A METHOD FOR
SEALED PERSONNEL PASSAGE
THROUGH
A SEALED BARRIER

By

Homer A. Moulthrop

Process Systems Design and Development
Process Design Engineering
Facilities Engineering Department
Chemical Processing Division

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Atlantic Richfield Hanford Company
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A METHOD FOR
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I. INTRODUCTION

In late 1963, impact of the Redox fire within the 233-S plutonium processing enclosure and its surrounding enclosed area made it very evident that better methods for entering plutonium enclosures were needed. Improved methods of personnel access into highly contaminated plutonium enclosures were explored. Greater mobility with increased comfort and safety was sought by use of a sealed suit with service line connections to the outside. This concept has since been progressively developed through the years. The work is being conducted in the Plastic Applications Contamination Control Laboratory.

II. ABSTRACT

A concept and method has been developed and demonstrated for permitting persons to pass through a sealed contamination barrier into a contaminated enclosure, and to return. This demonstrated method permits this transbarrier passage to be repeated any number of times in a practical and routine manner. At no time during the entrance or the exit is there an opening through the sealed contaminated barrier. This method, as conceived and demonstrated, is applied not only to the person making the transbarrier passage in a sealed suit, but also to all of the service lines which are disconnected and reconnected between each personnel entrance.

The concept and demonstrated method, provides for keeping all service gear and service lines in a free-from-contamination condition at all times. This lack of contamination permits immediate reuse at the completion of any job entry.

Provision is also included for the quick and contamination-free rescue from the enclosure of any person who may become suddenly incapacitated while within the contaminated enclosure. The method has been demonstrated to be very practical and as fast and efficient as traditional entry and exit techniques. Cost is also reduced by avoiding need for replacing valuable gear such as cooling and communication equipment. These are worn under the sealed suits in all cases.

III. DESCRIPTION

A. Sealed Entries of Personnel

A concept for sealed personnel passage through a sealed barrier has been developed which permits persons to enter and exit from a contaminated or polluted enclosure without at any time physically contacting the contaminants or polluting substances. Entry is made in a sealed suit with a sealed oversuit through a plastic bag sealed airlock which at no time permits an opening to exist through the sealed barrier surrounding the enclosure being entered.

B. Sealed Umbilical Tube

Life support, communication, and comfort services are supplied to the person in the suit through an umbilical tube which itself is sealed at all times against exposure to the contaminants or polluting substances and atmosphere of the enclosure.

C. Sealed Exits of Personnel

At such time as the person in the sealed suits having made a sealed entry into the enclosure wishes to exit, he does so with the help of an assistant. The exit is made in a sealed manner without at any time creating an opening which would permit escape of contaminants or polluting atmosphere from the enclosure. Penetration of contaminants into the suit is also prevented not only by the suits being sealed, but also by the higher pressure within the suits.

D. Successive Personnel Passage

Having returned from the enclosure, the person or a fellow worker may use the same non-contaminated umbilical tube for re-entry and return for as many times as he may choose to make this sealed personnel passage across the sealed barrier of the enclosure.

This capability is based on including the umbilical tube in each sealed personnel passage across the contamination barrier. This inclusion is done without at any time contaminating the ends of the service lines which are protruded outside of the enclosure with each exit. This permits a succession of different workers to maintain a continuing operation day-after-day within a contaminated enclosure. In doing so, even during the most extended operation, there is no hole created in the sealed barrier which permits any of the contained contaminants or polluting atmosphere to escape.

E. Retrieval of Equipment at End of Job

An additional feature of the sealed personnel passage through a sealed barrier is the retrieval for possible reuse of all service lines within the suits and umbilical tube at job completion. The retrieval can be readily performed since any contamination of them is prevented by the sealed protecting covers.

F. Rescue of Incapacitated Worker from Enclosure

Another unique feature of this sealed system for work within contaminated enclosures is the capability of rescuing an incapacitated worker from the enclosure quickly. It is done without contamination either of the rescuers or the rescued person. Demonstrated time for critical rescue operations is less than two minutes.

G. Efficiency of Sealed Personnel Passage Equal that of Airlock Entries

Timed operations made during the feasibility testing of the sealed passage methods demonstrated the efficiency to be equal or exceeding that of comparable airlock or open door methods.

