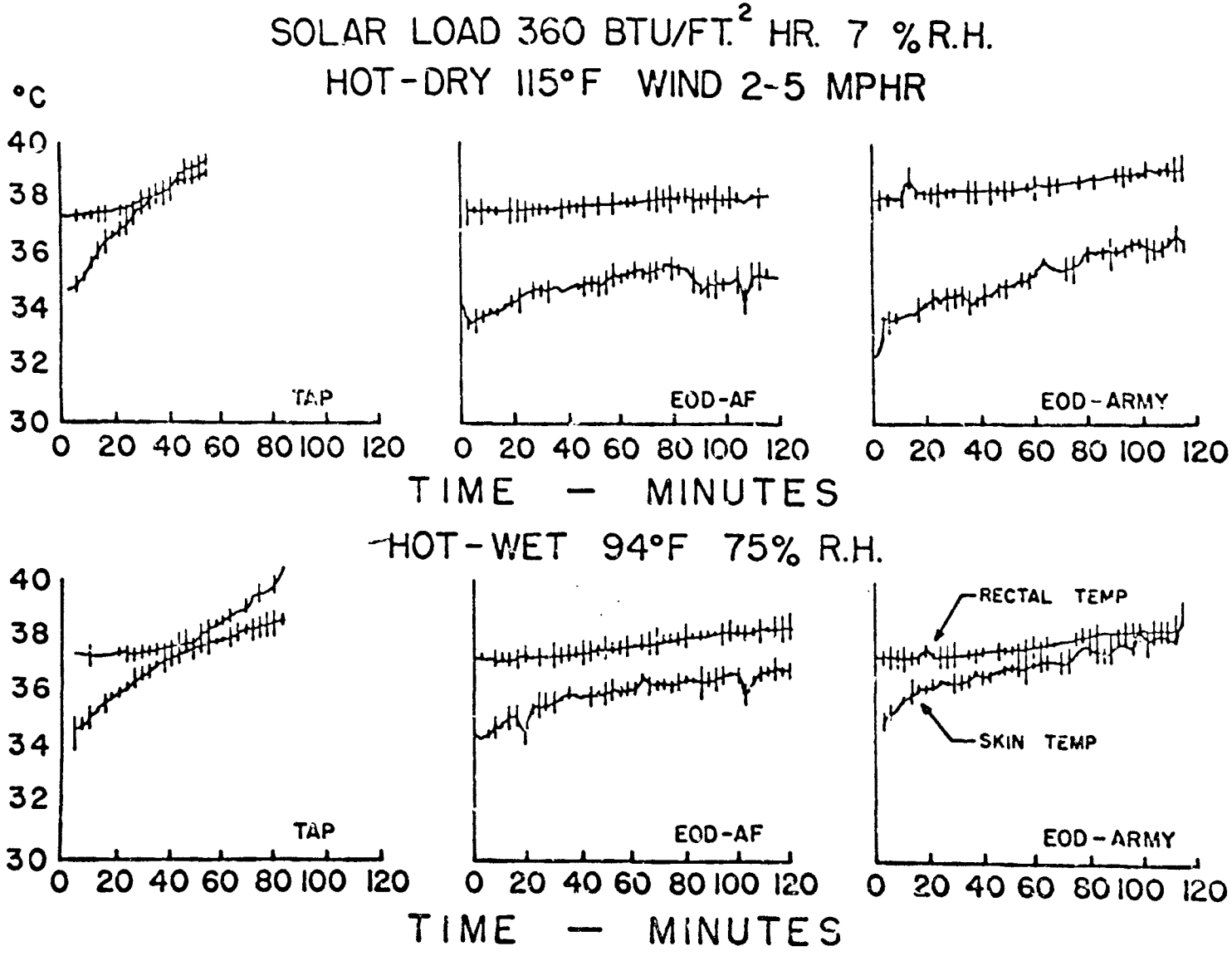
*A product of DuPont, Inc.

OPTIONAL COMMERCIAL COOLING VEST

OUTER SUIT MODIFIED FOR OPTIONAL COOLING VEST

FIGURE 1. Liquid cooling pack.

Figure 2


SOLAR LOAD 360 BTU/FT.² HR. 7 %R.H.
HOT-DRY 115°F WIND 2-5 MPHR
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38
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TAP
EOD-AF
EOD-ARMY
0 20 40 60 80 100 120
TIME — MINUTES
HOT-WET 94°F 75% R.H.
RECTAL TEMP
SKIN TEMP
TAP
EOD-AF
EOD-ARMY
0 20 40 60 80 100 120
TIME — MINUTES

contribute toward the effectiveness of the whole system. The whole system, with its microclimate controlled unit, must be reduced to a minimum of weight and bulk, compatible with the levels of protection which are necessary to protect the suited man as an effective worker, while performing his operational tasks in toxic environments.

C. Review of Army Developed Microclimate Controlled Clothing Systems

In the past years a great deal of research and development effort has been conducted by the U.S. Army to develop portable microclimate controlled systems for use with impermeable protective clothing. It is now possible to provide microclimate controlled protective clothing systems to alleviate heat stress when operating in high ambient temperatures. In 1960 the U.S. Army Natick Research and Development Command (NARADCOM), sponsored a study to determine the feasibility of developing a heat-regulated, chemical-protective clothing system for the combat soldier. As a result of this study it was concluded that the engineering of a combined protective ensemble whose microclimate inside the clothing could be regulated by a powered life-support backpack was technically achievable. The concept of a protective system as formulated and analyzed, combined the following essential components into a total personal protective system:

1. A combined protective headgear assembly.

2. A multifunctional garment including handwear and footwear.

3. A lightweight self-contained heat regulation device that can be integrated with the basic clothing assembly.

Following these earlier studies, several prototype systems were fabricated and tested in the climatic chambers at NARADCOM. The results showed conclusively that an individual wearing a completely impermeable system can be maintained functionally effective while performing moderate activity in ambient temperatures ranging between 4.4°C and 49°C (39.9°F and 120.2°F) provided the microclimate inside the clothing could be controlled. Based on the above findings, the following systems were developed at NARADCOM:

1. Protective Outfit, Toxicological, Microclimate Controlled (POTMC) (Figure 3).

2. Biological Protective Suit Systems (Figure 4). Both systems are capable of isolating the wearer from toxic environments for a period of two hours at ambient temperatures of 4.4°C and 49°C (39.9°F and 120.2°F). These suits have the versatility of using different types of life support equipment:

1. Open cycle ventilating (filtered ambient air) backpack.

2. Partially closed cycle conditioned air (Cryogenic) backpack.

3. Remote clean air source via umbilical hose. (Open cycle or closed cycle).

These suit systems represent significant milestones of Army and Industry-oriented chemical protective suit technology.

FIGURE 3. PROTECTIVE OUTFIT, TOXICOLOGICAL, MICROCLIMATE CONTROLLED

FIGURE 4. BIOLOGICAL PROTECTIVE SUIT SYSTEM

Suit System Descriptions

The Protective Outfit Toxicological Microclimate Controlled (POTMC) seen in Figure 3 is for Explosive Ordnance Disposal Personnel. This protective system consists of a high temperature resistant nylon coverall, a butyl rubber suit, an air distribution undergarment, butyl rubber gloves, butyl rubber boots, a polycarbonate shoulder supported helmet, a lightweight communication head set, and a battery-powered, air-filtering backpack.

Figure 5 shows the flow pattern of the ventilating air through the suit's layer system. This method of air distribution operates on the same principle as a double-walled heat exchanger. The ventilating air in the suit diffuses over the torso, arms, and legs between the impermeable vent air separator wall and the underwear. The ventilating air flows parallel to the body down to the extremities. At these points the ventilating air reverses its direction of flow and diffuses between the impermeable air-sealing-layer and ventilating air-separator wall. The exhaust air is now flowing parallel to the body and counter to the ventilating air and is discharged outside the suit through the exhaust valves.

This method of counterflow distribution of the suit's ventilating air assures that a highly turbulent ventilating air will come in contact with the body. The high turbulence achieved increases the overall heat and mass transfer coefficient prevailing on the skin surfaces, and thereby increases the effectiveness of heat regulation. The partitioned exhaust air which flows counter to the ventilating air serves as a buffer layer between the outside environment and air flowing directly over the body. The advantages of a buffer air layer are as follows:

1. Reduces temperature gradient between the outside environment and the air flowing in contact with the body surface.

2. Provides an extra safety mechanism against any inward leakage of toxic agents through tears or punctures in the outer protective layer of the suit by discharging through these agents.

3. The air separator wall is lightweight, butyl-coated nylon rip-stop fabric which maintains a balanced flow of ventilating air over the body, even when the outer impermeable air layer is punctured; it also serves as a second toxicological protective layer.

All materials used in the fabrication of this ensemble are either stretchable, or cut on the bias to achieve a high degree of mobility. The ensemble is relatively form-fitting and highly flexible. Butyl boots and butyl gloves are used to protect the extremities. Connection of the handwear and footwear to the suit is achieved by locking disconnects. Two gas-sealing zippers are used for the main closure of the suit. All hardwear connectors and closures are shielded by butyl rubber protectors.

The helmet consists of a rigid polycarbonate shell with a large clear area to provide nearly unrestricted visibility. It is supported on the shoulders. Ventilating air for breathing and cooling is delivered to the head area through a built-in manifold in the air distribution system in the undergarment. At the base of the visor there is a rubber mouthpiece attached to an emergency breathing adaptor which contains two one-way flapper valves: one valve is for

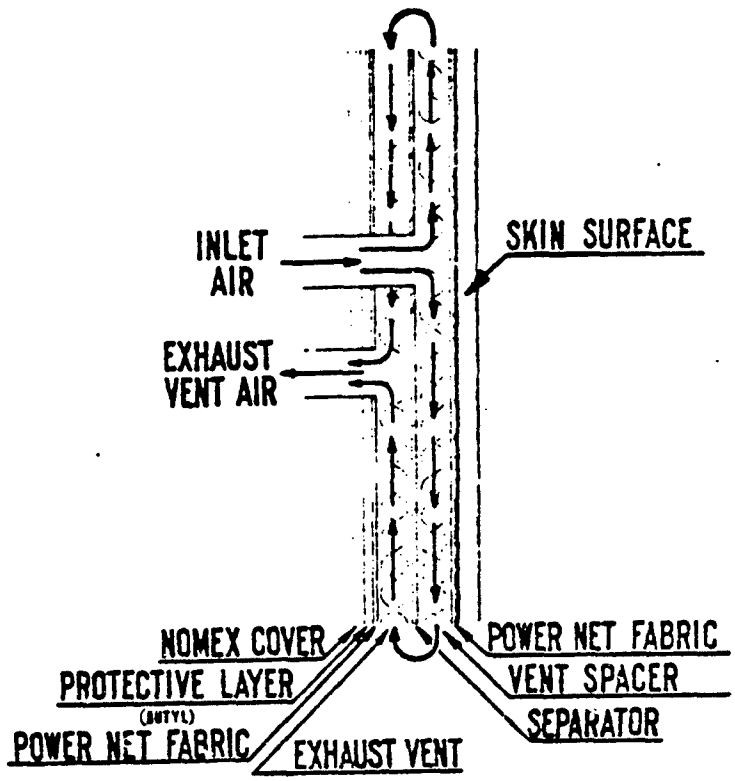

FIGURE 5. Airflow pattern through composite fabric layers of suit (POTMC) assembly.

inhalation and the other to direct exhaled air away from the visor and to prevent carbon dioxide (CO_2) buildup in the helment. The emergency breathing adaptor permits direct breathing from various types of emergency-breathing and life-support devices.

The connecting link between the suited man and the outside environment is the life-support backpack. This consists of three basic components:

1. a high efficiency blower
2. an expendable gas/aerosol filter
3. a power pack to drive the blower.

The expendable filter and blower are located in a molded plastic housing carried on the upper section of the man's back. The power pack consists of two waist-belt-suspended pouches each containing a rechargeable nickelcadium (Ni-Cd) battery. The power pack is readily accessible to the suited man for fast replacement in contaminated environments. The complete suit as described weighs approximately 25 kg (55.1 lb) and has a two-hour mission time. However, the mission time can be extended an additional two hours with a change to fully charged batteries.

This Toxicological Protective Suit System has the versatility to be used in a wide variety of special applications where toxicological protection is required.

The Biological Protective Suit System for Laboratory Personnel seen in Figure 4 was designed to protect personnel working with infectious materials. This one-piece suit design contains an effective lightweight ventilation undergarment which can be easily interchanged with other encapsulating garments of the same suit configuration. An airflow of 564 l/min (19.9 ft^3/min) of clean air from a remote air source is supplied to the suit via an umbilical hose. The system contains a pre-air filter at the suit air-inlet manifold and an emergency breathing air filter. The helmet is a clear one-piece polycarbonate bubble supported on the shoulders by a simple plastic collar. A lightweight communications system is included as part of the system. The unique feature of this protective suit design is in the configuration of the main suit closure. It provides the equivalent ease of self-donning and doffing as that of a two-piece clothing system. This protective suit was developed for the Industrial Health and Safety Office at Ft. Dietrick, Maryland.

DESIGN AND SPECIFICATION

A. Proposed Design Concept for Environmental Protection Agency (EPA)

The Hazardous Environmental Protective (HEP) ensemble prototype may be described as a system consisting of all the components necessary to produce a self-contained envelope, capable of providing the user protection against the adverse chemical environments expected in the tasks associated with EPA spill on-scene coordinators.

The ensemble will be constructed of materials that will best withstand exposure to those chemicals listed in the "Chemical Hazard Response Information System". The major components that will comprise the HEP ensemble will be the self-contained air breathing mask, (NARADCOM Drawing 8–2–651, liquid cooled cap/vest, and protective suit, (NARADCOM Drawing 8–2–650, existing Nomex coverall, butyl rubber gloves, butyl rubber boots, and support items.

B. Design Guide Lines

These general design requirements for the Hazardous Environmental Protective (HEP) ensemble are based upon the mission profile for EPA on-scene coordinators.

1. The ensemble must provide toxicological protection at ground zero of spill area.

2. The ensemble must be of modular design for easy maintenance.

3. The ensemble must have good mobility and be easy to don and doff.

4. Protective suit must be sized to fit over a nomex coverall.

5. Suit design must reflect versatility to incorporate a water-cooled cap/vest system for head and body cooling when working in high temperature ambients.

6. Suit must be durable, lightweight, and of low bulk to fit in a carrying bag for easy transport.

7. Life support equipment must supply breathable air for a period of not less than 30 minutes per air bottle.

8. Air breathing apparatus to contain a standard connector with adaptor to permit refilling at site from locally available air support equipment.

9. The ensemble must be capable of operating over an ambient temperature range of −17.8°C and 37.8°C (0°F and 100°F).

C. Description of Suit – Microclimate Controlled System

The liquid cooled microclimate control system worn under the protective suit controls the body's heat balance. A highly efficient liquid transport material has been developed to replace the current typical tygon tubing networks usually used for liquid cooling garment applications. This newly developed material is less than six mils thick and has flow channels built into it. These channels are close to the surface of the body resulting in considerably higher transfer capabilities. This material is not bulky and is highly flexible, and therefore, it conforms easily to the body's shape for comfortable wear.

This material has been fabricated into a cap and vest configuration. These items along with a 12-volt, dc, fluid pump, heat exchanger, and ice canister, comprise the component parts of this system. A quick disconnect fitting connects the cap and/or vest to the heat exchanger. The rechargeable battery pack and ice canister provide approximately two hours of operation for head cooling only, and approximately one hour for both head and torso cooling.

D. Description of Outer Suit

The outer suit will be fabricated from butyl coated nylon fabric. This outer suit will provide an impermeable barrier against the corrosive chemicals encountered in a chemical spill. The suit will be a one-piece, coverall configuration, and its main entrance closure will be a pressure-type sealing zipper. The arm and leg cuffs will contain a double cuff to seal with the gloves and boots. The hood shown in NARADCOM Drawing 8–2–650, is a part of the suit and will be designed to fit under the hard hat and to seal with the Air Breathing Mask.

E. Description of Inner Suit

The inner suit will also be of a coverall configuration and will be sized to fit over the user's clothing consisting of a shirt and/or sweater and trouser. It will be constructed from high temperature resistant nylon cloth. The purpose of this garment is to provide the user a second layer of protection under the impermeable suit and also to provide the flexibility of using this garment in combination with other system components, but less the impermeable suit, against those spill materials which do not require an impermeable barrier for protection. Existing Nomex coveralls used by chemical spill personnel can be used as the inner coverall.

F. Description of Boots and Gloves

The boots and gloves will be constructed of Butyl rubber.

G. Description of Self-Contained Air Breathing Apparatus

Two types of breathing apparatus are under consideration; namely, the open-circuit and closed-circuit systems.

1. The open circuit system is supplied from compressed air or liquid (cryogenic) air source. The system can operate either in a demand mode, which will develop negative pressure

within the system, or in a pressure-demand mode, which will maintain positive pressure within the system throughout the respiratory cycle. In either mode, pressurized air is supplied from a cylinder, passed through a regulator to reduce pressure, then supplied to the facepiece for respiration; exhaled air is then vented to the atmosphere.

2. The closed circuit system recirculates the exhaled gas thereby permitting the unit to be much smaller and lighter than conventional open-circuit equipment. Exhaled carbon dioxide is removed by a disposable carbon dioxide (CO_2) absorber. Make-up oxygen is added at a continuous flow 3.6 l/min, (0.13 ft^3 min); the air is cooled and then recirculated for breathing.

H. Proposed Specifications

Proposed specifications for final configuration of chemical protective (EPA) are outlined in Appendix A. Appendices B and C, respectively, present instructions for maintenance and storage and donning and doffing.

CONCLUSIONS

The state of the art is such that a modular protective ensemble for EPA personnel was built from off-the-shelf equipment. This ensemble (NARADCOM Drawing 8–2–650) contains all the components necessary to isolate the user from a toxic environment. It is sufficiently lightweight and of low bulk to be transported in a suitcase type container. Through the use of modular components, the user has the option to select different combinations of modular components in the ensemble to best accomplish his mission requirements. For easy maintenance and reliability, the major and subcomponents in the ensemble are replaceable by modular units. To extend the suit stay time in hot environments, the ensemble contains a modular liquid-cooled cap and vest to control the microclimate inside the suit. Life support is maintained by either an open circuit or closed circuit breathing apparatus. To minimize field support of this ensemble, the breathing devices are equipped with fixtures to permit recharging with air or oxygen from equipment available in the vicinity of the user.

RECOMMENDATIONS

1. The suit systems fabricated under this effort be used only for the purpose of verifying the system design.

2. These suit systems be distributed to field operators who would train with the suit system in mock, chemical spill, incidents. After six months of field training usage, the comments of the users be reviewed and evaluated for suggested and/or recommended changes, and accordingly make changes to the base line configuration of the suit design.

3. Once the base line design configuration is modified, a second generation suit reflecting the new design changes be built in production for field use. The design to be modified to accommodate the liquid cooling pack worn inside suit as shown in Figure 1 and that booties be deleted as reflected in Section 5 of the proposed specification (Appendix A).

4. The suit mask seal be designed and fabricated of molded rubber, as shown in NARADCOM Drawing 8–2–651.

5. The search be continued for a new impermeable material to replace the existing Butyl-coated nylon.

APPENDIX A

APPENDIX A

PROPOSED SPECIFICATION FOR CHEMICAL PROTECTIVE SUIT (EPA)

1. Scope

Scope. This specification covers a chemical protective suit made of Butyl Coated Nylon.

Classification. The chemical protective suit (EPA) shall be one type in the following sizes as specified (see 6.1):

Schedule of Sizes

Small-Long	**Medium Long**	**Large-Long**	**X-Large-Long**

2. Applicable Documents

2.1 Issues of Documents. The following documents of the issue in effect on the date of invitation for bids or requests for proposal, form a part of this specification to the extent specified here.

SPECIFICATIONS

FEDERAL

L–P–375	Plastic Film, Flexible, Vinyl Chloride
V–T–385	Thread Polyester
DDD–L–20	Labels; For Clothing, Equipage and Tentage (General Use)
PPP–B–636	Boxes, Shipping, Fiberboard
PPP–T–45	Tape, Gummed, Paper, Reinforced, and Plain, for Sealing and Securing

MILITARY

MIL–P–116	Preservation – Packaging, Methods of
MIL–B–543	Buckles, Tongueless and Web Strap
MIL–T–5038	Tape, Textile and Webbing Textile, Reinforcing Nylon
MIL–V–10134	Valve, Outlet, Protective Mask, C15
MIL–C–12189	Cloth Coated: Butyl Coated, Toxicological Agents Protective
MIL–F–43514	Fastener, Plastic, for Equipage Items
MIL–B–43515	Belt, Man's, Waist, Blue 334 (Army Band Uniform)
MIL–W–43668	Webbing, Textile, Bulked Nylon
MIL–S–51141	Suit Protective, Impermeable, Supplied-Air M4

STANDARDS

FEDERAL

FED–STD–191	Textile Test Methods

FED–STD–406 Plastics: Methods of Testing
FED–STD–601 Rubber: Sampling and Testing
FED–STD–751 Stitches, Seams and Stitching

MILITARY

MIL–STD–105 Sampling Procedures and Tables for Inspection by Attributes
MIL–STD–129 Marking for Shipment and Storage

DRAWINGS

US ARMY NATICK RESEARCH AND DEVELOPMENT COMMAND

8–2–389	Fastener Plastic for Equipage Items: Attaching Tools
8–2–650	Suit, Chemical Protective (EPA); Assembly
8–2–651	Suit, Chemical Protective (EPA); Seal Facemask
8–2–652	Suit, Chemical Protective (EPA); Hard Hat Retaining Assembly
8–2–653	Suit, Chemical Protective (EPA); Fluid Coupling (Cool Head) Assembly and Details
8–2–654	Suit, Chemical Protective (EPA); Wrist Details
8–2–655	Suit, Chemical Protective (EPA); Leg Cuff Details

(A miniature copy of NARADCOM Drawing 8–2–650 is attached for information only).

(Copies of specifications, standards, purchase descriptions, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer).

2.2 **Other Publications.** The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated the issue in effect on the date of invitation for bids or request for proposal shall apply.

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT

National Motor Freight Classification

(Application for copies should be addressed to the American Trucking Association's, Inc., Traffic Department, 1616 P. Street, N.W., Washington, D.C. 20036).

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification

(Application for copies should be addressed to the Uniform Classification Committee, Room 1106, 222 South Riverside Plaza, Chicago, IL 60606).

3. Requirements

3.1 First Article. When specified (see 6.1) the contractor shall furnish a sample for first article inspection and approval (see 4.3 and 6.3).

3.2 Materials.

3.2.1 Coated Cloth. The coated cloth shall be cloth, nylon, butyl-coated conforming to MIL–C–12189.

3.2.2 Strapping. Strappings used to seal seams and around slide fasteners shall be 25.4 ± 1.59 mm (1 ± 1/16 inch) wide. These strappings shall be bias cut from cloth as specified in 3.5.4.

3.2.3 Adhesives for Wrist and Leg Cuffs, Strapping and Patches. The adhesive used to cement the wrist and leg cuffs and the strapping and abrasive patches shall be a chlorprene base solvent adhesive (see 6.2). The leg and sleeve shall not slip off the cuffs when tested as specified in 4.5.5 and 4.5.6. The adhesive when applied and tested as specified in Table IV shall not crack or flake, and the hydrostatic resistance of the adhesive coated cloth shall be equal to that of the butyl-coated cloth before cementing.

3.2.4 Thread. The thread shall be polyester thread, size B2 or E3, conforming to type I, class 1, subclass A, color Olive Drab S-1, C.A. 66022 of V–T-285. Color fastness is not required.

3.2.5 Slide Fasteners. Inner slide fastener shall be 1,219.2 mm (48 inches) in length, pressure sealing, and have a molded black rubber lip oriented to the outside of the suit conforming to B. F. Goodrich Company Style 1430 or equal. The outer slide fastener shall be 1270 mm (50 inches) in length, pressure sealing, and have molded, black rubber lips oriented to the outside of the suit, conforming to B. F. Goodrich Company series 500, style 530 or equal closed ends, zipper size No. 6, nylon tape. There shall be no evidence of broken or loose scoops, crosswise separation of closed slide fastener chain, cuts or tears in rubber sealing lips and cut or tear in labyrinths when tested as specified in 4.4.1.1.

3.2.6 Slide Fastener Thong. The slide fastener thong shall be made from a double layer of the coated cloth specified in 3.2.1. The two layers shall be cemented together (lightly coated side to lightly coated side) with the adhesive specified in 3.2.3. The width of the finished thong shall be 11.11 mm ± 1.59 mm (7/16 ± 1/16 inch) wide and 431.8 mm ± 12.7 mm (17 ± 1/2 inches) long before doubling and knotting.

3.2.7 Reinforcement Patches and Butyl Washers. The reinforcement patches and butyl washers shall be cut from the coated cloth specified in 3.2.1.

3.2.8 Buckle. The buckle shall conform to type V, class 3, size 25.4 mm (1 inch) of MIL–B–543.

3.2.9 **Webbing Nylon.** The nylon webbing attached to the male section of the plastic fastener shall conform to type III of MIL–W–43668. The color of the tape shall be Olive Drab 7.

3.2.10 **Webbing Nylon.** The webbing nylon to accommodate the hood buckle shall conform to type III of MIL–W-43668. The color of the tape shall be Olive Drab 7.

3.2.11 **Fastener Plastic.** The plastic fastener shall conform to MIL–F–43514. The webbing nylon attached to the male section of the plastic fastener and the webbing nylon to accommodate the hood buckle shall be attached as shown in NARADCOM Drawing 8–2–652.

3.2.12 **Arm Cuff Wristlet.** The finished arm wristlets shall be cylindrical in shape and shall have a beaded roll edge 6.350 mm to 9.525 mm(1/4 to 3/8 inch) in diameter on one end. The wristlet shall be fabricated from unsupported film of butyl compound specified for the wrist seals in MIL–S–51141. The finished wristlets shall be 0.635 ± 0.127 mm (0.025 ± 0.005 inch) thick, 107.95 mm ± 3.175 mm (4–1/4 ± 1/8 inches) in diameter and 76.2 mm ± 3.175 mm (3 ± 1/8 inches) in length.

3.2.13 **Wrist Cuff.** The wrist cuff shall conform to NARADCOM Drawing 8–2–654. The cuff shall be made of polypropylene.

3.2.14 **Leg Cover, Roll Down.** The leg cover, roll down shall be cylindrical in shape and shall have a beaded or rolled edge 3.175 mm to 4.762 mm (1/8 to 3/16 inch) in diameter on one end. The leg cover shall be fabricated from unsupported of butyl compound specified for pant leg seals in MIL–S–51141. The finished leg cover shall be 0.635 mm ± 0.127 mm (0.025 ± 0.005 inch) thick, 166.5 mm ± 3.175 (6–5/9 ± 1/8 inches) in diameter and 76.2 mm ± 3.175 mm (3 ± 1/8 inches) in length.

3.2.15 **Leg Cuff.** The leg cuff shall conform to NARADCOM Drawing 8–2–655. The leg cuff shall be made of polypropylene.

3.2.16 **Fluid Coupling.** The fluid coupling installed on both sides of the suit wall shall be made of delrin conforming to NARADCOM Drawing 8–2–653.

3.2.17 **Labels.** All labels shall conform to DDD–L–20, type I, class I. All labels shall be cemented directly on the coated cloth in the location specified in the manufacturing operations. The labels shall be typed with the information shown in 3.2.17.1 and sprayed with a clear coating.

3.2.17.1 **Identification Label.** Each chemical protection suit (EPA) shall have one identification label and shall contain the following information.

NOMENCLATURE
SIZE
PART NO.
SERIAL NO.
PURCHASE DESCRIPTION
DATE

3.2.17.2 **Caution Label.** The caution label shall include the following legend:

CAUTION

1. DO NOT IMMERSE SUIT SYSTEM IN THE FOLLOWING DECONTAMINATION AGENTS:

   DANC–DS_2 – CAUSTIC SODA – BOILING WATER

2. SUIT SYSTEM CONTAINS FERROUS METALS. USE PROPER CAUTION IN VICINITY OF MATERIALS HAVING MAGNETIC PROPERTIES.

3.3 **Design.** The chemical protective suit (EPA) is a coverall type, loose-fitted, long sleeved, a one-piece hood attached to the front and back of the suit, and a slide fastener to don or take off the suit. The suit assembly shall be shown on NARADCOM Drawing 8–2–650.

3.4 **Patterns.** Standard patterns for use in cutting working patterns will be furnished by the Government. The patterns provide a 9.525 mm (3/8 inch) seam allowance for all joining seams, except joining of the hood to the front of suit, for which there is a 6.350 mm (1/4 inch) seam allowance.

3.4.1 **Pattern Parts.** The component parts shall be cut from materials as specified and according to the number of parts listed in Table I.

TABLE I. LIST OF PATTERN PARTS

Material	Pattern Nomenclature	Cut Parts
Cloth, Coated: Butyl	Front	2
Coated	Back	2
	Hood	1
	Sleeve	2
	Slide fastener reinforcement patch	2
	Shoulder/Hood gore	1
	Fluid coupling reinforcement patch	1
	Bootie – upper	1
	Bias arm strapping	2
	Strip Hood cementing	1
	Regulator Seal and Cover	1
	Label reinforcement	1
	Hood buckle reinforcement	4
Polycarbonate	Hard hat, cut Line Template	1

3.5 Construction

3.5.1 **Stitches, Seams, and Stitching.** Stitch, seam, and stitching types, specified in table II, shall conform to FED–STD–751. Where two or more seam or stitch types are given for the same operation, any one of them may be used. Seam allowances shall be maintained with seams sewn so that no raw edges, run-offs, twists, pleats, puckers, or open seams will result. All seams shall start and finish evenly. Thread tension shall be maintained so that there is no tight or loose stitching.

3.5.1.1 **Stitches per 25.4 mm (inch).** The minimun and maximum number of stitches per 25.4 mm (inch) shall be as specified in table II.

3.5.1.2 **Thread Breaks and Ends of Seams.** Ends of all seams and stitching, when not caught in other seams, shall be backtacked not less than 12.7 mm (1/2 inch). The ends of a continuous line of stitching shall be overlapped no less than 12.7 mm (1/2 inch). The ends of label stitching shall be overlapped not less than three stitches. Thread breaks shall be secured by stitching back of the break not less than 12.7 mm (1/2 inch). Skipped stitches or thread breaks on 401 stitch type may be repaired by using 301 stitch type.

3.5.2 **Manufacturing Operations Requirements.** The chemical protective suit (EPA) shall be manufactured in accordance with operation requirements specified in table II. The contractor is not required to follow the exact sequence of operations listed.

3.5.3 **Shade and Size Marking.** The component parts of the chemical protective (EPA) shall be marked to insure a uniform shade and size throughout the garment.

3.5.4 **Seam Strapping.**

3.5.4.1 **Preparation of Seam Area for Strapping.** Prior to application of the cement, the seam, the area along the seam where the strapping is to make contact, and the surface of the strapping to be adhered, shall be thoroughly cleaned with rubber solvent naphtha or other suitable cleaning agent which is not a solvent for the butyl coating compound. In addition, the above procedure shall be employed for all cementing operations.

NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN/ LOOPER	COVER
1.	**Cutting.** All butyl piece parts should be marked on the heavy coated side (shiny side) of the butyl coated nylon. No pin tickets shall be used, and no drill holes shall be made. The butyl suit shall be cut in strict accordance with the patterns furnished, which show size and notches for proper assembly of parts and placement of hardware, abrasion, and reinforcement patches.						
2.	**Cut nylon webbing and sear the raw edges with a hot knife.** a. Cut two nylon webbing pieces, 25.4 mm (1 inch) wide by 88.9 mm ± 6.350 (3–1/2 ± 1/4 inches) long to accommodate the hood buckle. b. Cut two nylon webbing pieces for the latch locking clips 215.9 mm ± 6.350 mm (8–1/2 ± 1/4 inches) long to accommodate the hood buckle. c. Cut two nylon webbing pieces 12.7 mm (1/2 inch) by 63.5 mm (2–1/2 inches) long for slide fastener restraints. d. Cut two nylon webbing pieces, 25.4 mm (1 inch) by 76.2 mm (3 inches) ± 6.350 mm (1/4 inch) long for the bump cap.						
3.	**Cut fittings.** a. Cut hood buckle reinforcement patches 50.8 mm (2 inches) diameter for inside of hood. b. Cut hood buckle reinforcement patches 38.1 mm (1–1/2 inches) diameter for outside of hood.						

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NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS (cont'd)	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN/ LOOPER	COVER
3.	**Cut fittings. (cont'd)**						
	c. Cut sufficient amount of strapping to seal garment seams, including face seal.						
	d. Cut off sufficient amount of strapping to seal arm cuff wristlets and leg cover roll down.						
	e. Cut rolled bead on two arm cuff wristlets and two leg cover roll downs.						
	NOTE: All strapping pieces and reinforcement patches shall be abraided, including bonding areas at wrists and leg cuff.						
4.	**Join shoulder hood gore to fronts.** Join shoulder hood gore to fronts, turn seam allowance toward the back and top-stitch 4.762 mm (3/16 inch) to 6.350 mm (1/4 inch) from fold.	301 301	SSa–1 LSQ–2(b)	8–10 8–10	E–3 E–3	E–3 E–3	
5.	**Join center back and center fronts of suit.**	301	SS2–1	8–10	E–3	E–3	
	a. Join center back and center fronts of suit, turn seam.	301	LSQ–2(8)	8–10	E–3	E–3	
	b. Cut hood buckle reinforcement patches 38.1 mm (1–1/2 inches) diameter for outside of hood.						
	c. Cut sufficient amount of strapping to seal garment seams, including face seal.						
	d. Cut off sufficient amount of strapping to seal arm cuff wristlets and leg cover roll down.						
	e. Cut rolled bead on two each arm cuff wristlet and leg cover roll downs.						
	NOTE: All strapping pieces and reinforcement patches shall be abraided, including bonding areas at wrists and leg cuff.						

NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS (cont'd)	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN/ LOOPER	COVER
6.	**Join shoulder hood gore to fronts.** Join shoulder hood gore to fronts, turn seam allowance toward the back and top-stitch 4.7625 mm (3/16 inch) to 6.350 mm (1/4 inch) from fold.	301 301	SSa–1 LSQ–2(b)	8–10 8–10	E–3 E–3	E–3 E–3	
7.	**Join center back and center fronts of suit.** Join center back and center fronts of suit, turn seam allowance to one side and top-stitch 4.7625 mm (3/16 inch) to 6.350 mm (1/4 inch) from fold.	301 301	SSa–1 LSQ–2(8)	8–10 8–10	E–3 E–3	E–3 E–3	
8.	**Join shoulder seams.** Join shoulder seams, turn seam allowance to back and top-stitch 4.7625 mm (3/16 inch) to 6.350 mm (1/4 inch) from fold.	301	LSQ–2(b)	8–10	E–3	E–3	
9.	**Cement and strap both shoulders, and hood gore.** Cement and strap both shoulders, and hood gore (see operation 4) inside and outside of suit.						
10.	**Stitch slide fastener to suit.**						
	a. Bond the pressure sealing zipper to torso assembly at the inside slide fastener line. Be sure slide fastener and torso assembly marks all match. Allow assembly to sit for 1 to 2 hr after bonding.						
	b. Stitch slide fastener to suit with two rows of stitching 3.175 mm (1/8 inch) and 15.875 mm (5/8 inch) from outer edge of outer slide fastener tape.	301	SSbd–1	8–10	E–3	E–3	
	NOTE: Slide fastener should be installed opening left to right.						
	c. Attach slide fastener restraint (see 2–c) at both ends of zipper, with the raw edge of webbing even with zipper tape edge and double-stitch through zipper and front of suit.						
	NOTE: The edge of the retainer shall be positioned 25.4 mm (1 inch) to 31.75 mm (1–1/4 inch) from zipper stopper.						

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NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS (cont'd)	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN/ LOOPER	COVER
11.	Cut out slide fastener opening, at left and right front.						
12.	**Make and attach hood to suit.**						
	a. Fold hood face to face and stitch, turn seam allowance to one side and top-stitch 4.7625 mm (3/16 inch) to 6.350 mm (1/4 inch) from folded edge.	301	SSa–1	8–10	E–3	E–3	
	b. Stitch label to label reinforcement patch 3.175 mm (1/8 inch) to 4.7625 mm (3/16 inch) from edge of label.	301	LSbJ–1	8–10	E–3	E–3	
	c. Bond label backing to inside of hood according to marks on patterns.						
	d. Bond the hood buckle reinforcement patch (see 3.b) to the outside of hood according to marks on patterns.						
	e. Bond regulator seal, hood, to inside of hood centered around regulator hole.						
	f. Stitch seal to hood 3.175 mm (1/8 inch) from outside edge all around.	301	LSbJ–1	8–10	E–3	E–3	
	g. Join hood to suit. Align notch and stitch hood to suit, turn seam allowance towards suit and top-stitch 3.175 mm (1/8 inch) to 4.7625 mm (3/16 inch) from fold.	301 301	SSa–1 LSq–2	8–10 8–10	E–3 E–3	E–3 E–3	
13.	**Attach webbing and buckles to hood (see fig. 6) – NARADCOM Drawing 8–2–650. (fig. 1)**						
	a. Thread webbing through buckle. Center webbing cover 38.1 mm (1–1/2 inch) diameter reinforcement patches, turn ends of webbing under 12.7 mm (1/2 inch) and sew a 9.525 mm (3/8 inch) box stitch.	301		10–12	E–3	E–3	

NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS (cont'd)	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN/ LOOPER	COVER
13.	**Attach webbing and buckles to hood (see fig. 6) – NARADCOM Drawing 8–2–650.** (fig. 1) (cont'd)						
	NOTE: Buckle must be pointing towards the top of hood before sewing (see mark on patterns).						
	b. Attach webbing to plastic fastener over the back of latch and mark location of latch parts on the webbing. Punch a 3.175 mm (1/8 inch) diameter hole at locations marked on the webbing.						
	Place the nylon webbing and the latch locking clip onto the part of the latch receptical and pin the latch posts over using snap set die (see NARADCOM Drawing 8–2–389).						
	c. Lace webbing through the buckle, turn the end 12.7 mm (1/2 inch) ± 3.175 mm (1/8 inch) and stitch 3.175 mm (1/8 inch) from raw edge.						
14.	**Attach fluid coupling.** Bond the fluid coupling reinforcement patch according to marks on patterns on the right torso front.						
15.	**Attach sleeves to suit.**						
	a. Join sleeves to body of suit according to notches on patterns. Turn seam allowance towards the body and top stitch 4.7625 mm (3/16 inch) to 6.350 mm (1/4 inch) from fold.	301	SSa–1	8–10	E–3	E–3	
	b. Bond the bias arm strapping to the outside of the scye opening seams. The strapping should be centered over the seams.						
16.	**Join front parts to back parts of suit.**						
	a. Join the back to fronts, turn seam allowance towards the back of suit and top stitch 4.7625 mm (3/16 inch) to 6.350 mm (1/4 inch) from fold.	301 301	SSa–1 LSq–2	8–10 8–10	E–3 E–3	E–3 E–3	

NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS (cont'd)	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN/ LOOPER	COVER
16.	Join Front parts to back parts of suit. (cont'd)						
	b. Join the inseam of suit, lap the front of the back and top stitch 4.7625 mm (3/16 inch) to 6.350 mm (1/4 inch) from fold.	301	LSq–2(b)	8–10	E–3	E–3	
17.	Strapping suit. All bonding of seam strapping abrasion patches, etc., shall use the following procedures:						
	1. Clean areas to be bonded with solution.						
	2. Abraid bonding areas.						
	3. Rinse bonded area with clean water to remove all dirt and grit.						
	4. Prior to applying adhesive, wipe the bonding areas with a 1011 solution of Isopropyl Alcohol and Toluene and allow the bonding area to dry.						
	5. Apply one coat of adhesive to the bonding areas and allow it to dry						
	6. Apply a second coat of adhesive to the bonding areas and allow them to dry.						
	7. Adhere bonding areas together by reactivating adhesive on one bonding surface a small portion at a time as it is being laid down.						
	a. Bond 25.4 mm (1 inch) (see 3.c) bias strapping over the outside of all sewing seams. The strapping should be centered over the seams.						