H. Application to Crew Operation

Normally a personnel access port is made available for each person working in a suit. Thus, a crew of three persons working within a contaminated enclosure would be provided with three personnel ports and three ports for the umbilical tubes. In addition, a fourth personnel port would be reserved in a stand-by condition for personnel rescue should a person become incapacitated within the enclosure. However, in situations where large crews are required, more than one worker can enter and exit from the same personnel port using an elongated entrance bag. A separate eight inch diameter port is still required for each worker's umbilical tube.

I. Use of Service Manifold

To provide for an orderly work area, a service manifold for systematizing the connections and routing of all service lines to and from the sealed suits has been developed. Lines outside the enclosure area are suspended above the floor to permit an unobstructed floor

[REDACTED]

area near the personnel access ports. A manifold for servicing a crew of three or four workers has been designed and is detailed in drawings H-2-34630, H-2-34631, H-2-34763, H-2-34765, H-2-34766, H-2-35046, and H-2-35018.

J. Controlled Comfort Inside of Suit

The completely and constantly sealed condition of the suit and its umbilical suit service line tube makes it feasible to locate the relatively expensive vortex tube and other air cooling equipment within the suit and its attached suit service bundle.

This proximity of cooling equipment to the person in the suit and its adjustment by outside control of air pressures permit a person to perform work within the suit for extended periods without any body perspiration or other discomfort.

K. Constant Two Way Communication Potential

The fact that no holes are made in the sealed barriers including the suit and the suit service line tube during successive entry and exit makes it practical to equip the person in the suit with sophisticated communication equipment without risk of its becoming contaminated. This communication capability plus nearly full visibility promote increased worker efficiency. Drawings H-2-35046 and H-2-35018 describe the telephone communication system which was specifically designed for use in sealed suits with the central console located in the sealed suit service manifold.

L. Reduced Cost of Operation

A major advantage of this method of sealed passage through sealed barriers, in addition to eliminating need for occasional outside area decontamination, is reduced cost of operation. Only the single relatively inexpensive secondary outer suit is not reusable after each entry and exit. All other clothing including overalls, inner plastic suit, and all service lines are maintained free of contamination and require no replacement. Sophisticated communication and cooling equipment can be used with notable improvements in efficiency and comfort since the continuously sealed barriers eliminates the need for decontamination and probable discard after each entry associated with air lock or other nonsealed entry and exit techniques.

[REDACTED]

M. Designation of Required Equipment

Equipment required for personnel passage through a sealed barrier may be grouped into the following six categories:

- Barrier and Access Equipment
- Sealed Suits
- Equipment Inside of Sealed Suits
- Suit Service Line Tubes
- Service Lines Outside Enclosure
- Utilities Supply Equipment

The general items within each of these categories consists in most cases of two or more components. Many of these components are also comprised of more than one part.

Tables in the appendix present a complete listing of all equipment required for sealed personnel passage through a sealed barrier. The equipment is listed in outline form as shown below:

- I. (Equipment category)
 - A. (General item)
 - 1. (Component or type)
 - a. (Part or type)

This arrangement provides opportunity to relate each of the equipment parts to its respective component and general item within each category.

N. Number Required of Each Equipment Item or Part

Table I, in addition to designation of all items of equipment and the component parts by name, also lists the number of each which is required. Three conditions for use are shown. One is for a single entry into an enclosure by one person. A second is for a crew of three persons entering an enclosure simultaneously and being replaced by three others immediately upon exit and with two other persons in attendance at all times outside the enclosure to assist this continuous operation. The third case is the same as the second except that all equipment which is retrievable from the first job is reused at the second job at another location

The significant observation to be made from this listing is that nearly all of the equipment is reusable. Once the equipment has been acquired for sealed personnel passage through a sealed barrier, any number

of such entries can be made into enclosures with only minimal equipment cost. Specifically, only one outer suit and one bag is required per entry and only one contamination seal cover is required per service line during the conduct of a job at a given location. An inexpensive adapter assembly package must be replaced after each 20 entries on a given service line. A plastic bag for disposal collection of used outer suits is required for each five or so entries. All other items of equipment are reusable.