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					NEEDLE	BOBBIN/ LOOPER	COVER
17.	Strapping suit. (cont'd)						
	b. Bond all around the slide fastener assembly.						
	c. Bond the slide-fastener reinforcement patches on the outside of the garment, around the ends of zipper.						
18.	Bond arm cuff wristlets. (See fig. 5, NARADCOM Drawing 8–2–654).						
	a. Bond the arm cuff wristlets to the outside wrist area of the sleeve at the areas located by the marks on patterns.						
	b. Bond 25.4 mm (1 inch) wide bias strapping around the edge of the arm cuff wristlets.						
	c. Bond wrist cuffs to ends of sleeves.						
19.	Bond leg bottom. (See NARADCOM Drawing 8–2–655) (fig. 6) (Center strapping over edge of leg cover).						
	a. Bond booties to bottom of inside of leg bottoms.						
	b. Bond the leg cuffs to outside bottom of legs.						
	c. Bond the leg cover roll down to the outside of the leg of the suit at the area located by the pattern marks.						
	d. Bond the 25.4 mm (1 inch) wide bias strapping around the edge of the leg cover roll down.						

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NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS (cont'd)	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN, LOOPER	COVER
20.	**Attach fluid coupling.** a. Punch 55.5625 mm (2–3/16 inch) diameter holes and 60.325 mm (2–3/8 inch) diameter holes at the location marks on the fluid coupling reinforcement patch. b. Install the fluid coupling on both sides of the suit wall, through the holes in the fluid coupling reinforcement patch. **NOTE:** Connectors are oriented towards top of suit.						
21.	**Assemble hard hat.** a. Using the hard hat, cut line template, (see table I) mark the cut line for removal of the cap beak according to pattern. b. Cut off the cap beak and grind the edges smooth. c. Place the nylon webbing, hard hat over the back of the latch receptacle and mark location of latch posts on the webbing. Punch a 3.175 mm (1/8 inch) diameter hole at locations marked on webbing. (See fig. 3, NARADCOM Drawing 8–2–652). d. Place the nylon webbing, hard hat, and the latch receptacle locking clip onto the posts of the latch receptacle. e. Peen the latch posts over using snap set die (See NARADCOM Drawing 8–2–389). f. Remove suspension system from hard hat and sew nylon webbing to sizing band between front and back head strap with a 19.05 mm (3/4 inch) box stitch. Make sure latch is turned toward outside of cap. g. Install suspension system back into hard hat.						

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NO.	Table II. MANUFACTURING OPERATIONS REQUIREMENTS (cont'd)	STITCH TYPE	SEAM AND STITCHING TYPE	STITCHES PER INCH	THREAD		
					NEEDLE	BOBBIN/ LOOPER	COVER
22.	**Attach butyl face seal.** Instructions for attaching the face mask seal to the suit in accordance with NARADCOM Drawing 8–2–651, Figure 2, shall be furnished upon production of first suit.						

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3.5.4.2 **Application of Seam Strapping.** Strapping shall be applied to both the inside and the outside of all seams (except where the slide fasteners are stitched to the suit and are only strapped on the outside) using the adhesive specified in 3.2.3. Each individual seam shall be strapped with a continuous length of strapping. Piecing of strapping shall not be permitted. When the strapping is centered over the seam and pressed into position, the cement line may extend a maximum of 19.05 mm (3/4 inch) on either side of the strapping.

3.5.5 **Repairs in Coating of the Finished Suit Assembly.** Areas continuing coating defects may be repaired by application of two round, superimposed, 38.1 mm ± 6.35 mm (1–1/2 ± 1/4 inch) diameter patches with one patch on the inside of the suit and the other on the outside of the suit. Patches shall be made of the coated cloth specified in 3.2.1 and shall be adhered with the cement specified in 3.2.3. The lightly coated side of the patch shall be cemented to the suit, and the patch shall extend a minimum of 12.7 mm (one-half inch) beyond all edges of the damaged area. The patch shall be smoothly and evenly adhered over its entire area and shall be well adhered to the coated cloth so that, when subjected to flexing action between the hands, will show no lifting of the edge, and no cracking, flaking or removal of the cement or patch. The repaired area shall show no stiffening or tackiness which would affect the serviceability.

3.5.5.1 **Location and Number of Repairs.** Repairs not exceeding eight in number may be made to each suit assembly, provided not more than two repairs are made in either sleeve nor more than three repairs made on any body part.

3.6 **Performance.**

3.6.1 **Adhesion of Strapping.** After application of the strapping as specified in 3.5.4, the adhesion property shall meet the requirements of Table III when tested as specified in Table IV.

TABLE III. Adhesion of Strapping.

Characteristic	Minimum Requirements
	Adhesion, newton per metre (pounds per inch) of width:
Initial	525.38 N/m (3.0 lb/inch)
After water immersion	350.25 N/m (2.0 lb/inch)
After heat aging	350.25 N/m (2.0 lb/inch)

3.7 **Leakage.** The chemical protective suit (EPA) shall be free from leaks when tested as specified in 4.4.3.

3.8 **Workmanship.** The finished chemical protective suit (EPA) shall conform to the quality of product established by this purchase description and the occurrence of defects shall not

exceed the applicable acceptable quality level. The suit shall not contain cuts, holes, tears, abrasion marks, nor scratches which extend through coating where fabric yarns or weaves can be seen. Components shall not be omitted, damaged, misplaced, or malformed. Stitchings shall not be omitted, and seams shall be the type specified. All metal and plastic components shall function properly and shall not contain sharp burrs or edges. Straps shall not be omitted and shall be properly stitched. Markings shall not be missing, incomplete, incorrect, illegible, unspecified size, improper location, or not accomplished in the specified manner.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.1.1 Certificate of Compliance. Where certificates of compliance are submitted (see 4.4.1.2), the Government reserves the right to check test such items to determine the validity of the certification.

4.2 Classification of Inspection. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.3).

b. Quality conformance inspection (see 4.4).

4.3 First Article Inspection. When specified (see 6.1) the sample furnished in accordance with 3.1 shall be inspected as specified in 4.4.2 and 4.4.3 for compliance with design, construction, workmanship, and dimensional requirements.

4.4 Quality Conformance Inspection. Except as otherwise specified herein, sampling for inspection shall be performed in accordance with the provisions of MIL–STD–105.

4.4.1 Component and Material Inspection. In accordance with 4.1, components and materials shall be inspected in accordance with all the requirements of referenced specifications, drawings, and standards unless otherwise excluded, amended, modified, or qualified in this specification or applicable purchase document. In addition to the testing provisions combined in subsidiary specifications, drawings, or standards, testing shall be performed on components listed in table IV for characteristics noted. The sample unit for testing the adhesive shall be one pint. The sample size shall be two and each sample unit shall be taken from a different container in the lot.

INSTRUCTIONS FOR TESTING — TABLE IV

CHARACTERISTIC: Component and Lot size Expressed in Terms of	CHARACTERISTIC	Specification Reference: Requirement	Specification Reference: Test Method	Requirements Applicable To: Individ Unit	Requirements Applicable To: Lot Aver	Number Determinations Per Unit per Sample Unit	Results Reported As: Pass or Fail	Results Reported As: Numerically to Nearest	Inspect Level	AQL
Strapping adhesive (5 gallons)	Cold crack of cement film	3.2.3	4.5.4 2/	–	X	1	X			
	Hydrostatic resistance:									
	–before applying cement	3.2.3	5512 1/ of FED–STD–191	–	X	2	–	3,447.38 Pa(0.5 P.S.I.)		
	–after applying cement	3.2.3	5512 2/ of FED–STD–191	–	X	2	–	3,447.38 Pa(0.5 P.S.I.)		
	Adhesion:	3.6.1	4.5.3.1 3/	–	X	5	–	17.51N/m (0.1 pds)		
	–after water immersion	3.6.1	4.5.3.2 3/			5	–	17.51N/m (0.1 pds)		
	–after heat aging	3.6.1	4.5.3.3 3/	–	X	5	–	17.51N/m (0.1 pds)		
Slide fasteners (inner and outer)		3.2.5	4.4.1.1	ea.	–	1	X		100%	

[1]Two 203.2 by 203.2 mm (8 by 8 inch) pieces of the coated cloth specified in 3.2.1 shall be used to determine hydrostatic resistance.

[2]Three 203.2 by 203.2 mm (8 by 8 inch) pieces of the coated cloth specified in 3.2.1 shall be coated with the adhesive specified in 3.2.3 and shall be used to perform the tests for the characteristic cold crack and hydrostatic resistance applicable to component cement (see 4.5.4 for method of applying cement).

[3]Three panels, specially prepared by the contractor, each consisting of two 101.6 mm (4 inches) wide by 0.91 m (1 yard) long pieces of the coated cloth specified in 3.2.1, shall be joined using the seam and stitch type specified in table II. The seamed samples shall then be strapped on one side only, with 25.4 mm (1 inch) wide strip of strapping material specified in 3.2.2 utilizing the adhesive specified in 3.2.3.

NATICK Form 598
1 Mar 77 EDITION OF 1 JUL 76 IS OBSOLETE.

4.4.1.1 **Slide Fastener Test.** Affix each slide fastener at each end to a wood or metal frame shaped at one end to simulate the curvature of the suit in the crotch area. After locking fastener in test frame, close and open the slide fastener 20 times in rapid succession. Remove slide fastener from frame and examine for conformance to 3.2.5.

4.4.1.2 **Certificate of Compliance.** Components and materials listed below may be accepted on the basis of a contractor's certificate of compliance.

Component	Required Paragraph
Slide fasteners	3.2.5
Cleaning agent (solvency)	3.5.4
Cement (composition)	3.2.3

4.4.1.3 **In-process Inspection.** in-process inspection shall be performed whenever the non-performance of any operation or omission of any component cannot be determined during examination of the completed end item. Evidence of the supplier's noncompliance with requirements of the specification disclosed during in-process inspection may be cause for rejection of all items wherein noted deficiencies are suspected to exist. Final determination of suspected noncompliance shall be accomplished at the discretion of the Government, by partial or complete disassembly of the chemical protection suits (EPA) in question.

4.4.2 **Examination of the End Item.** The defects found during the examination of the end item shall be classified in accordance with 4.4.2.1 and 4.4.2.2. The applicable inspection levels and exceptable quality levels shall be as indicated in 4.4.2.3. The sample unit for the visual examination in 4.4.2.1 shall be one chemical protection suit (EPA).

4.4.2.1 **Visual Examination of Chemical Protection Suit (EPA).** The chemical protection suit (EPA) shall be examined for defects in finish, design, material, construction, workmanship, and marking.

TABLE V. TESTING OF THE END ITEM

Examine	Defect	Classification Critical	Major	Minor
Finish:				
Color	Variation in color.			X
Cleanliness	Spot, stain, or streak more than 25.4 mm (1 inch) in combined direction which cannot be readily removed with naphtha or water.			X
	Cement line extends more than 19.05 mm (3/4 inch) on either side of the strapping on major portion of seam.			X
	Any characteristic not in accordance with specified requirements (unless otherwise indicated herein).		X	
Material:				
General	Any component not fabricated of the specified material (unless otherwise indicated herein).		X	
Coated cloth	Cut, hole, tear which extends through or exposes the base cloth.	X		
	Abrasion mark or scratch which extends through the coating to a point where base fabric yarns or fabric weave can be seen.	X		
	Uncoated area.	X		
	Pit, blister, tunnel, or delamination of coating.	X		
	Lump or imbedded foreign matter which protrudes so as to be readily abraded from material or easily removed.	X		
	Crease or wrinkle resulting in adhesion of surface or delamination of coating when corrected by manual pressure.	X		
NOTE:	A pick glass may be used to determine the degree of deficiency under "coated cloth" classifications.			

TABLE V. TESTING OF THE END ITEM

Examine	Defect	Classification Critical	Major	Minor
Construction and workmanship (generally applicable to all components unless otherwise specified herein)	Any component omitted, damaged, misplaced, operation omitted or not properly performed, seriously affecting serviceability.		X	
	Any component misplaced, omitted, damaged, operation not properly performed, affecting serviceability but not seriously.			X
	Any component damaged, misplaced, operation omitted or not properly performed, which may result in injury to the user.	X		
	Any component or assembly malformed seriously affecting serviceability.		X	
	Any component or assembly malformed affecting serviceability but not seriously.			X
Repairs	Patch less than 31.75 mm (1 1/4 inches).		X	
	Patch greater than 44.45 mm (1 3/4 inches) but not greater than 2 inches.			X
	Patch greater than 50.8 mm (2 inches).		X	
	More than two repairs per sleeve.			X
	More than three repairs per body part.		X	
	More than eight repairs per suit.		X	
	Damaged area patched on one side only.		X	
	Heavily coated side of patch cemented to the suit.			X
	Patch extends less than 12.7 mm (1/2 inch) beyond all edges of the damaged area.		X	
	Patches not superimposed by more than 6.35 mm (1/4 inch).			X
	Edge listing of patch, cracking, flaking or removal of the cement or patch when hand flexed as specified in 3.5.5.	X		
	Patch not smoothly and evenly adhered.		X	
	Patch area excessively stiff or tacky affecting serviceability.	X		

TABLE V. TESTING OF THE END ITEM

Examine	Defect	Classification Critical	Major	Minor
Seams and stitching	Not seam type specified.		X	
	Not stitch type specified.			X
	Stitching omitted where required.		X	
	One or two stitches per 25.4 mm (inch) less than the minimum specified.			X
	Three or more stitches per 25.4 mm (inch) less than the minimum specified.		X	
	More than the maximum number of stitches per inch but not damaging fabric.			X
	More than the maximum number of stitches per 25.4 mm (inch) damaging fabric.		X	
	One or more rows of stitching forming box stitching omitted or insecure to a degree where assembly may become detached.		X	
	One or more rows of stitching forming box stitching loosely accomplished but assembly is not expected to become detached.			X
	Gage of stitching irregular or not, as specified.			X
	End of all stitching when not caught in other seams or stitching, back stitched less than 6.35 mm (1/4 inch).			X
	Stitching of thread breaks overlapping in less than 12.7 mm (1/2 inch) at each end of break.			X
	Any raw edges where not permitted.			X
	Any open seam (see NOTE).			X

NOTE: When one or more stitches are broken or two or more consecutive skipped stitches or any runoff occurs on a single-stitched seam or on both rows of stitching on a double-stitched seam, it shall be classified as a major defect. When one or more stitches are broken or two or more continuous skipped stitches or any runoff occurs on only one row of a double-stitched seam, it shall be classified as a minor defect.

TABLE V. TESTING OF THE END ITEM

Examine	Defect	Classification		
		Critical	Major	Minor
Strapped seams	Any seam open completely through suit.	X		
	Strapping omitted on both sides of any seam where double-strapping is required.	X		
	Any seam strapped on only one side where double-strapping is required.		X	
	Strapping on both sides in the same area of seam not securely affixed, i.e., strapping not properly cemented so that it can be readily pulled off seam with little resistance.	X		
	Strapping on only one side of double-strapped seam not securely affixed.		X	
	Strapping not securely affixed on specified single-strapped seams.		X	
	Any blister or delamination in central area of strapping affixed and the bonded portion of strapping is securely cemented to cloth.			X
	Strapping on one side of a double-strapped seam does not completely cover stitching on seam.		X	
	Strapping on both sides in the same area of seam does not cover stitching on seam.	X		
	Strapping off center by more than 3.175 mm (1/8 inch) but covers seams and stitching.			X
	Any opening at edge of strapping 1.5875 mm (1/16 inch) or more but does not extend to the stitching.			X
	Any opening extending to the stitching.		X	
	Any individual seam not having a continuous length of strapping.		X	
	Piecing of strapping on individual seams.		X	

TABLE V. TESTING OF THE END ITEM

Examine	Defect	Classification		
		Critical	Major	Minor
Metal and plastic components	Any metal component missing, reversed on assembly, or not properly affixed to a degree where it may become detached from assembly or is damaged to a degree that it will not function.		X	
Metal components	Any metal component not properly affixed but will adequately be retained on assembly or is damaged but will function as intended.			X
	Any sharp burr or edge.			X
Face seal	Not beaded at the end.	X		
	Face seal does not fit mask.	X		
Sleeve and leg wristlets	Not beaded at the end.		X	
	Wristlet does not fit the wrist cuff or leg cuff.		X	
Webbing straps	Any strap omitted.		X	
	End of any strap not turned under and stitched.			X
Restraint	Not attached as specified.			X
	One restraint missing.		X	
	Positioned 12.7 mm (1/2 inch) more or less from zipper stopper.			X
	One-half inch longer or 12.7 mm (1/2 inch) shorter than specified in No. 2C of table II.		X	
Marking	Missing, incomplete, incorrect, not legible, not specified size, not in proper location or not accomplished in the specified manner.			X

4.4.2.2 Packaging Inspection. An examination shall be made to determine that preservation packaging, packing, and marking comply with requirements of section 5. Defects shall be scored in accordance with the list below. The sample unit shall be one shipping container fully prepared for delivery with the exception that it need not be closed. Examination for closure defects listed below shall be made on shipping containers fully prepared for delivery. The lot size shall be the number of shipping containers in the end item inspection lot. The applicable inspection level and the acceptable quality level (AQL) shall be as indicated in 4.4.2.3.

Examine	Defect
Marking (exterior and interior)	Omitted, incorrect, illegible or improper size, location, sequence or method of application.
Materials	Any component missing, damaged or not as specified.
Workmanship	Inadequate application of components, such as — incomplete closure of container flaps, improper taping, loose strapping or inadequate stapling. Bulged or distorted container.
Contents	Number of interior packages per shipping container is more or less than required.

4.4.2 3 Inspection Levels and Acceptable Quality Levels (AQLS). The inspection levels and acceptable quality levels, expressed in defects per hundred units, shall be as follows:

	Inspection Level	Critical	Major	Total
Paragraph 4.4.2.1	II	1/	4.0	15.0
Paragraph 4.4.2.2	S–1			2.5

1/ Any critical defect found during sampling inspection for major and total defects shall be cause for rejection of the lot represented by sample. One hundred percent inspection shall be performed for critical defects on each lot found acceptable under sampling inspection. Any suit found to contain a critical defect during the 100 percent inspection shall be rejected. At its discretion, the Government may verify the results of the contractor's examination by 100 percent examination or by sampling inspection.

4.4.3 **Testing of the End Item.** The finished chemical protective suit (EPA) shall be tested for the leakage characteristic listed in table V. The lot size for sampling purposes shall be expressed in units of one chemical protective suit (EPA) each. The sample unit shall be one finished chemical protective suit (EPA). The sample size shall be as specified below. The lot shall be unacceptable if one or more sample units fail to meet the leakage requirement specified.

Lot Size	Sample Size
800 or less	2
801 to 22,000	3
22,001 and over	5

TABLE V. Testing of the end item

Charac.	Requirement Paragraph	Test method	No. determinations per sample unit	Results reported numerically to nearest
Leakage	3.7	4.5.2	1	Pass or fail

4.5 **Tests.**

4.5.1 **Test Conditions.** Results of physical tests obtained under test conditions defined in FED–STD–191, FED–STD–406, or FED–STD–601 shall be acceptable except in case of dispute; in dispute cases, tests shall be conducted with both the specimen and test apparatus under standard conditions as defined in FED–STD–191.