O. Description of Required Procedures

Figures 1 through 22 describe in specific detail, with step-by-step illustration, each of the significant procedures involved in sealed personnel passage through a sealed barrier. The illustrations include retrieval of service lines and rescue of incapacitated workers, as well as the fundamental operations such as sealing jacket and trousers together to form a suit, sealing the suit service sleeve to the umbilical tube, sealed exit, and removal of the previous entry suit upon re-entry. These and all other procedures involved in the overall operations are included in the figures. The overall arrangement of equipment with respect to personnel is also shown.

IV. POTENTIAL APPLICATIONS TO PLUTONIUM HANDLING

The method described herein has application to conduct of manual operations over a period of several hours for each entry into an enclosure. This includes not only existing plutonium handling facilities wherever enclosure size and arrangement will permit such entries, but also any enclosure which might be established on an emergency basis to cope with any unusual plutonium handling problem. In addition, the method has potential for broadening the scope of plutonium handling capabilities. Likely opportunities for such expanded application include the restoration of plutonium burial sites to normal environmental standards. Associated candidate opportunities also include dismantling and decontamination of equipment containing plutonium and the sorting of plutonium bearing wastes prior to incineration or long-term storage.

V. A MEANS TOWARDS CURTAILING ENVIRONMENTAL CONTAMINATION

This method of sealed barrier personnel passage has broad and environmentally significant industrial application beyond its immediate use in enclosures highly contaminated

with plutonium. In fact, it can be applied to any situation where such factors as intense heat or high radiation do not prevent personnel entries.

To date, the prohibitive cost of replacing or decontaminating expensive suits and gear has discouraged extended work in suits within enclosures containing environmentally hazardous contaminants

Now sealed handling of the discardable inexpensive outer suit prevents the more expensive inner suits and sophisticated body gear from any contact with contaminants. Since the service lines are also similarly protected with sealed coverings, these provisions avoid any need for time consuming, costly decontamination or replacement of the personnel, the equipment, or the work area.

The resulting freedom from contamination of all items except the sealed outer suit and service tube cover permits use of sophisticated body gear including sophisticated communication and cooling equipment. This greatly increases the safety, comfort, and efficiency of the worker. Not only does this permitted continuous reuse of such equipment, because of no loss due to contamination greatly reduce the long range cost of operation, but it also reduces substantially the volume of contaminated solid waste which is created with each enclosure entry by other methods.

This method for sealed personnel passage through a sealed barrier, therefore, provides a safe practical means for working in comfort and safety within enclosures where harmful contaminating substances can be confined and concentrated rather than dispersed and diluted into the environment as at present.

Recently developing social pressures to eliminate all industrial effluents contributing to pollution of the environment should provide impetus for adopting this method of sealed personnel passage through sealed barriers.

TABLE I - Equipment and Material for Sealed Barrier Personnel Passage

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3-man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reusable items</u>
I. Barrier and Access Equipment			
A. Access Panels	2	4	4
		(includes panel for rescue of injured workers)	
B. Access Ports			
1. Personnel Ports	2	4	4
		(includes port for rescue of injured workers)	
2. Service Line Ports	1	3	3
3. Material Disposal Ports	1	1	1
4. Port Rim Clamps	3	8	
C. Personnel Port Coverings			
1. Initial Entry Bag	1	3	3
2. Successive Entry Bag	One bag required for each port entry		
3. Final Cleanup Bag	1	3	3
D. Servicing Port Coverings			
1. Service Line Port Cover	1	3	3
2. Disposal Port Seal Cover	1	3	3
3. Material Disposal Bags	1	One for each five entries	
E. Access Port Shields			
1. Personnel Port Shields	1	4	4
2. Servicing Port Shields	1	4	4
II. Sealed Suits			
A. Outer Suit	1	One per entry	One per entry

No. of the Equipment Items Required for

<u>Equipment and Material Items</u>	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3-man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reusable items</u>
1. Outer Trouser	1	One per entry	One per entry
a. Outer body-leg section	1		
b. Outer service sleeve	1		
c. Adhesion exit strip	1		
d. Suit removal zipper	1		
e. Rubbers for feet	1 pr	One per entry	None (laundered recycle)
2. Outer Jacket	1	One per entry	One per entry
a. Blouse helmet section	1		
b. Waist to trouser seal	1		
B. Inner Suit	1	*6	None
1. Inner Trousers	1	*6	None
a. Inner body-leg section	1		
b. Inner service sleeve	1		
c. Trouser sealing band	1		
d. Suspenders	1		
2. Inner Jacket	1	*6	None
a. Blouse sleeve section	1		
b. Neck section	1		
c. Jacket sealing band	1		
3. Helmet	1	*6	None

*Includes three relief workers for continuous operation.