4.5.2 **Leakage.** The wrist, leg openings, and neck of the chemical protective suit (EPA) shall be blocked off from within by tapered plugs of such dimensions as to provide a slip fit with neither wrinkle nor undue extension of the cloth. Two of the five plugs shall be provided with nipples, one for attachment to an air line and the other for attachment to a water manometer (inclined type). The chemical protective suit (EPA) shall be air inflated to 10 ± 1.0 mm (0.39 ± 0.039 inches) water pressure and progressively brushed with a 0.25-percent soap solution until completely covered. No bubble shall be observed at any point in the chemical protective suit (EPA) within an estimated interval of 30 seconds subsequent to application of the soap solution. Appearance of a bubble (any leakage) within the 30-second observation shall be cause for rejection of the lot.

4.5.3 **Strapping Adhesion.**

4.5.3.1 **Strapped Seams.** After the seam strapping assembly has aged under standard conditions for 48 hours, the adhesion of strapping to the seams shall be determined as specified in Method 5962 of FED–STD–191 except as follows: The adhesion shall be the lowest individual load resistance registered in newton per metre (N/kg) (pounds per inch) of strapping

width on the autographic chart for 76.2 mm (3 inches) of seam strapping separation in lieu of the average of the five highest peak loads resistance registered for 76.2 mm (3 inches) of separation of strapping.

4.5.3.2 Strapped Seams After Immersion. The seams shall be immersed for two hours in boiling water, removed, immersed for 15 minutes in water in 23.9°C ± 2.8°C (75°F ± 5°F), removed from the water, and while still dripping wet, tested for strapping adhesion as specified in 4.5.3.1.

4.5.3.3 Strapped Seams After Heat Aging. The seam samples shall be exposed for seven days in a circulating air oven at 70°C ± 1.1°C (158°F ± 2°F), removed from the oven and brought to equilibrium under standard conditions and then tested for strapping adhesion as specified in 4.5.3.1.

4.5.4 Cold Crack of Cement Film. Coated cloth squares of material specified in 3.2.1 not less than 203.2 by 203.2 mm (8 by 8 inches) shall be completely coated on one side only, with two layers of cement. The cement shall be applied in accordance with the procedure followed in strapping the seams. The test specimen shall be dusted, tack free after drying and shall be tested at −28°C. (−20°F.), as specified in Method 5874 of FED−STD−191, after conditioning for four hours ± 15 minutes at the test temperature. All specimens shall be conditioned for not less than 72 hours at standard conditions prior to performing the tests. In the performance of the test, the cement side shall be considered the heavily coated side.

4.5.5 Adhesion of Leg Cuff to Trouser Leg. The leg cuff to be tested shall be clamped in a horizontal position, with the clamps arranged symmetrically at four points around the periphery of the leg cuff and with the leg cuff uppermost and trouser leg below. About 152.4 mm (six inches) below the leg cuff, a round wooden disk about 25.4 mm (one inch) thick shall be placed inside the leg and shall be clamped to it in a horizontal position by means of a ladder clamp or by other suitable means. The disc and clamp shall be lined with pressure sensitive adhesive coated cloth tape to prevent scoring or other damage to the coated fabric leg material. The disc diameter shall be approximately that of the sleeve at the position of the disc, so as to be free of folds or stretching. The adhesive bond between leg cuff and boot shall be subjected for four hours to the pull of 11.34 kg (25-pound) weight placed and centered on the disc inside the leg, and the bonded joint shall then be examined for conformance to 3.2.3.

4.5.6 Adhesion of Wrist Cuff to Sleeve. The test arrangement and procedure shall be the same as specified for the leg cuff bond except that the test weight shall be 6.80 kg (15 pounds), and the disc diameter shall be reduced as required for fit without fold or undue stretching of the sleeve fabric.

5. PACKAGING

5.1 Preservation-Packaging. Preservation-packaging shall be level A or C as specified (see 6.1).

5.1.1 Level A. All the projecting hardware on the suit shall be cushioned in accordance with method III of MIL--P−116. Each suit with slide fastener closed, shall be laid out flat,

front up, and then be neatly and compactly folded with the leg, arm, and neck disconnects lying flat within the folded garment. One folded suit, with the component brace on top shall be packaged together in a snug-fitting fiberboard box conforming to style RSC, type CF (variety SW), class domestic, grade 200 of PPP–B–636. Box closure shall be the same as normally used by the contractor for retail distribution.

5.1.2 **Level C.** Each suit shall be preserved-packaged to afford adequate protection against physical damage during shipment from the contractor to the first receiving activity. The package and the quantity per package shall be the same as that normally used by the contractor for retail distribution.

5.2 Packing. Packing shall be level A, B, or C (see 6.1).

5.2.1 **Level A Packing.** Four suits of one size only, preserved-packaged as specified in 5.1, shall be packed in a snug-fitting fiberboard shipping container conforming to style RSC, grade V2s of PPP–B–636. Level A packages shall be packed flat, two in length, one in width, and two in depth within a shipping container. Each fiberboard container shall be closed in accordance with method III, waterproofed in accordance with method V, and reinforced as specified in the appendix of PPP–B–636, except that the inspection shall be in accordance with 4.4.2.2. Toward the end of the contract, or when there are fewer than the required amount per container of the same size, mixed sizes may be packed within the same container.

5.2.2 **Level B Packing.** Four suits of one size only preserved-packaged as specified in 5.1, shall be packed in a snug-fitting fiberboard shipping container conforming to style RSC, type CF (variety SW) of SF, class domestic, grade 275 of PPP–B–636. Level A packages shall be preserved-packaged flat, two in length, one in width, and two in depth within a shipping container. Each shipping container shall be closed in accordance with method II as specified in the appendix of PPP–B–636, except that the inspection shall be in accordance with 4.4.2.2. Toward the end of the contract of when there are fewer than the required amount per container of the same size, mixed sizes may be packed within the same container.

5.2.2.1 **Weather-Resistant Fiberboard Containers.** When specified (see 6.1), the fiberboard shipping container shall be a grade V3c, V3s, or V4s fiberboard box fabricated in accordance with PPP–P–636 and closed in accordance with method III as specified in the appendix of PPP–B–636, except that the inspection shall be in accordance with 4.4.2.2.

5.2.3 **Level C Packing.** Suits preserved-packaged as specified in 5.1, shall be packed in a manner to insure carrier acceptance and safe delivery at destination at the lowest transportation rate for such supplies. The quantity per shipping container shall be the same as that normally used by the contractor for retail distribution. Containers shall be in accordance with Uniform Freight Classification or National Motor Freight Classification, as applicable.

5.3 **Marking.** In addition to any special marking required by the contract, interior packages and shipping containers shall be marked in accordance with MIL–STD–129.

5.3.1 **Labels, Mixed Sizes.** Each shipping container packed with mixed sizes shall have securely attached to the end and side, directly under the printing or stencilling, a white paper label 127 mm by 101.6 mm (5 by 4 inches) with the words "MIXED SIZES" plainly printed or stamped thereon and under these words shall be legibly printed or stamped the correct quantity and sizes contained therein.

6. NOTES

6.1 Ordering Data. Procurement documents should specify the following:

(a) Title, number, and date of this purchase description.

(b) Sizes required (see 1.2).

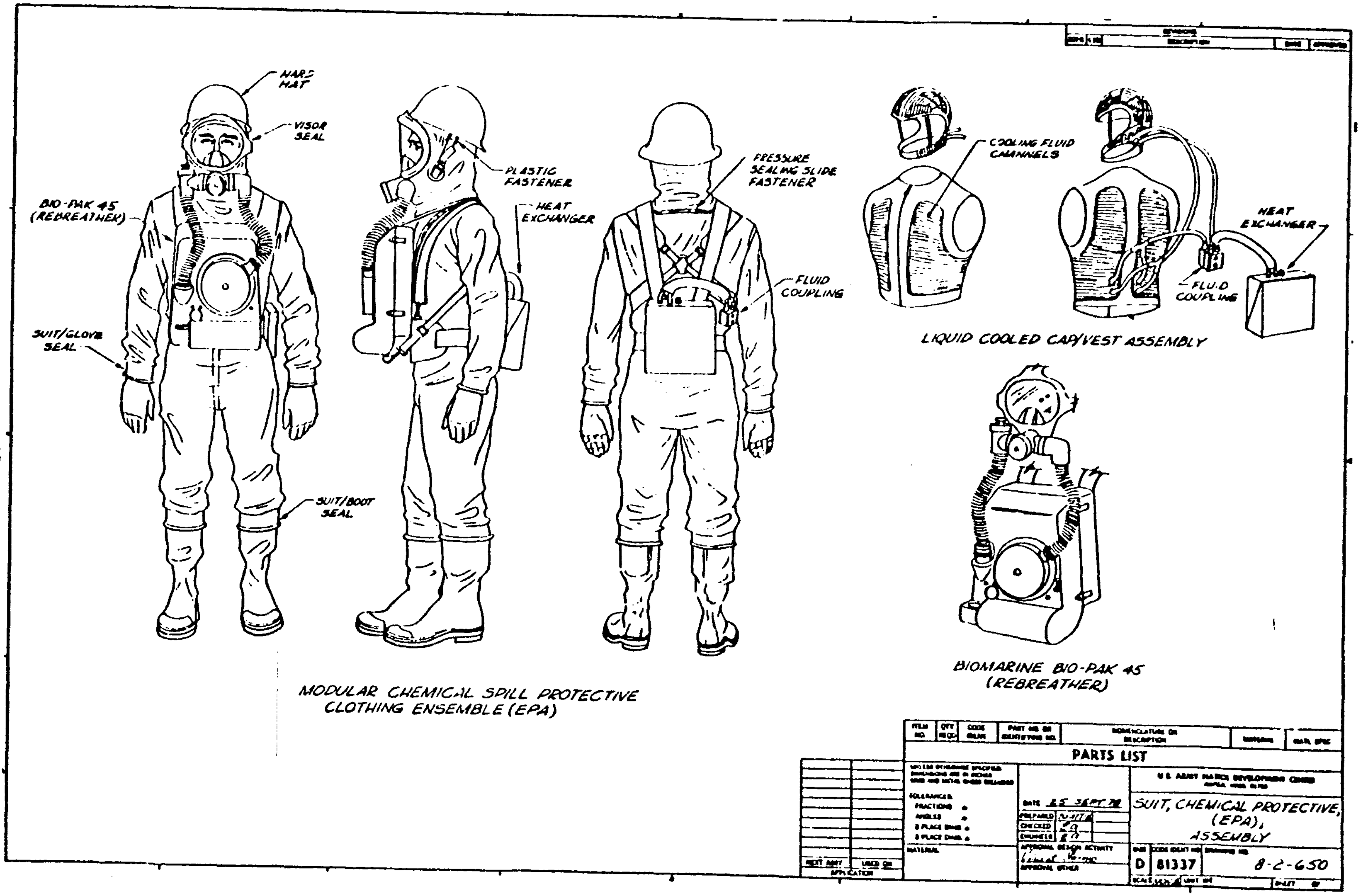
(c) When a first article is required (see 3.1, 4.3, and 6.3).

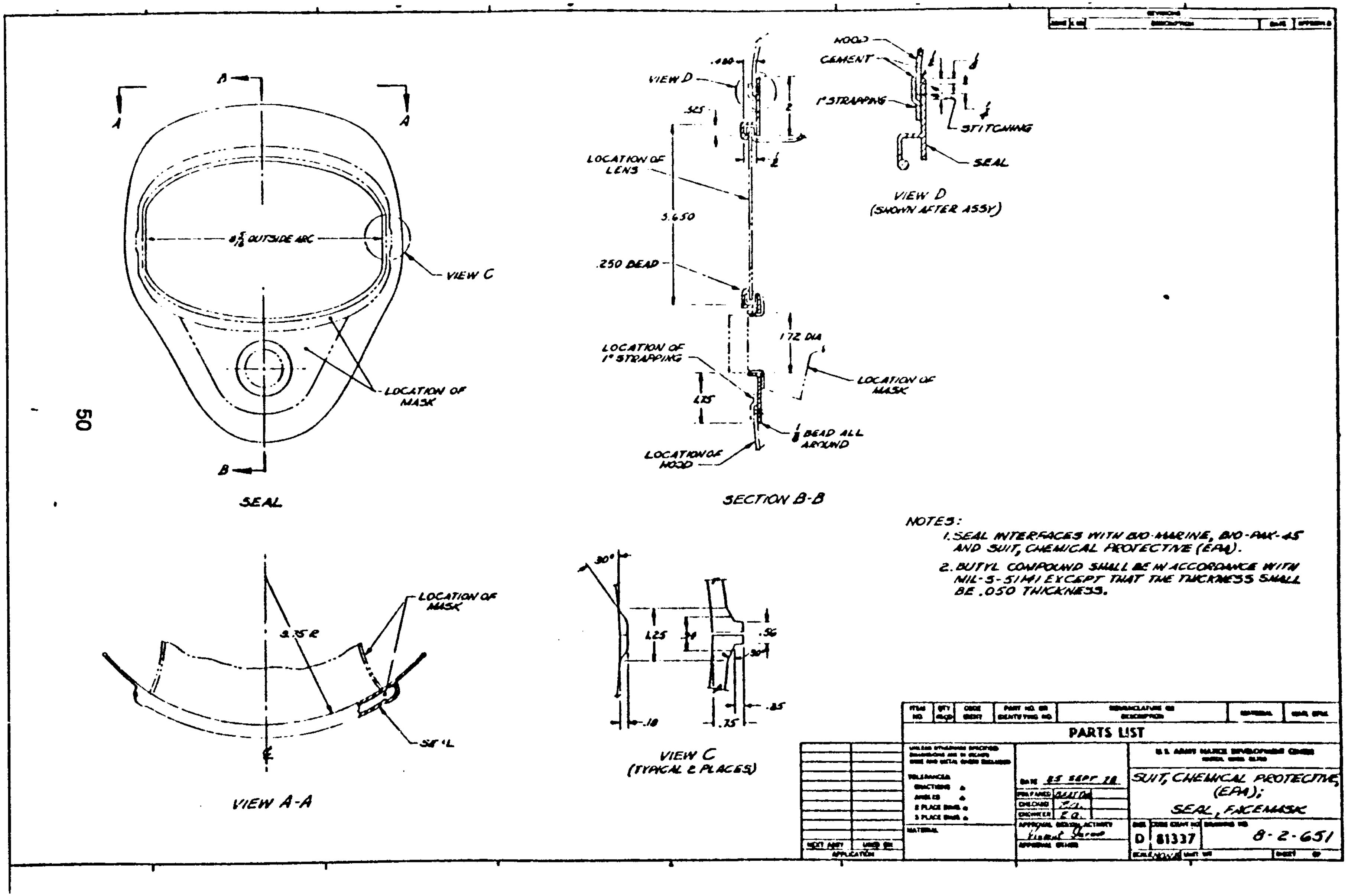
(d) Selection of the applicable levels of preservation-packaging and packing (see 5.1 and 5.2).

(e) When weather-resistant grade fiberboard shipping containers are required for level B packing (see 5.2.2.1).

6.2 Adhesive Bostik 1177 (Bostik Division, USM Company) has been used satisfactorily to meet the required performance (see 3.2.3).

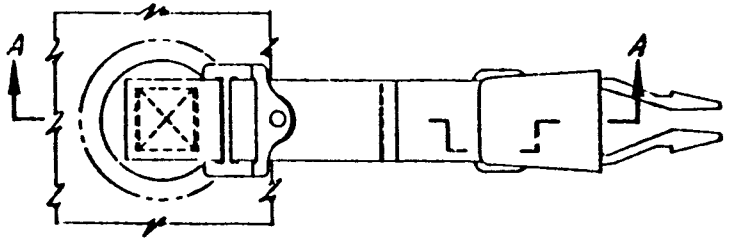
6.3 First Article. When a first article is required, it shall be inspected and approved under the appropriate provisions of paragraph 7–104.55 of the Armed Services Procurement Regulation. The first article should be a pre-production sample and consist of one complete chemical protection suit (EPA). The contracting officer should include specific instructions in all procurement instruments regarding arrangement for inspection and approval of the first article.

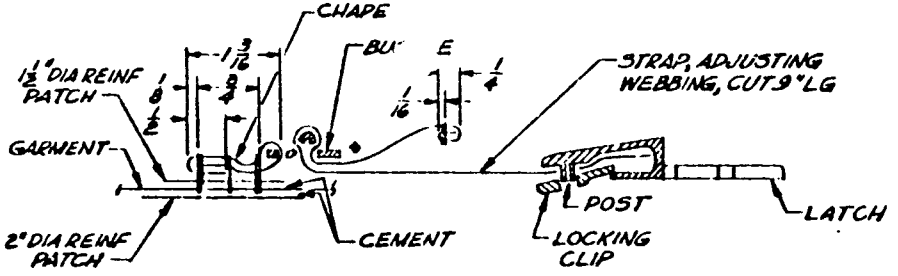

HARD HAT
VISOR SEAL
BIO-PAK 45 (REBREATHER)
SUIT/GLOVE SEAL
SUIT/BOOT SEAL
PLASTIC FASTENER
HEAT EXCHANGER
PRESSURE SEALING SLIDE FASTENER
FLUID COUPLING
COOLING FLUID CHANNELS
HEAT EXCHANGER
FLUID COUPLING
LIQUID COOLED CAP/VEST ASSEMBLY
BIOMARINE BIO-PAK 45 (REBREATHER)
MODULAR CHEMICAL SPILL PROTECTIVE CLOTHING ENSEMBLE (EPA)
PARTS LIST
DATE 25 SEPT 78
SUIT, CHEMICAL PROTECTIVE, (EPA), ASSEMBLY
D 81337 8-2-650


SEAL
VIEW C
LOCATION OF MASK
$8\frac{5}{8}$ OUTSIDE ARC
VIEW A-A
LOCATION OF MASK
9.75 R
SEAL
SECTION B-B
VIEW D
LOCATION OF LENS
5.650
.250 BEAD
LOCATION OF 1" STRAPPING
.172 DIA
LOCATION OF MASK
1/8 BEAD ALL AROUND
LOCATION OF HOOD
VIEW D
(SHOWN AFTER ASSY)
HOOD
CEMENT
1" STRAPPING
STITCHING
SEAL
VIEW C
(TYPICAL 2 PLACES)
NOTES:
1. SEAL INTERFACES WITH BIO-MARINE, BIO-PAK-45 AND SUIT, CHEMICAL PROTECTIVE (EPA).
2. BUTYL COMPOUND SHALL BE IN ACCORDANCE WITH MIL-S-5141 EXCEPT THAT THE THICKNESS SHALL BE .050 THICKNESS.
PARTS LIST
DATE 25 SEPT 78
SUIT, CHEMICAL PROTECTIVE, (EPA);
SEAL, FACEMASK
D 81337
8-2-651

NOTES:

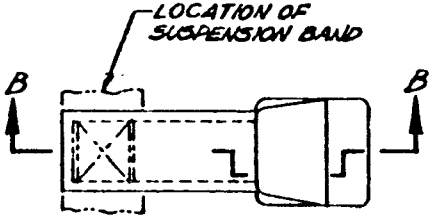
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

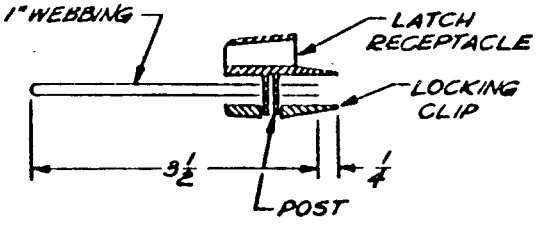




SECTION A-A

STRAP, HARD HAT RETAINING





SECTION B-B

CHAPE, HARD HAT

ITEM NO.	QTY REQD	CODE IDENT	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	MATL SPEC	DWG NO.