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3-man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reusable items</u>
C. Rescue Suit	1	1	1
1. Tunnel	1		
a. Tube section	1		
b. Leg section	1		
c. Gloved sleeves	8		
d. Adhesion strips	3		
2. Tunnel Anchors	4		
a. Barrier clamps	4		
b. Restraint cords	1		
3. Rescue Equipment			
a. Breathing air line	1		
b. Assault masks	3		
c. Knife	1		
III. Equipment Inside of Sealed Suits			
A. Suit Body Gear	1	*6	None
1. Services Support Belt	1	6	None
2. Jacket Breathing Air Lines	2	12	None
3. Cooling Vest	1	6	None
4. Communication Headgear	1	6	None
a. Microphone	1	6	None
b. Earplug	1	6	None
5. Half-masks, Modified	1	6	None

*Includes three relief workers for continuous operation.

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3-man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reusable items</u>
B. Suit Service Bundle	1	*6	None
1. Suit Service Flange	1	6	None
2. Cooling Assembly	1	6	None
a. Vortex tube	1	6	None
b. Inlet hose to vortex tube	1	6	None
c. Hot air vortex discharge hose	1	6	None
d. Vortex noise muffler	1	6	None
e. Cold air hoses			
1) Vortex to muffler	1	6	None
2) muffler to vest	1	6	None
3. Suit Service Sleeve Lines	6	36	None
a. Breathing air line with check valve	1	6	None
b. Breathing air line with quick disconnect	1	6	None
c. Suit air removal line	1	6	None
d. Suit pressure sensing line	1	6	None
e. Telephone connection	1	6	None
f. Flange to belt anchor cord	1	6	None
IV. Suit Service Line Tube (the location adjustment and length adjustment sections which never enter the enclosure are included in the service lines outside enclosure)			
A. Service Tube Lead Section	1	3	

*Includes three relief workers for continuous operation.

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3-man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reusable items</u>
1. Service Tube Flange	1	3	None
2. Service Lines (ea. 50 ft. long)	7	21	
a. Breathing air, 3/8" pressure hose (MSA or equiv)	1	3	None
b. Cooling air, 3/8" pressure hose (MSA or equiv)	1	3	None
c. Breathing air, 1" dia. flexible vacuum type hose	1	3	None
d. Hot air vortex discharge 1" dia, vacuum hose	1	3	None
e. Suit air pressure sensing line, 3/4" dia. vacuum hose	1	3	None
f. Suit air removal hose, 1-1/4" dia, vacuum hose	1	3	None
g. Telephone line	1	3	None
3. Service Line End Connector Sets, Male and Female	7	21	None
a. 1/8" Hansen quick disconnects or equiv.	1	3	None
b. 1/4" Hansen quick disconnects or equiv.	1	3	None
c. 3/4" nylon hose fittings	4	12	None
d. Amphenol connectors	1	3	None
4. Service Line Cover (51 ft. long)	1	3	None
5. Contamination Seal Cover			
a. Seal cover tube	1	3	3
b. Adapter changing attachment	1	3	3

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3- man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reus- able items</u>
6. Adapter assembly (replace after approx. 20 entries)	1	3	3
a. Adapter cover mount	1	4	None
b. Primary adapter cover	1	3	3
c. Adapter covers	20	60	60
d. Initial entry covers	1	3	3
7. Seal Cover Protection Sheath (optional use as a contact shield)	1	3	3
B. Suit Service Tube Extension Section (for tubes of more than 50 ft. length)	1	3	3
1. Service Lines (same as for the lead section; see Pts. IV A.3 a. through g.)	7	21	None
2. Service Line End Connector Sets, Male and Female (same as for lead section Pts IV A.4 a. through d.)	7	21	None
3. Service Line Cover (51 ft. long)	1	3	None
4. Seal Cover Tube (51 ft. long)	1	3	3
5. Seal Cover Protection Sheath (optional for contact shield)	1	3	3

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3-man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reusable items</u>
C. Suit Service Tube Handling Equipment			
1. Adapter Assembly Support Base	1	3	None
2. Service Line Retrieval Pull Cord	1	1	None
V. Service Lines Outside Enclosure			
A. Location Adjustment Section (Length approx 25 ft long)	1	3	None
1. Service Lines - same as for lead and extension sections except for 25 ft. length; see items IV A.3 a. through g.)	7	21	None
2. Service Line End Connector Sets - Male and Female - same as for lead section; see parts IV A.4 a. through g.)	7	21	None
3. Service Line Cover	1	3	None
B. Length Adjustment Section (lines vary in length at services manifold from 3 ft. to 7 ft.)	1	3	None
1. Service Lines - same as for other sections except for lengths; see parts IV A.3 a. through g.)	7	21	None
2. Service Line End Connection Sets - Male and Female - same as for lead section; see parts IV A.4 a. through g.)	7	21	None

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3-man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reusable items</u>
C. Telephone Extension	1	2	None
1. Service Line (50 ft long)	1	2	None
2. End Connector Set - Amphenol	1	2	None
3. Telephone Headset	1	2	None
D. Standby Suit Service Line	1	3	None
1. Service Lines (ea. 50 ft. long)	1	3	None
a. Breathing air, 3/8" pressure hose (MSA or equiv)	1	3	None
b. Cooling air, 3/8" pressure hose (MSA or equiv)	1	3	None
c. Telephone line	1	3	None
2. Service Line End Connector Sets, Male and Female	1	3	None
a. 1/8" Hansen* disconnect	1	3	None
b. 1/4" Hansen* disconnect	1	3	None
c. Amphenol connector	1	3	None
3. Service Line Cover	1	3	None
E. Inter-Entry Bag Air Evacuation Line - Approx 50 ft long, 3/8" dia. Tygon Tubing	1	1	None
VI. Utilities Supply Equipment			
A. Communications Console	1	1	None
B. Suit Services Manifold	1	1	None

*or equivalent

<u>Equipment and Material Items</u>	<u>No. of the Equipment Items Required for</u>		
	<u>Single Person Entry</u>	<u>Total on job site for unlimited 3- man entries</u>	<u>Subsequent 3-man crew entries at another job site using all reus- able items</u>
C. Breathing Air Cylinders	2	6 (2 on service manifold with 4 at job site in reserve)	
D. Mobile Air Supply Unit (for use where compressed air supply suitable for sealed suits is not otherwise satisfactorily available)	1	1	None
1. Truck with Flatbed	1	1	None
2. Air Compressor (50 cfm, oil free)	1	1	None
3. Air Compressor (100 cfm, 90 psi)	1	1	None
4. Air Reservoir Tanks	2	2	None

TABLE 2

Material and Equipment Used in Sealing and Fabrication of Plastic Items

	<u>Use</u>
I. Material	
A. Plastic Sheetings	Suits, bags, tubes
1. Transparent PVC, 4 to 10 mil	Suits, bags, tubes
2. Translucent PVC, 4 to 10 mil	Suits, bags, tubes
3. Polyethylene Strips, 1/8" x 2"	Inner suit sealing bands
4. Polyethylene Strips, 4 mil x 2"	Covering for sealing bands and exit strip
B. Adhesive Tape	Adapter, zipper stripping
1. Black PVC, 2" wide	Adapter, zipper stripping
2. White PVC, 2" wide	Adapter, zipper stripping
3. Adhesive Transfer, 2" wide	Adhesion exit strip, suit sealing
4. Masking, 3" wide	Exit-incision re-enforcement
II. Plastic Sealing Equipment	Fabrication of plastic items
A. Electronic Generators 1-2 KW	Plastic sealing
B. Electronic Sealing Appliances	Plastic sealing
1. Sealing Press	
2. Sealing Bar, clamp type	
3. Sealing pliers	
C. Hot Air Welder	Inner suit sealing bands
III. Miscellaneous Equipment	
A. Metal Covered Layout Table	Cutting out of plastic items
B. Special Sealing Dies	Making specialized plastic seals
C. Ball Pointed knife, small clamps	Suit-exit incision