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES WIRE AND METAL GAGES EXCLUDED

TOLERANCES:
FRACTIONS ±
ANGLES ±
2 PLACE DIMS. ±
3 PLACE DIMS. ±

MATERIAL

DATE 25 SEPT 78

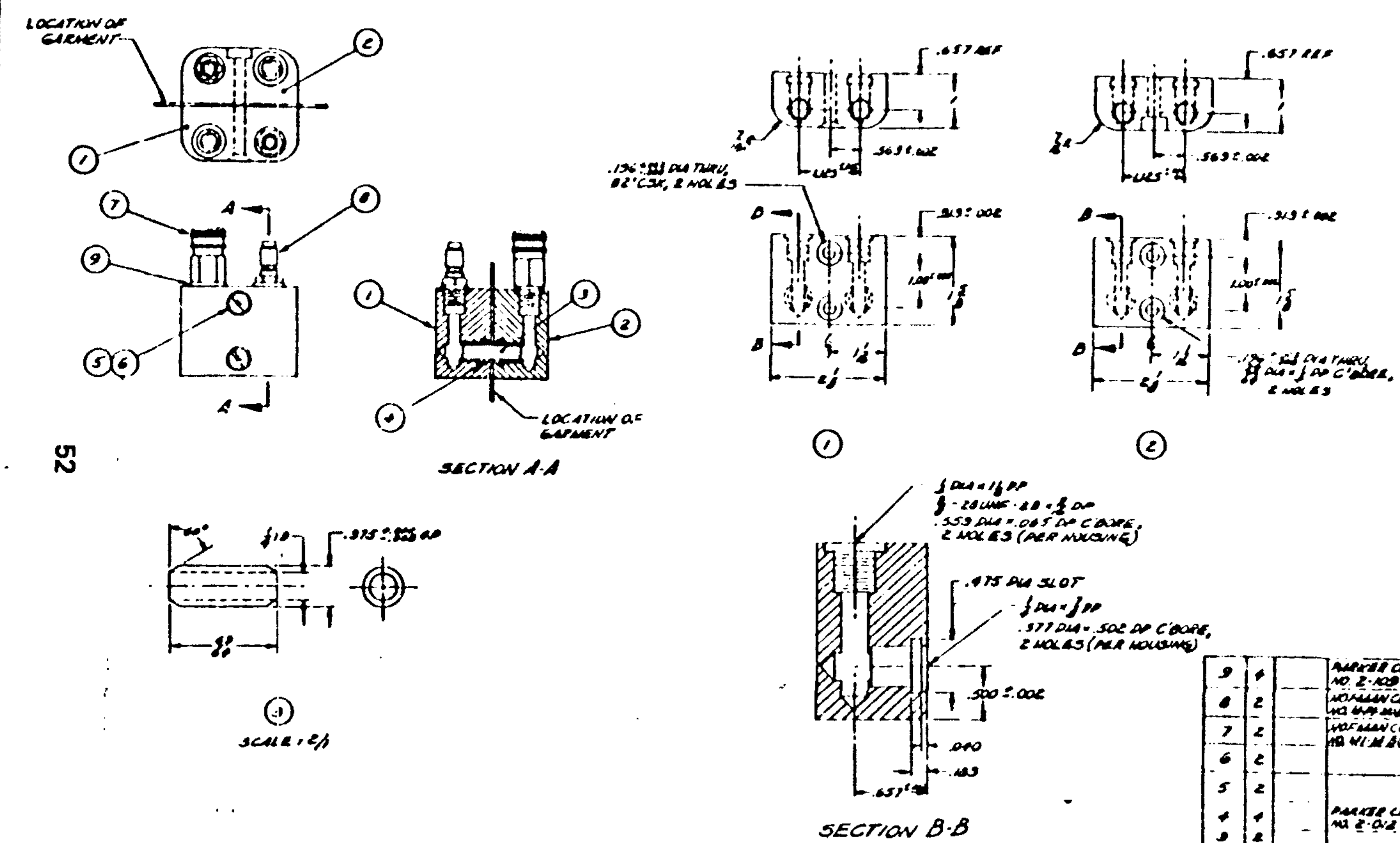
PREPARED	BCAttas
CHECKED	E.A.
ENGINEER	E.A.
APPROVAL DESIGN ACTIVITY	Vincent Santo
APPROVAL OTHER	

U.S. ARMY NATICK LABORATORIES
NATICK, MASS. 01760

SUIT, CHEMICAL PROTECTIVE (EPA);
HARD HAT RETAINING ASSY

SIZE	CODE IDENT NO	DRAWING NO.
C	81337	8-2-652

SCALE 1/1 | UNIT WT | SHEET OF



ITEM NO	QTY REQ'D	CODE IDENT	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	MATL SPEC
9	4	—	PARKER CO NO. 2-109	O-RING, .209 ID × .305 OD × .103 DIA	BUNA-N	—
8	2	—	HOFMAN CO NO. [illegible]	COUPLING, QUICK DIS-CONNECT (MALE)		—
7	2	—	HOFMAN CO NO. [illegible]	COUPLING, QUICK DIS-CONNECT (FEMALE)		—
6	2	—		NUT, HEX HD, NO. 10-28 UNF-2B	STL, CRES	—
5	2	—		SCR, MACH, FL HD, NO. 10-28 UNF-2A × [illegible] LG	STL, CRES	—
4	4	—	PARKER CO NO. 2-012	O-RING, .364 ID × .504 OD × .070 DIA	BUNA N	—
3	2	—	—	SLEEVE	DELRIN, COLOR WHITE	—
2	1	—	—	HOUSING, RIGHT HAND	DELRIN, COLOR WHITE	—
1	1	—	—	HOUSING, LEFT HAND	DELRIN, COLOR WHITE	—

PARTS LIST

U.S. ARMY NATICK DEVELOPMENT CENTER

SUIT, CHEMICAL PROTECTIVE (EPA); FLUID COUPLING (COOL HEAD) ASSY & DETAILS

DATE 25 SEPT [illegible]

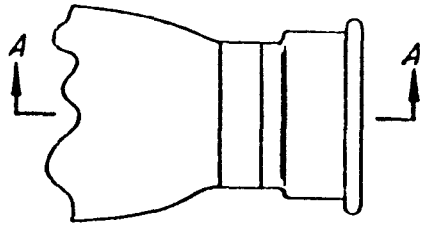
TOLERANCES FRACTIONS ± 1/64

D 81337 8-2-653

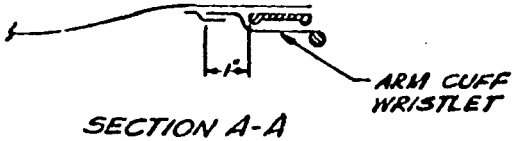
SCALE 1/1

NOTES:

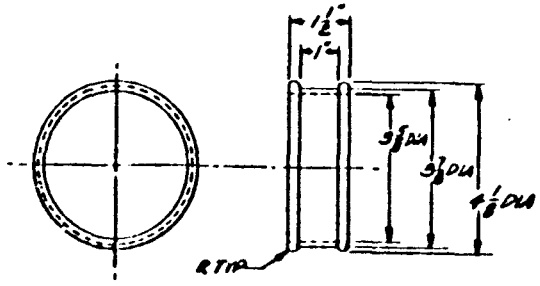
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



WRIST CUFF ASSEMBLY



SECTION A-A



CUFF, WRIST
MATL: RIGID PVC OR ABS
SCALE: ½

NOTE:
ALL SURFACES SHALL BE FREE OF VOIDS AND PITS.

53

ITEM NO.	QTY REQD	CODE IDENT	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	MATL SPEC	DWG NO.

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
WIRE AND METAL GAGES EXCLUDED

TOLERANCES:
FRACTIONS ±
ANGLES ±
2 PLACE DIMS. ±
3 PLACE DIMS. ±

MATERIAL

DATE 25 SEPT 78
PREPARED BEATTIE
CHECKED RO
ENGINEER RO

APPROVAL DESIGN ACTIVITY
Vincent Sarno
APPROVAL OTHER

U.S. ARMY NATICK LABORATORIES
NATICK, MASS. 01760

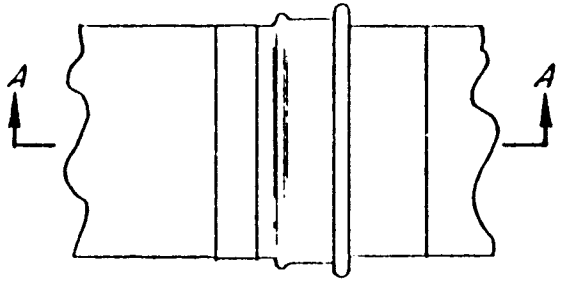
SUIT, CHEMICAL PROTECTIVE, (EPA);
WRIST DETAILS

SIZE	CODE IDENT NO.	DRAWING NO.
C	81337	8-2-654

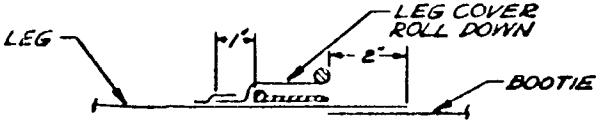
SCALE ½ | UNIT WT | SHEET OF

NOTES:

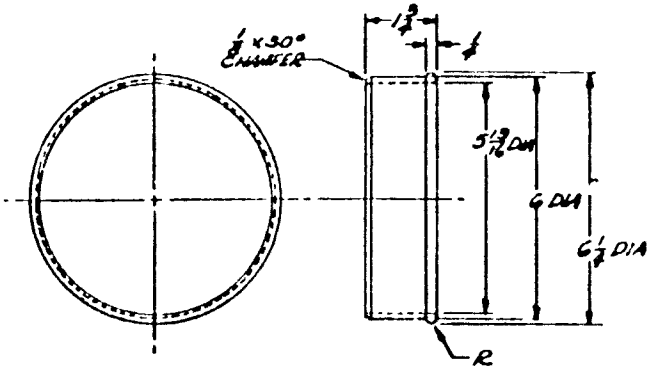
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



LEG CUFF ASSEMBLY



SECTION A-A



CUFF, LEG
MATL: RIGID PVC OR ABS
SCALE: 1/2

NOTE:
ALL SURFACES SHALL BE FREE OF VOIDS AND PITS.

54

ITEM NO	QTY REQD	CODE IDENT	PART NO. OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	MATL SPEC	DWG NO.

PARTS LIST

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES WIRE AND METAL GAGES EXCLUDED

TOLERANCES:
FRACTIONS ±
ANGLES ±
2 PLACE DIMS. ±
3 PLACE DIMS. ±

MATERIAL

DATE 25 SEPT 78
PREPARED BEATTIE
CHECKED EQ
ENGINEER EQ

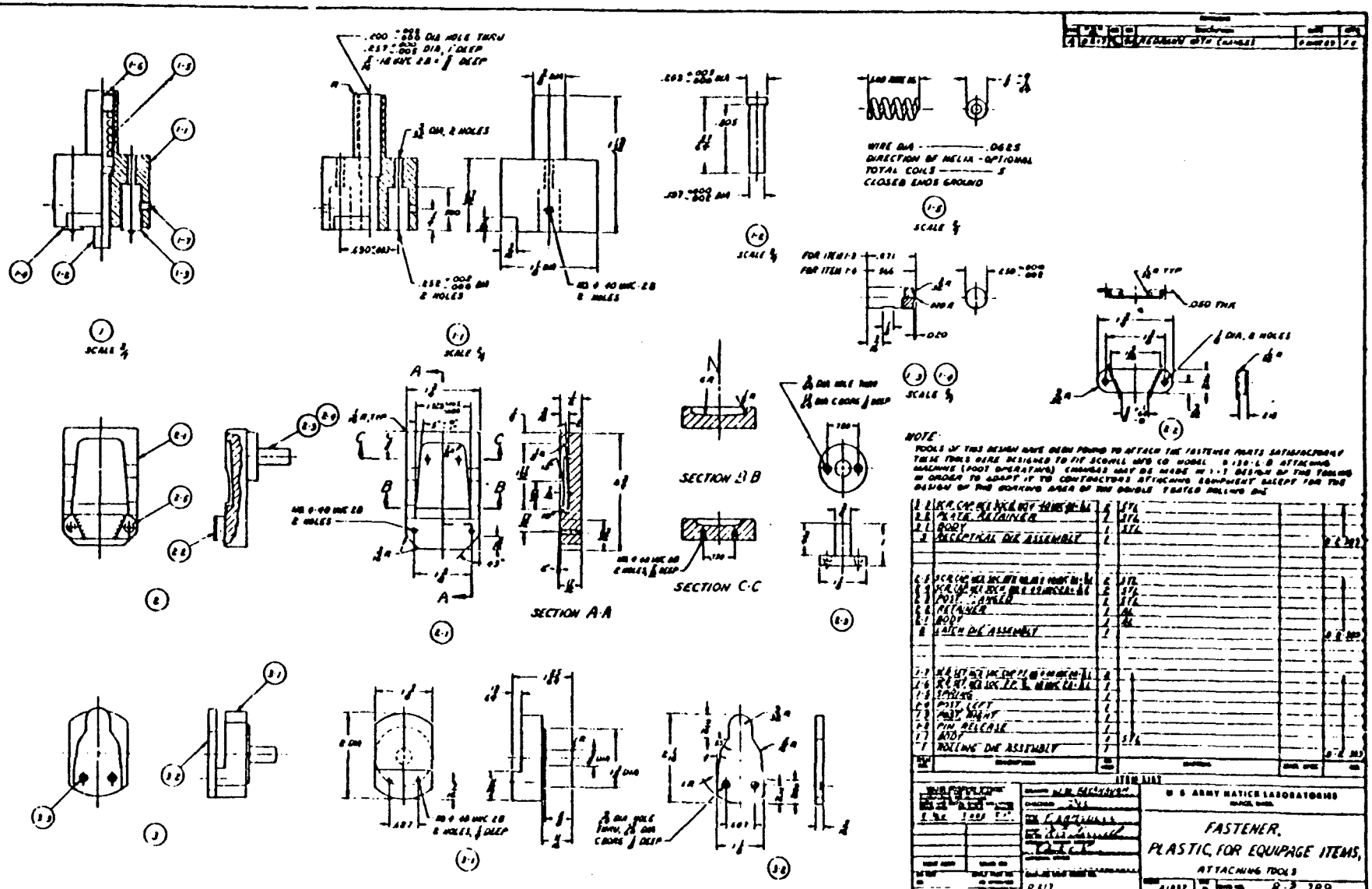
APPROVAL DESIGN ACTIVITY Vincent Daemid
APPROVAL OTHER

U.S. ARMY NATICK LABORATORIES
NATICK, MASS. 01760

SUIT, CHEMICAL PROTECTIVE, (EPA);
LEG CUFF DETAILS

SIZE	CODE IDENT NO	DRAWING NO.
C	81337	8-2-655

SCALE 1/2 | UNIT WT. | SHEET OF


SECTION A-A
SECTION B-B
SECTION C-C
SCALE 1/4
SCALE 1/2
NOTE
TOOLS OF THIS DESIGN HAVE BEEN FOUND TO ATTACH THE FASTENING PARTS SATISFACTORILY
THESE TOOLS WERE DESIGNED TO FIT SCOVILL AND CO MODEL
MACHINE (FOOT OPERATED) CHANGES MAY BE MADE IN
IN ORDER TO ADAPT IT TO CONTRACTORS ATTACHING EQUIPMENT EXCEPT FOR THE
DESIGN OF THE WORKING AREA OF THE DOUBLE TOOTED ROLLING DIE
U S ARMY NATICK LABORATORIES
FASTENER,
PLASTIC, FOR EQUIPAGE ITEMS,
ATTACHING TOOLS
8 2 389

APPENDIX B

APPENDIX B

MAINTENANCE AND STORAGE INSTRUCTIONS

A. Aeration

Upon return to home base, suit system components are unpacked from their containers and placed in a highly ventilated room for aeration. This step is performed to permit the greatest possible dissipation of chemicals from the surfaces of those components directly exposed to the contaminants. Support suit from a wooden hanger with zipper opened; spread out other components on floor or table and allow all items to stay in this area for a day or more.

N–O–T–E

USE CAUTION WHEN ENTERING AERATION ROOM TO REMOVE COMPONENTS. ROOM ENVIRONMENT MAY BE CONTAMINATED WITH TOXIC VAPORS.

B. Cleaning

a. After components are removed from aeration room, Suit assembly, less breathing mask, gloves, and boots, is washed in warm water (110°F maximum). The suit is held at the shoulder seams and completely immersed into a vat containing 15 gallons of water which contains eight ounces (1 cup) of standard household bleach solution. Then the suit is raised and dunked into the wash water to produce a mild washing action on the Butyl-coated fabric.

C–A–U–T–I–O–N

(DO NOT USE CHEMICAL SOLVENT TO CLEAN ANY FABRIC PORTION OF SUIT ASSEMBLY)

b. After the washing cycle is completed, suit is suspended from the shoulders by placement on a wooden clothes hanger.

c. Wipe dry all metal and plastic sub-components attached to the suit assembly. After the suit assembly is completely dried, apply a light coating of zipper lubricant (manufactured by GENERAL ELECTRIC CO., Silicone Products Division, Waterford, NY 12188) to zipper chain and rubber lips of suit gas-sealing closure.

d. Wash rubber boots and gloves inside and outside with warm sudsy water of soap or detergent. Rinse well and allow to air dry.

C. Storage

The following field decontamination, administrative storage will be restricted to certified protective clothing. Certified protective clothing are those clothes that, after use and decontamination, including aeration in a contaminated clothing holding area, are certified to be essentially free of vapors of toxic chemical contaminants.

D. Temporary Storage

Following aeration and during maintenance checks, each suit will be temporarily stored according to the following instructions.

a. Store all components of the same suit system in one area.

b. Store butyl suit supported from a wooden hander with gloves and boots attached. Close pressure sealing zipper about six inches from end.

E. Maintenance

If the butyl suit, gloves, or boots are damaged beyond repair, or show signs of heavy abrasion and broken gas sealing zipper, the butyl suit, gloves or boots should be removed from service. At this point damaged component or components are replaced with new component of the same size.

F. Permanent Storage

a. Place suit on clean floor or surface with the front side down and with arms and legs fully extended and apply talcum powder to inside and outside of suit and distribute powder over complete surface by use of a soft cloth.

Suit is folded as follows and placed in a polyethylene bag.

b. Starting from boot disconnect, fold back each leg section several times to crotch location and up to neck.

c. Gloves and boots are dusted with talcum powder and each pair is placed in a polyethylene bag.

d. Clean suit and components are then placed in carrying bag for permanent storage ready for next mission use.

G. Maintenance for the BIO PAK

All steps for maintenance and operation check-out for the Breathing Pack, including mask and its associated equipment, should be done in accordance with the manufacturer's Manual.