FIGURE 1

OVERALL ARRANGEMENT FOR SEALED PERSONNEL PASSAGE THROUGH A SEALED BARRIER

FIGURE 2

SEALED SUIT INTERNAL
SERVICE LINES

D. Clarke 1/9/70

CONTAMINATION SEAL COVER ARRANGEMENT
FOR SERVICE LINE TUBE

FRONT VIEW

SIDE VIEW

SEALED SUIT SERVICE
MANIFOLD CONNECTIONS

WITH THE WEARER ALREADY SEALED IN HIS INNER SUIT & RECEIVING BREATHING AIR THROUGH THE JACKET VALVED COUPLING, PULL OUTER TROUSER SERVICE SLEEVE OVER SERVICE SLEEVE OF INNER TROUSERS, DISCONNECTING COOLING & TELEPHONE LINES MOMENTARILY TO DO SO. WHEN BOTH OUTER TROUSERS & JACKET HAVE BEEN PUT ON, PROCEED WITH THE SEALING TOGETHER AS FOLLOWS: (a) POSITION THE JACKET OVER TROUSERS SO THAT THE COVERED ADHESIVE STRIP ON THE JACKET IS ALIGNED WITH THE COVERED ADHESIVE STRIP ON THE TROUSERS. THE JACKET WAIST IS FOLDED UP SO THAT THE SEALING BAND COVERS ARE EXPOSED.

b) AFTER HAVING TRANSFERRED THE BREATHING AIR FROM THE JACKET INLET TO THE REGULAR SERVICE SLEEVE CONNECTIONS, PEEL BACK THE JACKET SEALING BAND ADHESIVE COVERS TO CLEAR THE TROUSERS ADHESIVE STRIP. FOLD DOWN THE JACKET WAIST OVER THE TROUSERS. (c) ADJUST THE JACKET ON THE TROUSERS TO PREVENT STRAIN DURING USE BY HAVING THE WEARER BEND OVER PRIOR TO SEALING. THEN PULL THE TROUSERS ADHESIVE STRIP COVER DOWN TO CLEAR THE FOLDED DOWN BOTTOM EDGE OF JACKET. SEAL JACKET AND TROUSERS ALONG THE TROUSERS ADHESIVE STRIP BY PRESSING TOGETHER, WHILE MAKING SURE ANY WRINKLES ARE ELIMINATED.

d) PULL EACH END OF THE JACKET SEAL BAND ADHESIVE COVERS TO THE SIDE OF THE SUIT AND SMOOTH OUT ANY WRINKLES IN THE TROUSERS WAIST CIRCUMFERENCE TO WHICH THE JACKET SEAL BAND BECOMES ADHERED. (e) PRESS THE JACKET AND TROUSERS TOGETHER ALONG THE SEALING BAND ADHESIVE STRIP TO INSURE A SEAL. THE EXCESS JACKET CIRCUMFERENCE IS SEALED TO ITSELF ON EACH SIDE TO FORM A FIN, WHICH MAY BE TAPED DOWN TO THE JACKET. (f) REMOVE COVERING ON THE JACKET ADHESIVE STRIP AND REPLACE IT WITH THE EXTRA LENGTH OF THE TROUSERS COVER STRIP, TO FORM A CONTINUOUS ADHESIVE STRIP & COVER FROM LEG TO HELMET. (g) MAKE PULL TAB AT END OF STRIP ON TOP OF HELMET FOR EASY GRASPING OF STRIP FOR REMOVAL DURING EXIT.

OUTER SUIT SEALING PROCEDURE

FIGURE 9

1. ALIGN ZIPPER TAPE OF ADAPTER COVER AND OUTER SUIT SERVICE SLEEVE. TAPE IS TO BE SAME COLOR.

ADAPTER EXCESS TAKEN UP WITHIN SLEEVE FOLD.