APPENDIX C

DONNING AND DOFFING PROCEDURES

W A R N I N G

IN HOT WEATHER USER MUST REMOVE ALL CLOTHING EXCEPT UNDERWEAR, TROUSER, AND SOCKS PRIOR TO DONNING (WATER COOLED, VEST/CAP)

DON BIO–PAK – 45

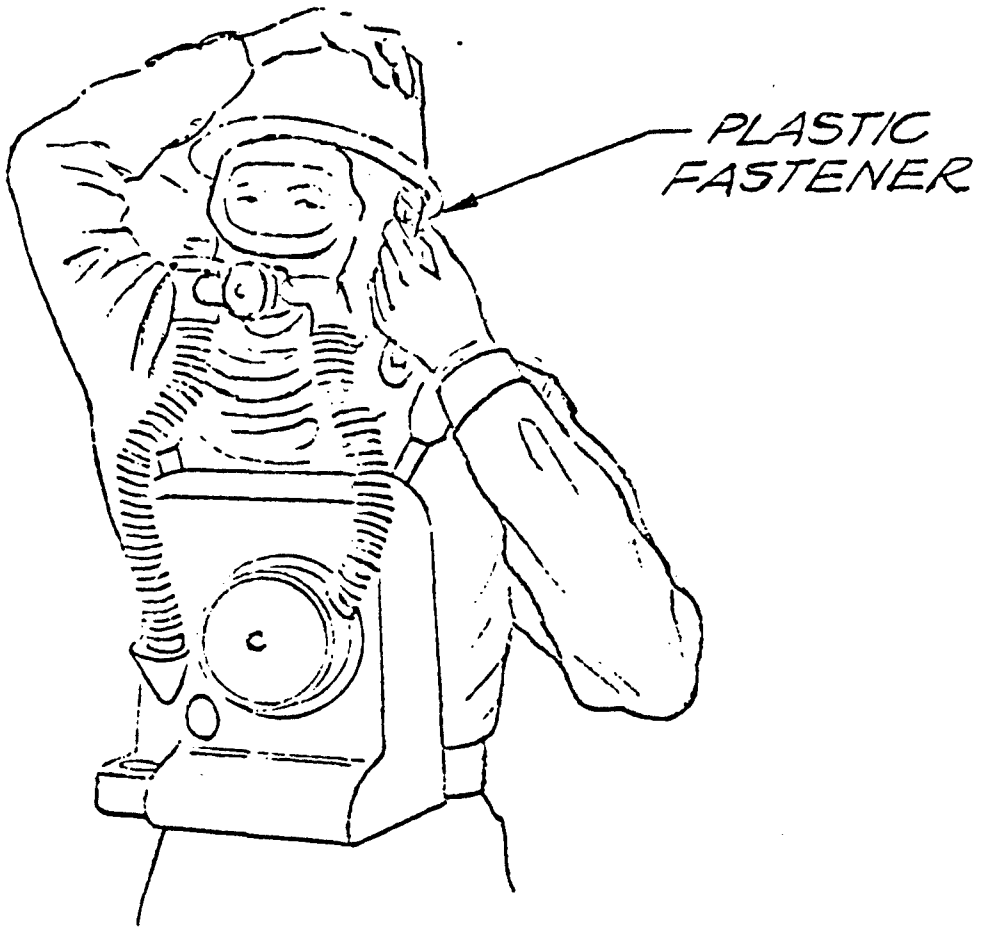
A. SLIP HARNESS OVER HEAD. WITH ONE HAND, HOLD UNIT IN PLACE AND WITH THE OTHER PULL BACK STRAP. REVERSE OPERATION FOR OTHER SIDE.

B. UNCLIP ONE END OF WAIST STRAP, LOOP AROUND BACK AND TIGHTEN. (ALL STRAPS SHOULD BE TAUT.)

C. WITH RIGHT HAND ATTACH INHALATION HOSE TO BREATHING PACK AS SHOWN ABOVE.

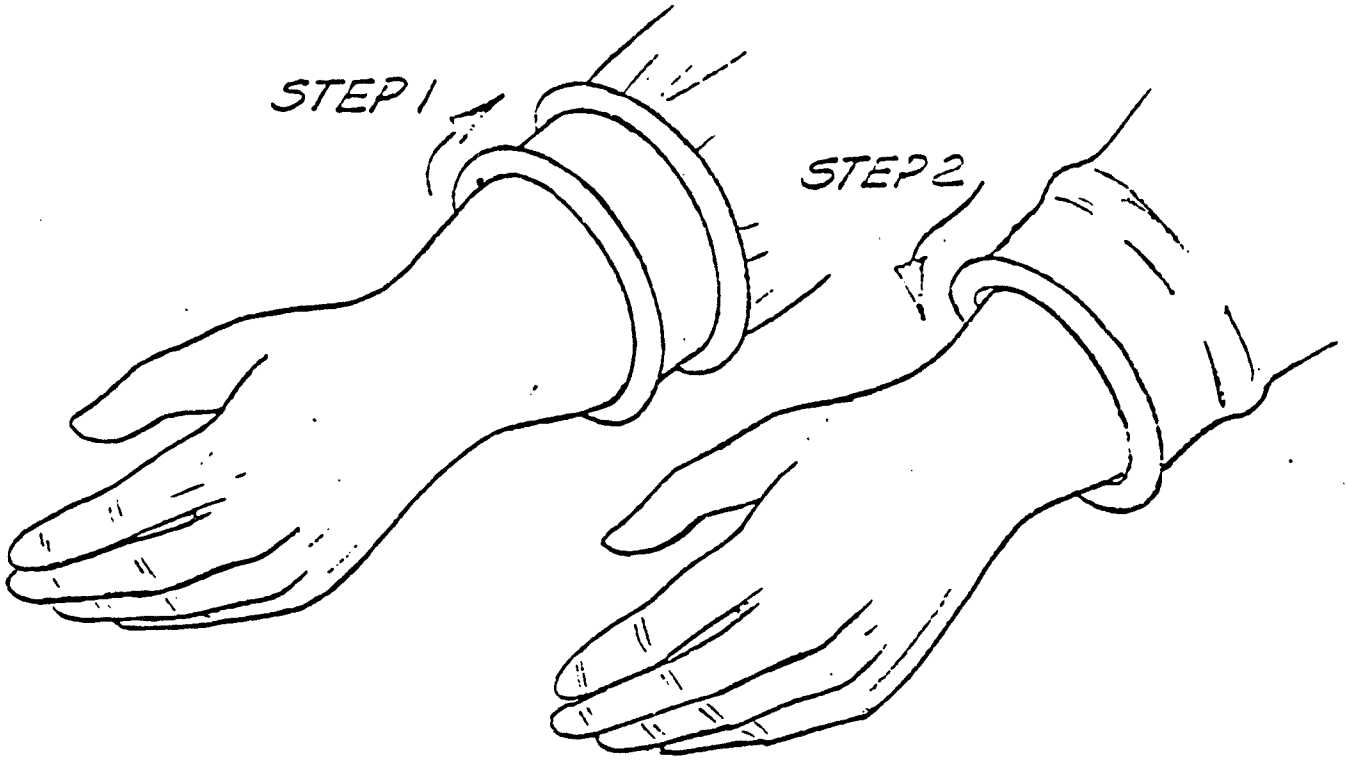
D. WITH LEFT HAND ATTACH EXHALATION HOSE TO BREATHING PACK AS SHOWN ABOVE.

E. CHECK AND FOLLOW OPERATIONAL INSTRUCTIONS GIVEN IN BIO–PAK 45 OPERATIONAL MANUAL.



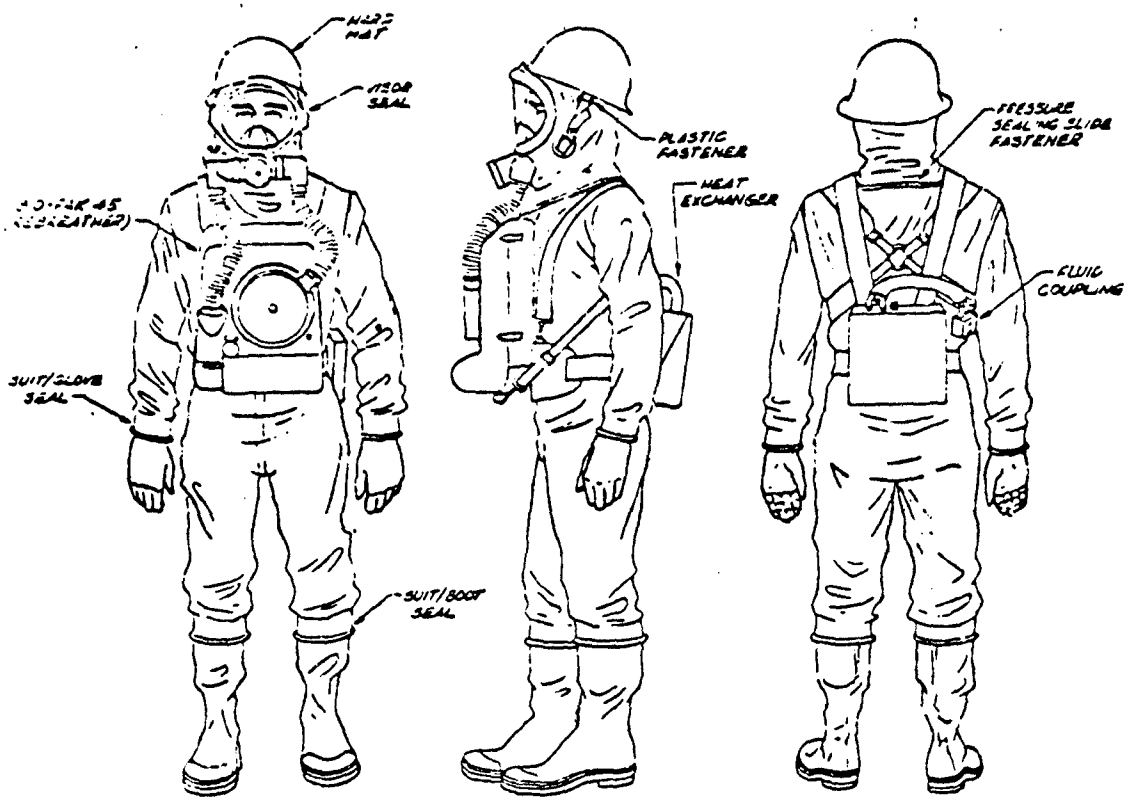
DON HARD HAT

DON HARD HAT AND ATTACH LEFT AND RIGHT SIDE OF RETAINING STRAPS TO HAT, AS SHOWN.



DON BUTYL GLOVES

STRETCH GLOVE ENTRANCE OVER PLASTIC SUIT CUFF AND ROLL DOWN SUIT RUBBER CUFF PROTECTOR AS SHOWN.



MODULAR CHEMICAL SPILL PROTECTIVE CLOTHING ENSEMBLE (EPA)

FULLY SUITED MAN DURING MISSION

DECONTAMINATION PROCEDURES:

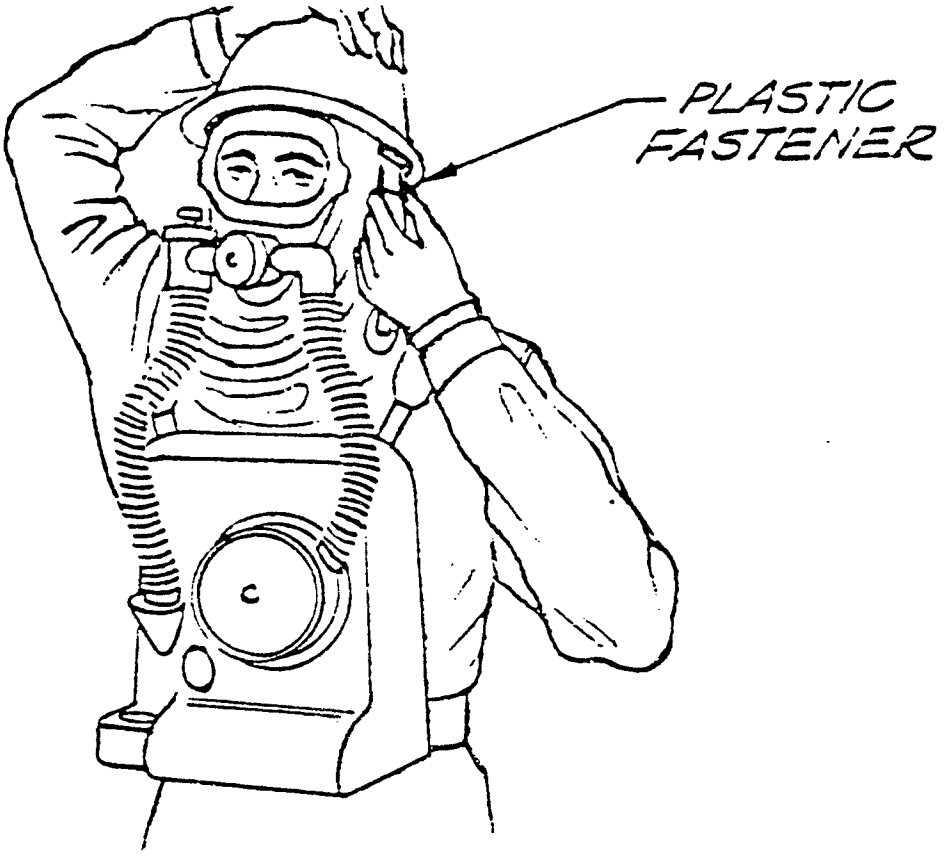
AT THE END OF A MISSION IN A TOXIC AREA THE SUITED MAN PROCEEDS TO THE DECONTAMINATION AREA.

C–A–U–T–I–O–N

DO NOT ATTEMPT TO DOFF THE SUIT ASSEMBLY UNTIL SUITED MAN HAS BEEN DECONTAMINATED.

N–O–T–E

RELY ON THE BUDDY SYSTEM THROUGHOUT THE DECONTAMINATION PROCEDURE.



REMOVE HELMET, DISCONNECT LIQUID COOLING PACK

1. DISCONNECT PLASTIC FASTENERS AND REMOVE HELMET.

2. DISCONNECTING LIQUID COOLING PACK ASSEMBLY: DISCONNECT LIQUID TRANSPORT HOSE FROM SUIT: UNFASTEN WAIST BELT AND HARNESS STRAPS; REMOVE LIQUID COOLING PACK AND PLACE ON GROUND.

N–O–T–E

DO NOT REMOVE OR TURN OFF BREATHING PACK

3. BY MEANS OF THE "BUDDY SYSTEM" THE BUTYL SUIT ASSEMBLY, HELMET, GLOVES, BOOTS, AND BREATHING PACK ASSEMBLY ARE SPONGED DOWN WITH HOT SOAPY WATER (130°F MAX).

N–O–T–E

   a. MAKE SURE THAT ALL EXPOSED SURFACES ARE THOROUGHLY WASHED AND RINSED UNDER A SHOWER OF HOT WATER (130°F MAX).

   b. AREAS OF THE SYSTEM WHICH HAVE BEEN IN CONTACT WITH LIQUID CONTAMINANTS ARE TREATED WITH DECONTAMINANTS SELECTED.

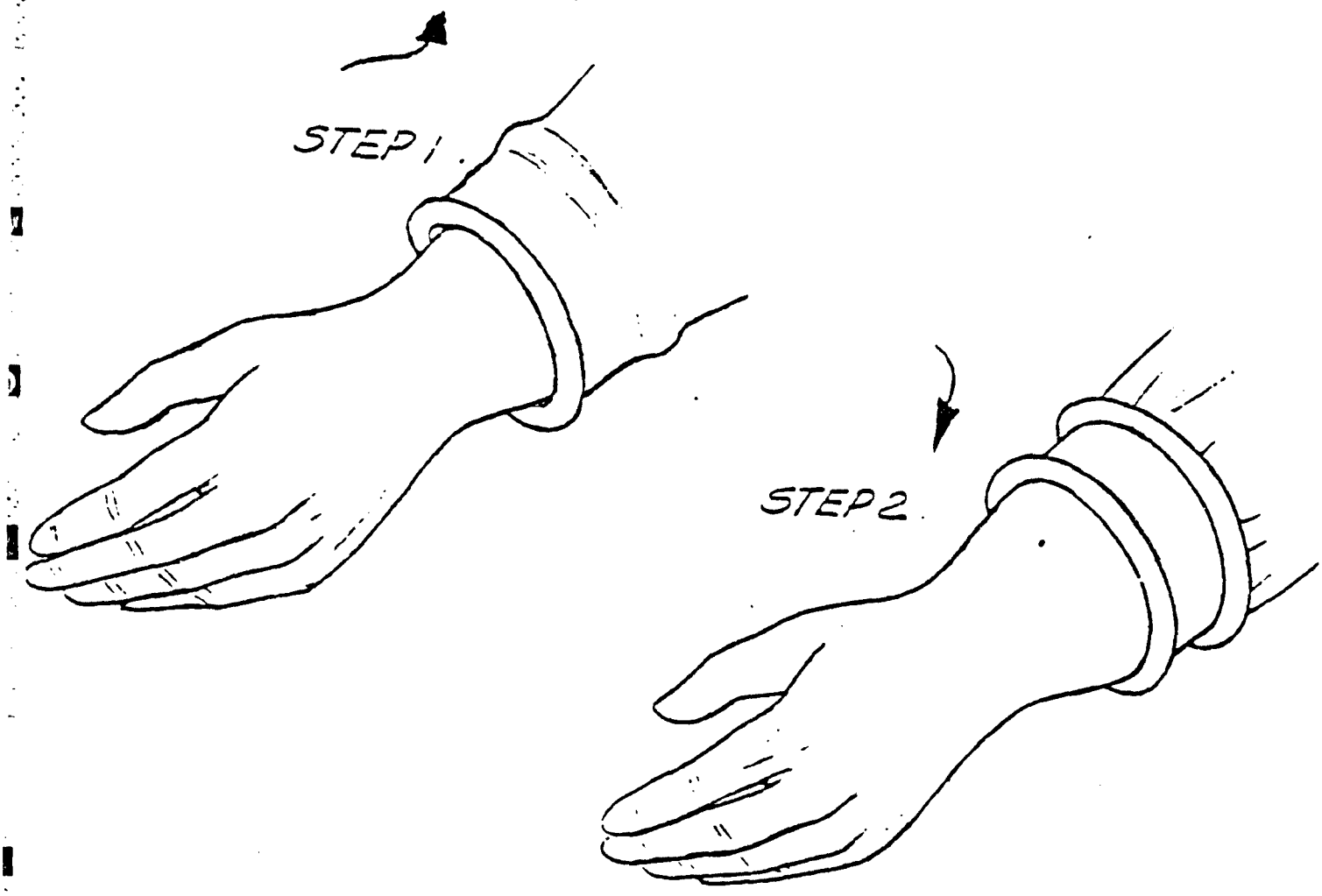
   c. THE SUIT ASSEMBLY AND ITS COMPONENTS ARE WIPED DRY WITH CLEAN WASTE CLOTHS.

      (THE USED WIPING CLOTHS ARE DISCARDED IN A RECEPTACLE WHICH IS SEALED FOR LATER DISPOSAL.)

DISCONNECT BREATHING PACK

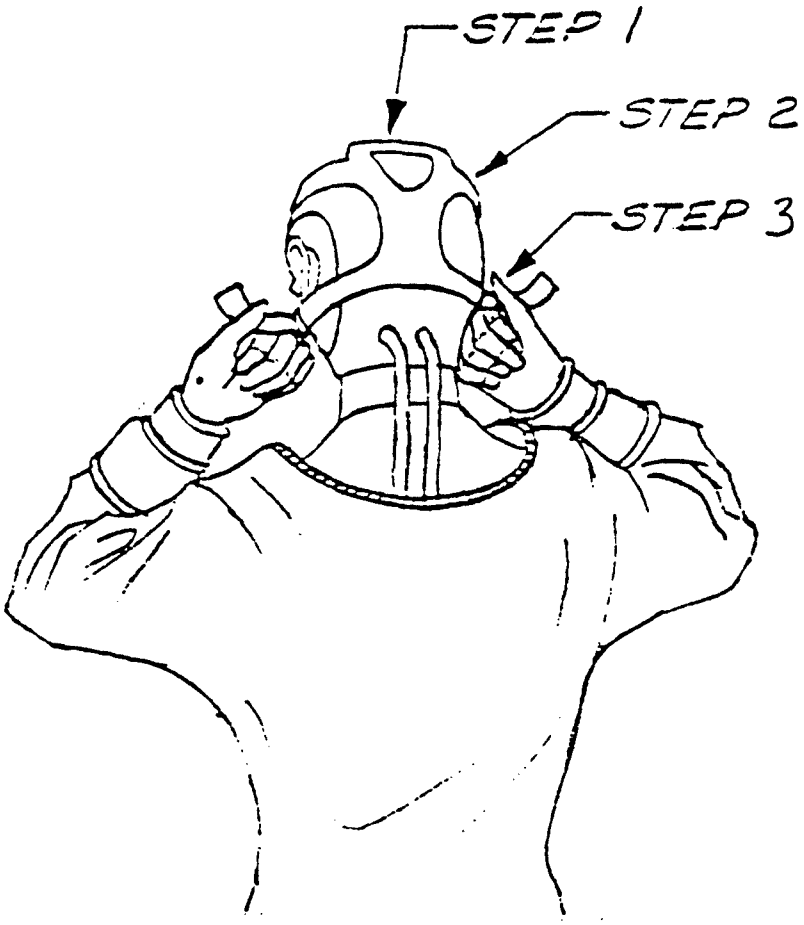
DISCONNECT THE TWO AIR INLET HOSES – FIRST EXHALATION AND THEN INHALATION FROM THE BREATHING PACK ASSEMBLY.

UNFASTEN THE WAIST BELT, THE HARNESS STRAPS, AND THEN PLACE BREATHING PACK ASSEMBLY DOWN ON GROUND. WASH BACK SIDE OF BREATHING PACK ASSEMBLY.



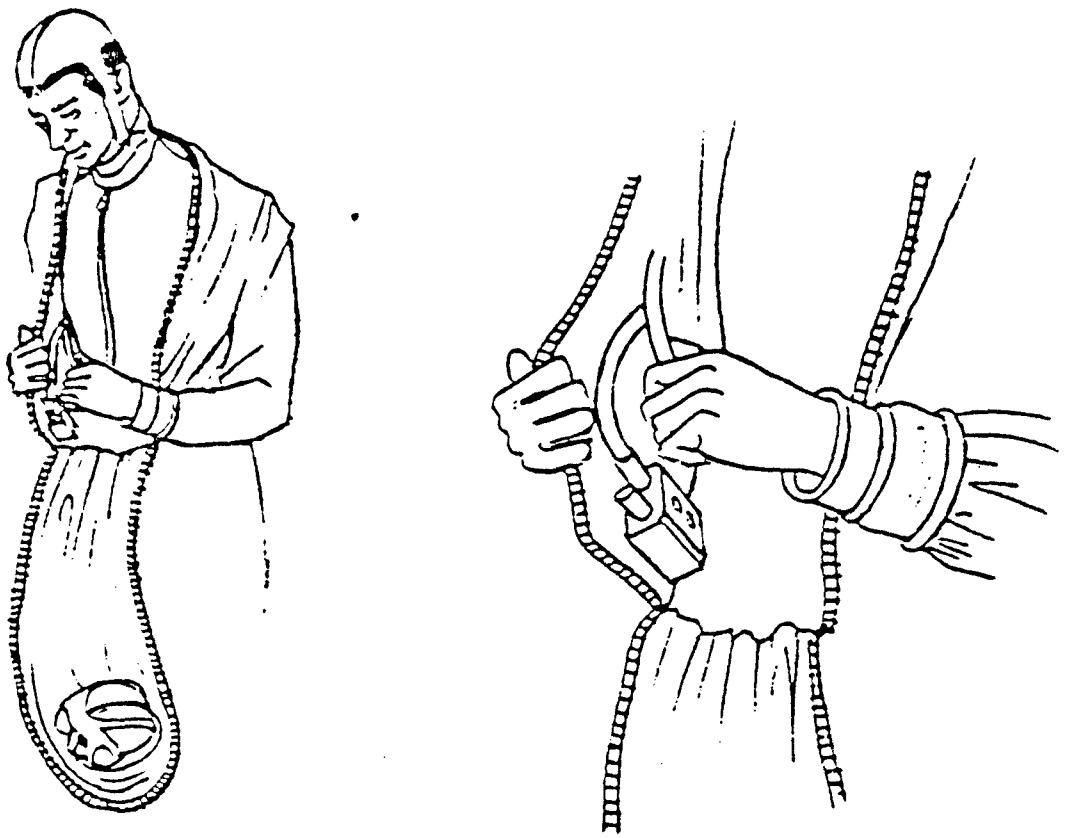
DOFFING BUTYL GLOVES

ROLL UP SUIT BUTYL RUBBER CUFF AS SHOWN IN STEP 1, AND REMOVE GLOVES. THE GLOVES SHOULD BE TURNED INSIDE OUT.

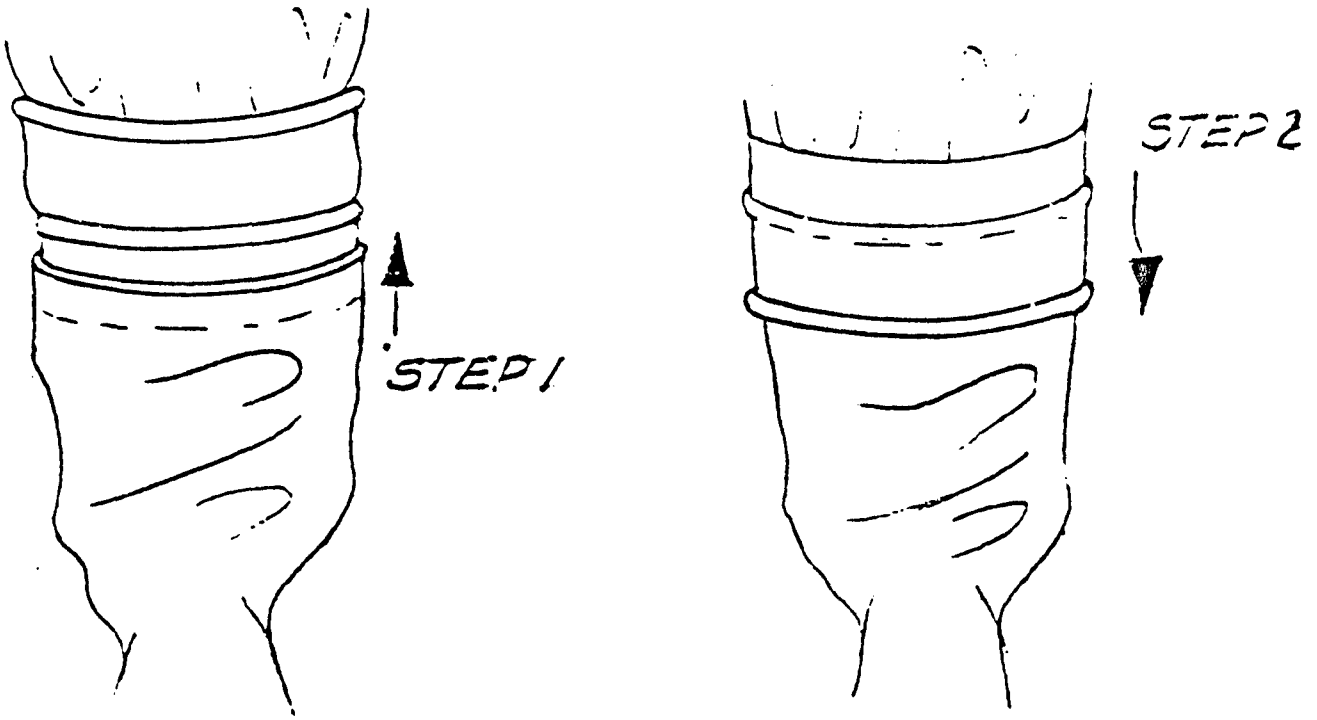


REMOVE MASK

OPEN SUIT MAIN ENTRANCE ZIPPER. AFTER ZIPPER IS COMPLETELY OPENED, PULL HOOD PORTION OF SUIT OVER THE HEAD EXPOSING MASK STRAPS AS SHOWN ABOVE. LOOSEN THE CHIN STRAPS, UPPER TEMPLE STRAPS AND TOP HEAD STRAP, BRING STRAPS OVER HEAD AND REMOVE MASK.



DISCONNECT LIQUID TRANSPORT HOSES FROM WATER COOLED VEST INSIDE BUTYL SUIT, AS SHOWN ABOVE.



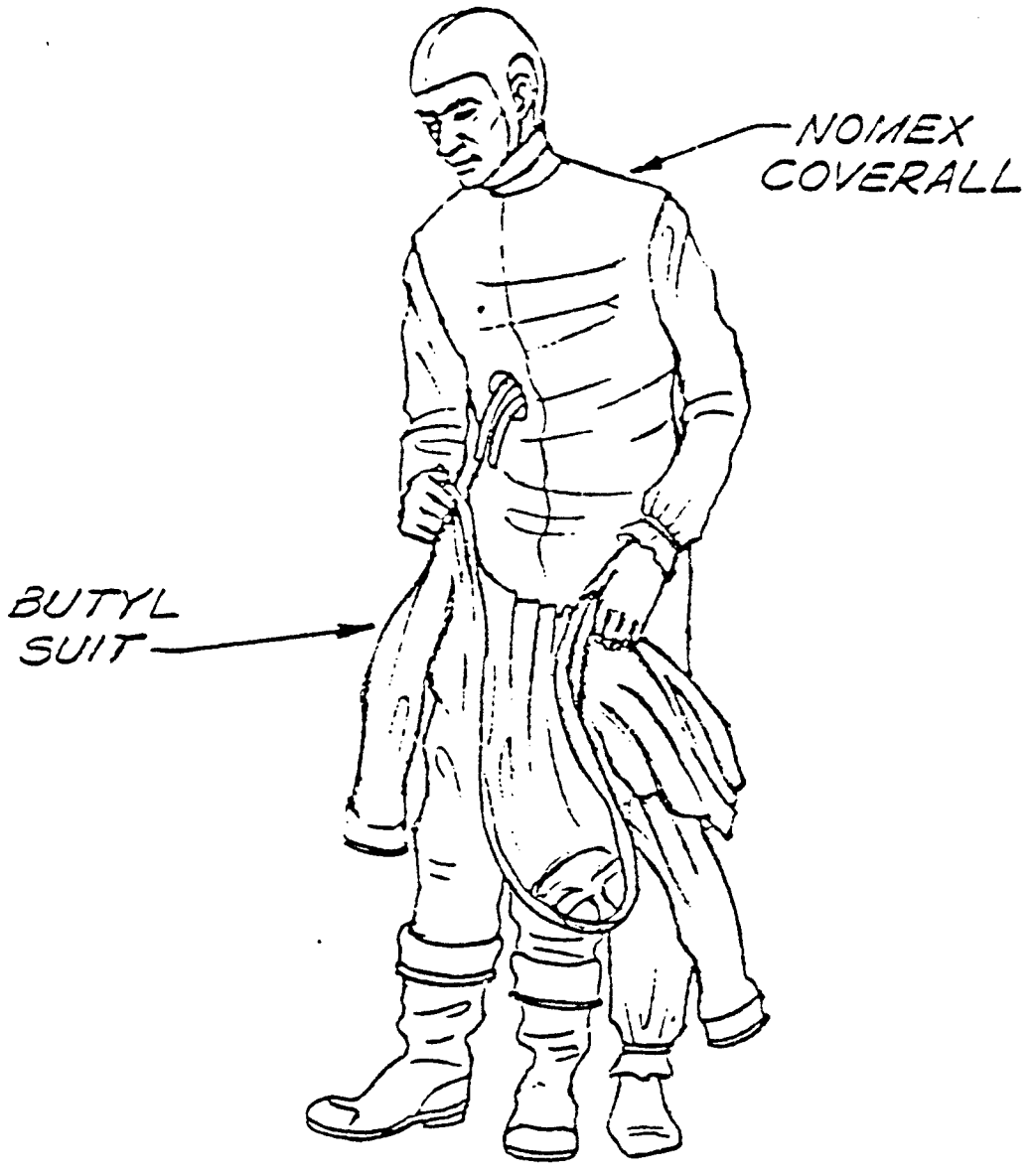
DOFFING AND DISCONNECT BOOTS FROM BUTYL SUIT

a. ROLL UP SUIT BUTYL RUBBER CUFFS AS SHOWN IN STEP 1.

b. DISCONNECT SUIT PLASTIC CUFF FROM TOP OF BOOTS.

N–O–T–E

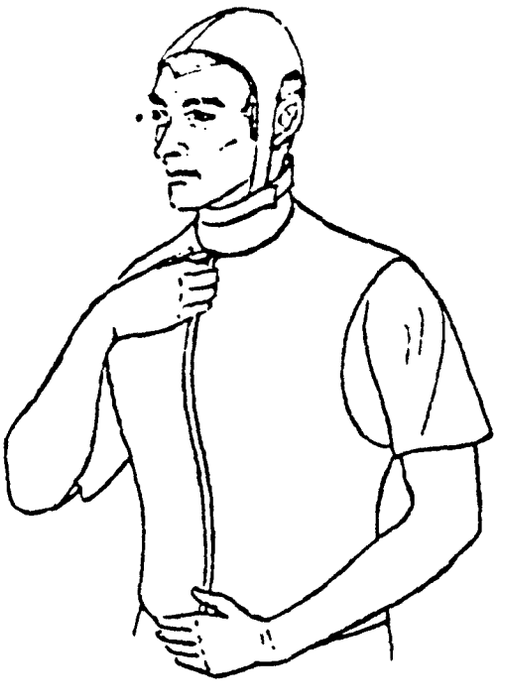
(IT IS OPTIONAL WHETHER TO DISCONNECT BOOTS PRIOR TO OR AFTER DOFFING OR BUTYL SUIT.)



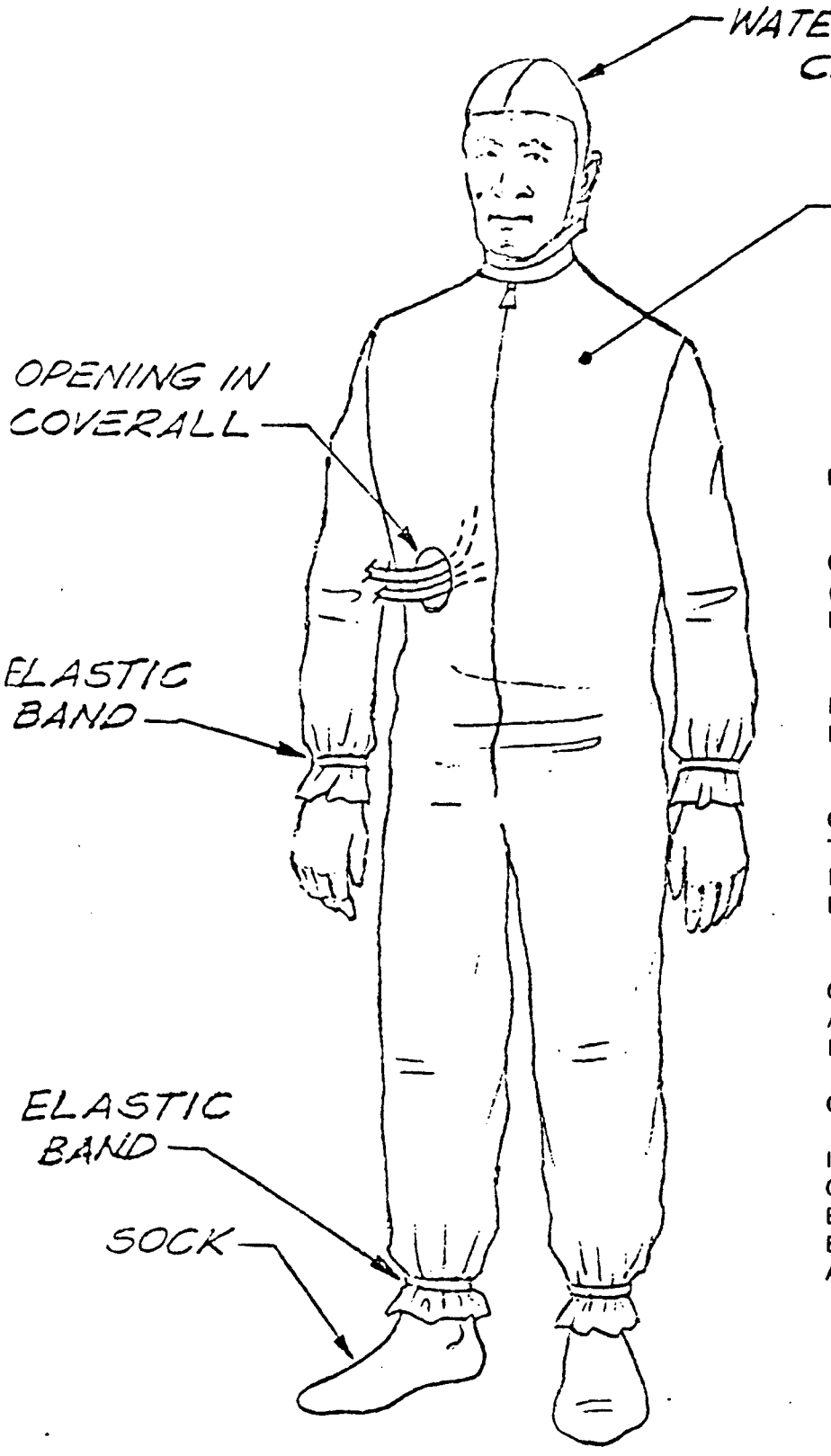
DOFFING BUTYL SUIT

WITH THE ASSISTANCE OF A TEAM MEMBER, SLIP THE SUIT ASSEMBLY OFF THE SHOULDERS. THEN PULL ARMS OUT OF THE SUIT SLEEVES ONE AT A TIME AS A TEAM MEMBER HOLDS ONTO THE GLOVE CUFF.

SLIP THE SUIT DOWN OVER THE LEGS AND PULL EACH FOOT OUT OF THE END UP THROUGH THE UNZIPPED AREA OF THE SUIT.



DON WATER COOLED VEST AND CAP AS SHOWN. CLOSE ZIPPER CLOSURE ON VEST AND ATTACH VELCRO LOCK ON CAP CHIN STRAP.



NOMEX COVERALL

DON WHITE NOMEX COVERALL

a. DON WHITE NOMEX COVERALL OVER LIQUID COOLING VEST. (REGULAR EPA ISSUE) CLOSE MAIN ENTRANCE OF COVERALL.

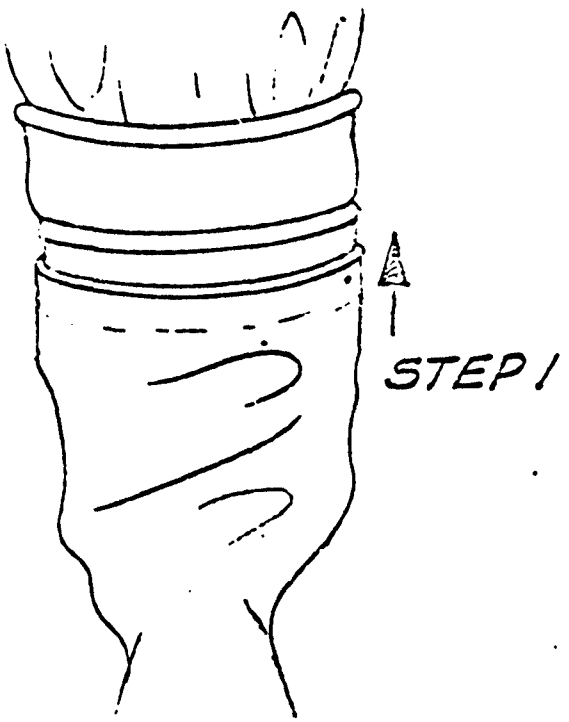
b. PASS LIQUID TRANSPORT HOSES FROM LCV THROUGH OPENING ON RIGHT SIDE OF NYLON COVERALL.