4. ADHERE BACK OF SUIT SLEEVE ZIPPER TAPE TO APPROX. 1" OF THE RENEWED ADHESIVE ON ADAPTER COVER ZIPPER TAPE.

2. PULL BACK PLASTIC ENDS OF TAPED SLITS, FROM BOTH COVER & SLEEVE, APPROXIMATELY 1/2 INCHES.

5. APPLY APPROX. 1 1/2" OF ADHESIVE TRANSFER TAPE TO RENEW THE ADHESIVE OF SUIT SLEEVE ZIPPER TAPE.

3. RENEW ADHESIVE ON ADAPTER COVER ZIPPER TAPE BY APPLYING APPROXIMATELY 1 1/2" OF ADHESIVE TRANSFER TAPE AND REMOVE PAPER BACKING (TYPICAL).

6. a) ADHERE THE PULLED BACK ADAPTER COVER ENDS TO THE NEW ADHESIVE; (b) NEXT APPLY APPROX. 1" OF ADHESIVE TRANSFER TAPE ON TOP OF THE NEWLY ADHERED ADAPTER COVER ENDS; (c) THEN ADHERE (NOT SHOWN) THE PULLED BACK SUIT SLEEVE ENDS TO THE ADAPTER COVER.

SEE FIG. II FOR FINAL ATTACHMENT STEPS.

PROCEDURE FOR SPLICING ZIPPER TAPE OF OUTER SUIT SERVICE SLEEVE TO ADAPTER COVER

TAPING FOR CIRCUMFERENTIAL SEALING OF OUTER SUIT SERVICE SLEEVE TO ADAPTER COVER

- a) FOLD BACK ADAPTER CHANGING ATTACHMENT OF THE CONTAMINATION SEAL COVER TO APPROX. ONE FOOT BEHIND END OF SERVICE LINES. (b) THREAD THE TIE STRAP THROUGH THE LOOP ON THE SEAL COVER TUBE.

- c) CONNECT EACH SERVICE LINE TO ITS RESPECTIVE SERVICE TUBE FLANGE CONNECTION. (d) FASTEN THE TIE STRAP SPRING SNAP TO THE FLANGE EYE BOLT AND ADJUST THE LENGTH OF TIE STRAP BY THREADING BOTH ENDS THROUGH THE ADJUSTMENT BUCKLE, OR TIEING TOGETHER, SO THAT THE SEAL COVER TUBE IS HELD IN PLACE ALONG WITH THE FOLDS IN THE ADAPTER CHANGING ATTACHMENT, THUS FACILITATING SUBSEQUENT ADAPTER ASSEMBLY CHANGES.

- f) TAPE END OF ADAPTER CHANGING ATTACHMENT OVER THE PRIMARY ADAPTER COVER AT THE REAR OF THE ADAPTER COVER MOUNT, USING THE CIRCUMFERENTIAL SEALING METHOD SIMILAR TO FIGURE 11. THE SERVICE LINE TUBE AND ADAPTER ASSEMBLY IS NOW READY FOR ATTACHING INITIAL ENTRY COVER AS SHOWN IN FIGURE 13-1.

PREPARATION OF SERVICE LINE TUBE FOR INITIAL ENTRY

FIGURE 14

1. (a) AFTER ATTACHMENT TO SERVICE LINE TUBE*, THE SUITED MAN STEPS INTO THE INITIAL ENTRY BAG AND A NEW ENTRY-EXIT BAG IS THEN INSTALLED BY BARRIER ATTENDANT. (b) THE REINFORCING TAPE AROUND THE SERVICE LINE ENTRY INCISION IS REMOVED. (c) THE ADAPTER ASSEMBLY INITIAL ENTRY COVER IS THEN DETACHED FROM THE SERVICE LINE TUBE BY PULLING THE TAB OF THE ZIPPER TAPE LOCATED INSIDE THE NOW EXPOSED ADAPTER ASS'Y ENTRY COVER.

* SEE FIGURE 16-1 FOR SERVICE LINE ATTACHMENT PROCEDURE.

2. WITH THE SERVICE LINE TUBE NOW FREE FROM THE INITIAL ENTRY BAG, (a) THE SUITED MAN REMOVES THE ZIPPER TAPE OVER THE VERTICAL PRECUT SLIT ON THE ENTRY BAG BY PULLING THE TABS AT EITHER END OF THE TAPE, CREATING A VERTICAL OPENING THROUGH WHICH (b) THE MAN STEPS INTO THE WORK ENCLOSURE AREA.