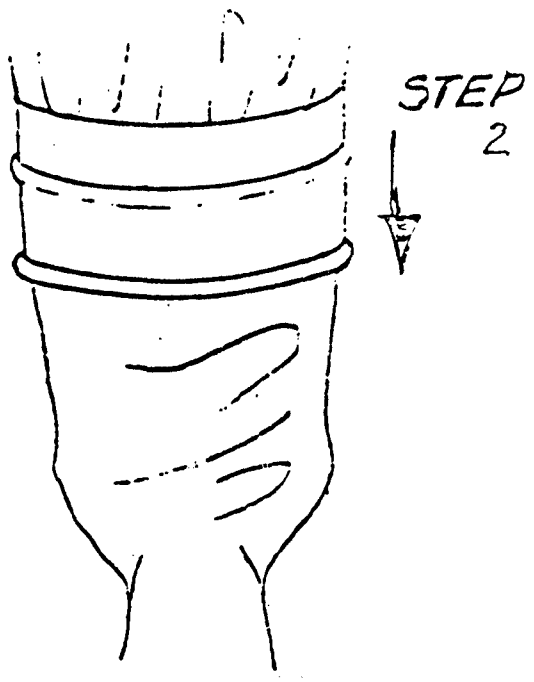
c. WRAP SLEEVE BOTTOM OF COVERALL ARM CUFFS, ONE AT A TIME, AROUND EACH WRIST AND HOLD IN PLACE WITH AN ELASTIC RUBBER BAND.

d. WRAP COVERALL LEG CUFFS, ONE AT A TIME, AROUND EACH ANKLE AND HOLD IN PLACE WITH AN ELASTIC RUBBER BAND.

CAUTION

IN STEPS c. AND d. ABOVE BE CAREFULL NOT TO TIGHTEN RUBBER BANS TOO TIGHTLY SO AS TO CUT OFF BLOOD CIRCULATION AT THE WRIST AND ANKLES.





N–O–T–E

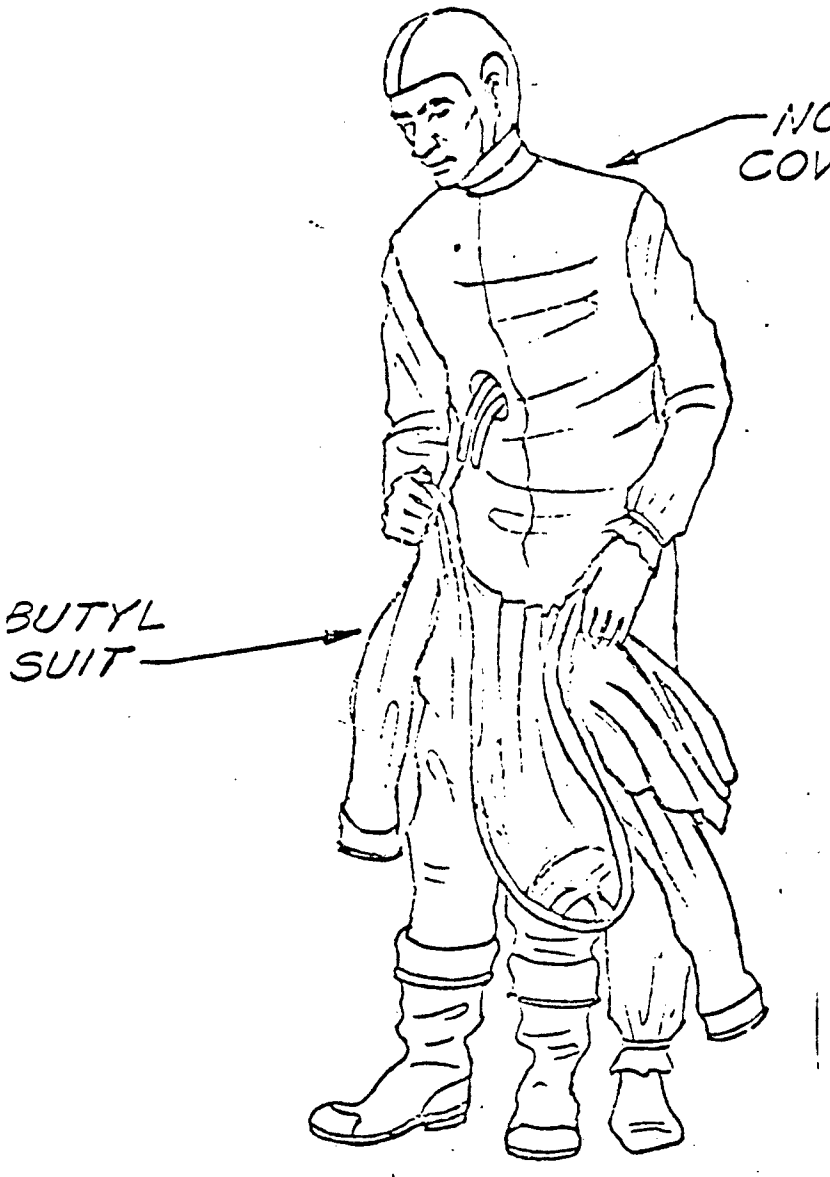
(IT IS OPTIONAL WHETHER TO ATTACH BOOTS PRIOR TO OR AFTER DONNING OF BUTYL RUBBER SUIT)

1. ATTACH BOOTS TO BUTYL RUBBER SUIT AS FOLLOWS:

a. MAKE SURE ROLL DOWN CUFFS ON BUTYL SUIT ARE ROLLED UP EXPOSING FULLY PLASTIC SUIT BOOT CUFFS.

b. ALIGN FIRST RIGHT FRONT LEG OF BUTYL SUIT WITH TOE OF RIGHT BOOT AND FULLY INSERT SUIT PLASTIC CUFF INTO TOP OF RIGHT BOOT. (SEE STEP 1) REPEAT SAME PROCEDURE FOR CONNECTING LEFT BOOT TO LEFT LEG OF BUTYL SUIT.

c. ROLL DOWN SUIT BUTYL RUBBER CUFFS AS SHOWN IN STEP 2 FOR RIGHT AND LEFT BOOT/SUIT CONNECTION.



WARNING

CHECK ATTACHMENT OF FACE MASK TO SUIT TO BE SURE THAT MASK IS PROPERLY MATED. CHECK RUBBER LIPS OF SUIT SEALS AROUND MASK VISOR FRAME FOR PROPER FIT.

(APPLY ANTI–FOGGING AGENT TO INSIDE MASK VISOR)

DONNING BUTYL RUBBER SUIT

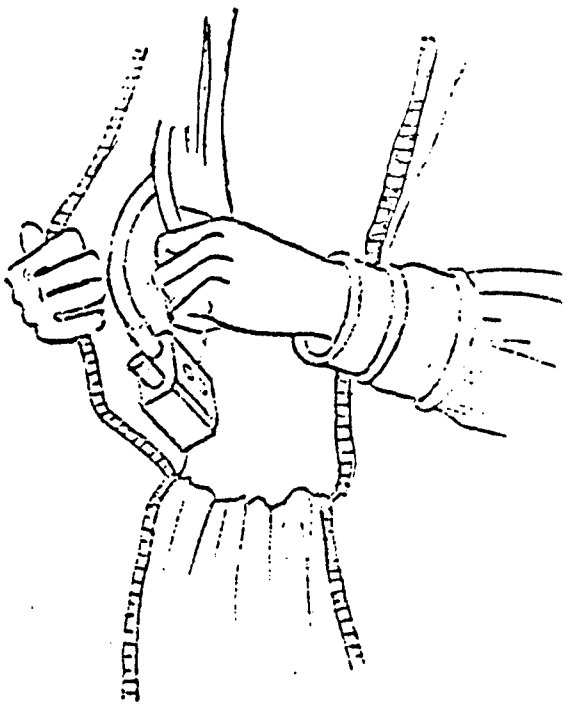
A. OPEN ENTRANCE/CLOSURE ZIPPER COMPLETELY.

B. GRASP BUTYL RUBBER SUIT WITH BOTH HANDS AT EACH END OF OPENED SUIT ZIPPER. SLIP RIGHT LEG INTO RIGHT SUIT LEG/BOOT.

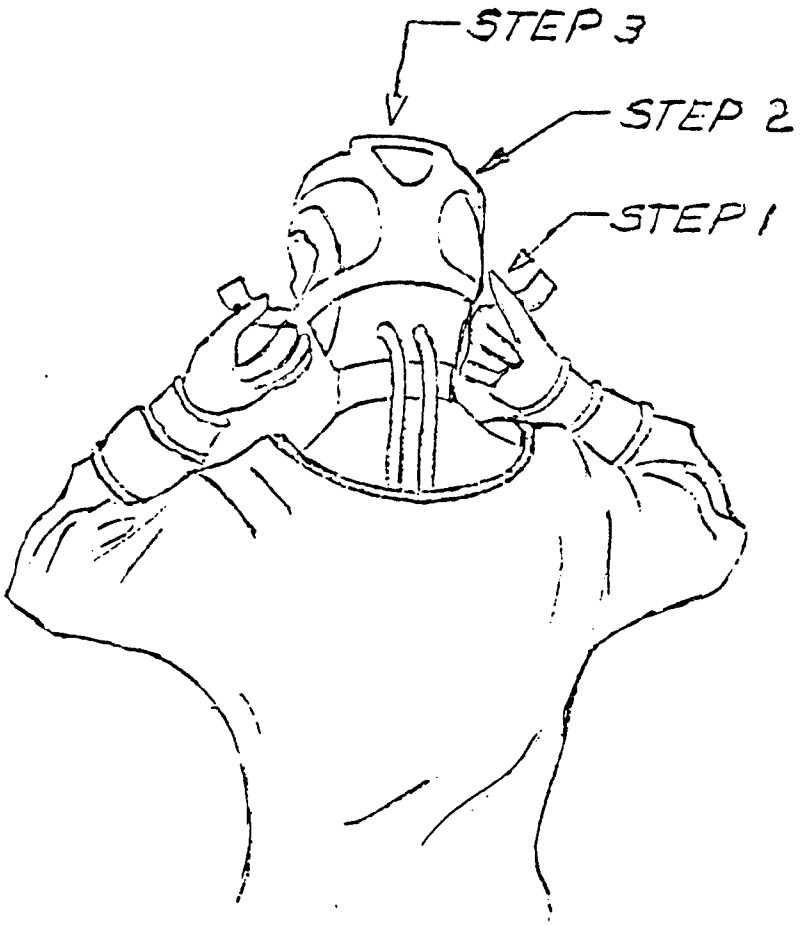
C. REPEAT PROCEDURE (B) ABOVE FOR LEFT LEG.

D. PULL LEGS OF BUTYL SUIT UP SNUGLY TO THE CROTCH AREA.

E. SLIP ARMS INTO BUTYL SUIT, ONE AT A TIME AND PULL OVER THE SHOULDER.



CONNECT LIQUID TRANSPORT HOSES FROM WATER–COOLED VEST TO SUIT LIQUID INTERFACE CONNECTOR ON INSIDE OF BUTYL SUIT.



DONNING FACE MASK

A. PULL BUTYL SUIT OVER FACE MASK EXPOSING MASK HEAD STRAPS.

B. LOOSEN ALL MASK HEAD STRAPS.

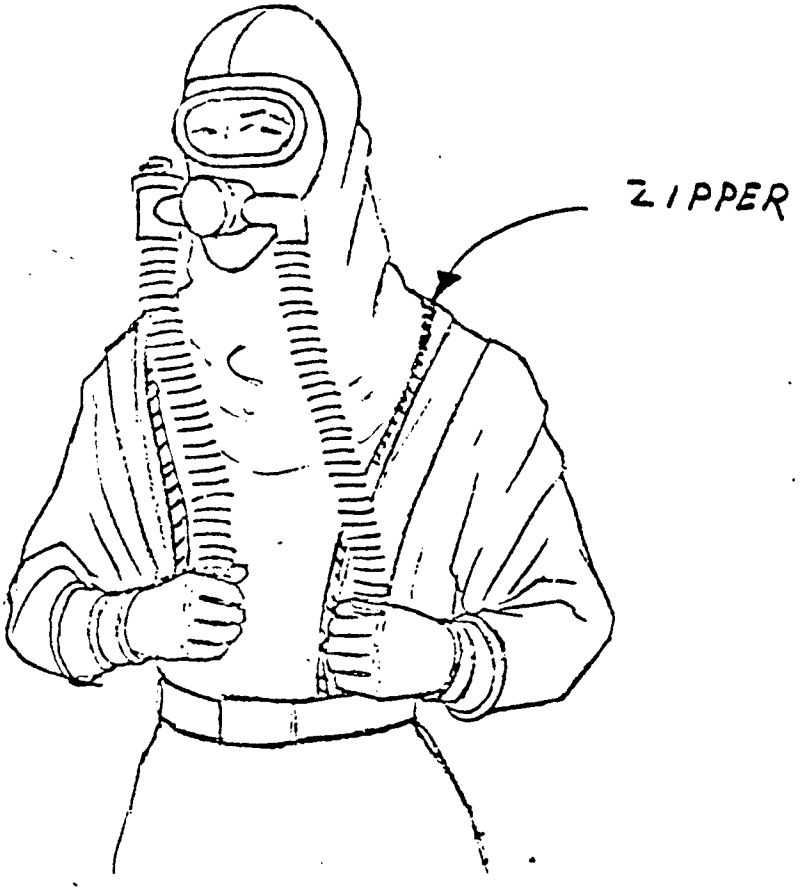
C. SLIP MASK HEAD STRAPS OVER HEAD AND PLACE MASK AGAINST FACE WITH NOSE CUP PROPERLY FITTED. HOLD MASK SNUGLY AGAINST THE CHIN, TIGHTEN LOWER CHIN STRAPS, UPPER TEMPLE STRAPS, THEN TOP HEAD STRAP.

D. PULL HOOD OVER HEAD.

DON LIQUID COOLING PACK (LCP).

CONNECT LIQUID TRANSPORT HOSES FROM LCP

TO SUIT LIQUID INTERFACE CONNECTOR.

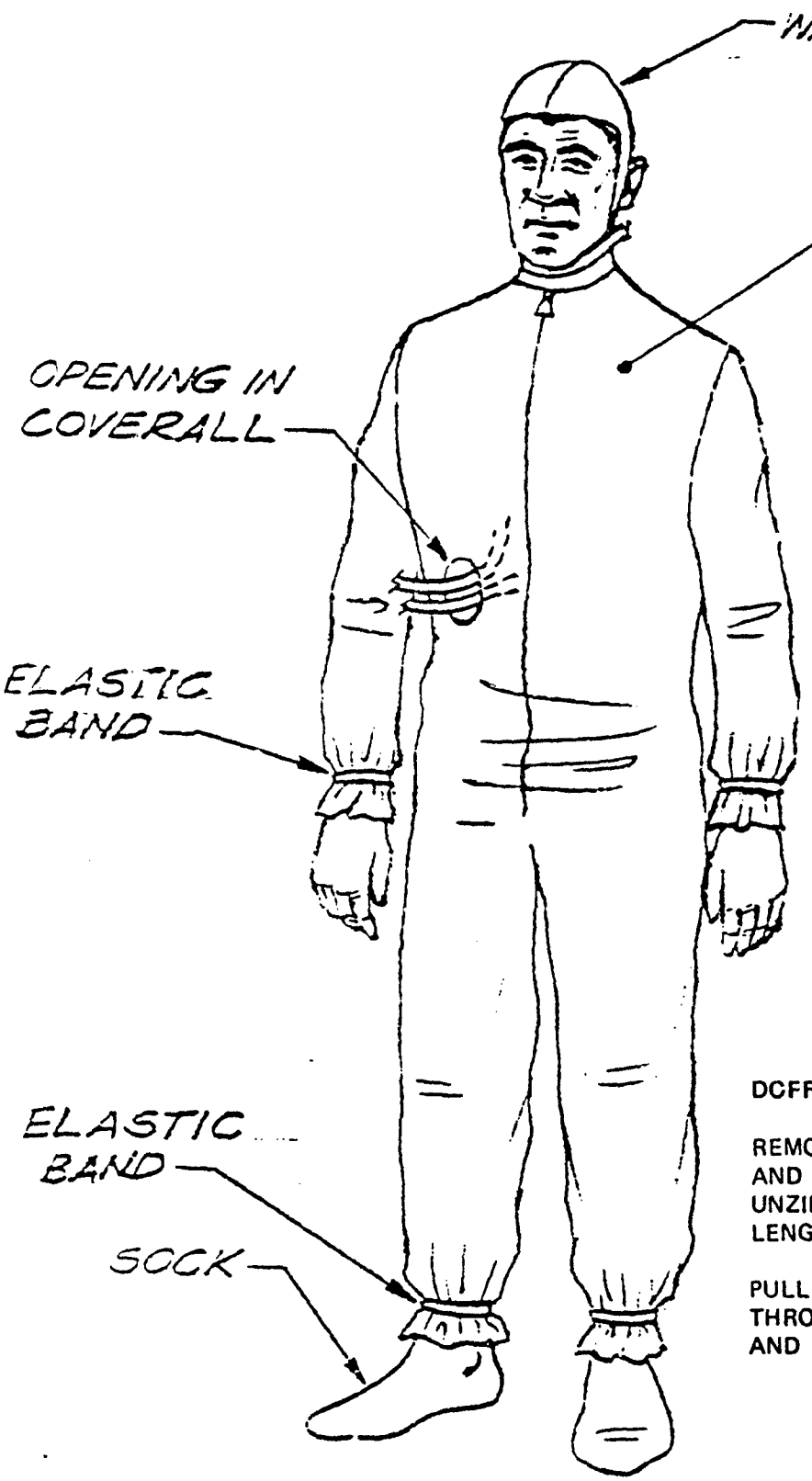


PROPER MASK SEAL

A. CHECK FOR PROPER MASK SEAL AND CHECK VALVE OPERATION BY BLOCKING INLET OPENING OF THE INHALATION HOSE WITH THE RIGHT HAND AND INHALING TO CREATE A VACUUM. THIS WILL MAKE MASK COLLAPSE AGAINST THE FACE. HOLD BREATH FOR FEW SECONDS TO INSURE THAT VACUUM HOLDS.

B. BLOCK OPENING OF EXHALATION HOSE WITH LEFT HAND AS SHOWN AND EXHALE TO CREATE A SLIGHT OVERPRESSURE. HOLD BREATH FOR A FEW SECONDS TO INSURE THAT PRESSURE HOLDS. (IF THIS TEST CANNOT BE SUCCESSFULLY COMPLETED, SEE TROUBLE SHOOTING AND REPAIRS SECTION OF BIOPAK 45 OPERATIONAL MANUAL.)

C. CLOSE MAIN ENTRY ZIPPER.

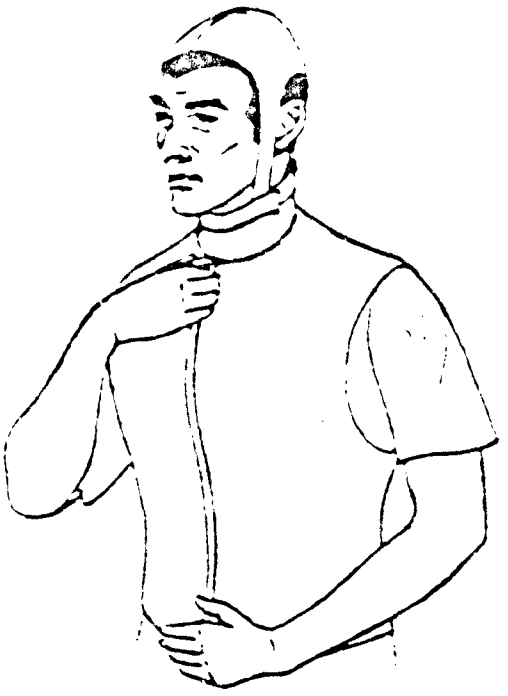


NOMEX COVERALL

DOFFING COVERALL

REMOVE ELASTIC BANDS FROM WRIST AND ANKLE AREA OF NOMEX COVERALL UNZIP NOMEX COVERALL TO FULL LENGTH OF ZIPPER.

PULL ENDS OF LIQUID HOSES BACK THROUGH OPENING OF COVERALL AND THEN DOFF COVERALL.



DOFFING COOLING VEST

UN–LOCK VELCRO FROM CAP CHIN STRAP AND REMOVE CAP FROM HEAD. OPEN VEST ENTRANCE ZIPPER AND DOFF VEST.

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