3. (a) THE SUITED MAN THEN ASSISTS THE BARRIER ATTENDANT IN REMOVING THE INITIAL ENTRY (GLOVED) BAG FROM THE PERSONNEL ACCESS PORT AND (b) PLACES THE BAG, AS WELL AS THE DISCARDED ADAPTER COVERS AND TAPE, INTO THE COLLECTOR BAG ON THE MATERIAL DISPOSAL PORT. THE SUITED MAN IS NOW READY FOR WORK.

PROCEDURE FOR INITIAL PERSONNEL ENTRY INTO ENCLOSURE

1. AFTER COMPLETING WORK ASSIGNMENT, THE PERSON IN SUIT (a) REMOVES HIS RUBBERS FROM FEET AND PLACES THEM IN THE MATERIAL DISPOSAL BAG. (b) AFTER ELIMINATING ANY WRINKLES ON THE BACK AND REAR OF THE RIGHT LEG OF THE OUTER SUIT, HE BACKS UP TO ENTRY-EXIT BAG. (c) THEN AN ADHESIVE STRIP RUNNING DOWN THE BACK AND RIGHT LEG, IS EXPOSED BY PULLING THE ADHESIVE COVER STRIP PULL TAB LOCATED NEAR THE TOP OF THE HEAD. THIS IS DONE BY PULLING THE COVER JUST A FEW INCHES AT A TIME AS THE BARRIER ATTENDANT APPLIES PRESSURE BY HAND SO THAT THE BAG AND OUTER SUIT BECOME FIRMLY ADHERED TOGETHER.

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2. WITH THE ADHESION COMPLETE FROM THE TOP OF THE HEAD DOWN TO THE BOTTOM OF THE RIGHT LEG, (a) A SMALL INCISION, ONLY A FEW INCHES LONG, IS MADE WITHIN THE TOP OF THE STRIP AND THROUGH THE BAG AND OUTER SUIT. MAKE CUT IN HELMET AREA TO AVOID CUTTING INNER SUIT. (b) THROUGH THIS OPENING APPLY A SMALL CLAMP ACROSS THE TOP OF THE CUT TO PREVENT AN UPWARD TEARING OF THE INCISION. (c) WITH A SPECIAL BALL POINTED KNIFE, MAKE AN INCISION DOWN THE MIDDLE OF THE ADHESION STRIP AND REINFORCE BY PLACING TAPE OVER EACH EDGE OF THE INCISION AND (d) CHECK THE INCISION FOR CONTAMINATION.

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FIGURE 1b

3. (a) THE PERSON IN SUIT REMOVES HIS RIGHT FOOT FROM THE OUTER SUIT AND STEPS BACK THROUGH THE INCISION INTO THE BAG. THE RIGHT FOOT IS THEN CHECKED FOR CONTAMINATION. (b) THE HEAD AND UPPER BODY IS THEN REMOVED FROM THE OUTER SUIT AND CHECKED FOR CONTAMINATION. (c) THE LEFT FOOT IS REMOVED FROM OUTER SUIT WITH ASSISTANCE FROM BARRIER ATTENDANT AND CHECKED FOR CONTAMINATION. (d) AS THE PERSON IN INNER SUIT STEPS OUT OF THE EXIT BAG, THE SERVICE LINE ADAPTER IS EXPOSED WHEN THE OUTER SUIT SERVICE SLEEVE IS TURNED INSIDE OUT. THE BARRIER ATTENDANT CAN NOW REMOVE THE INNER SUIT SLEEVE FROM THE ADAPTER AND DISCONNECT THE FLANGES (SEE FIGURE 3) TO COMPLETE THE EXIT.

1 ADHESIVE EXIT PROCEDURE

1. WITH THE PERSON PREPARING FOR ENTRY, SUITED UP AND RECEIVING AIR AND COMMUNICATION THROUGH THE STANDBY SUIT SERVICE LINES, (SEE FIGURE 1) (a) THE FLANGE OF HIS SUIT SERVICE BUNDLE IS JOINED TO THE FLANGE OF THE SERVICE LINE TUBE BY THE BARRIER ATTENDANT. (b) THE BREATHING AIR IS THEN TURNED ON AT THE MANIFOLD AND THE FLOW OF REMOVED SUIT AIR IS ADJUSTED TO GIVE A MODERATE SUIT INFLATION. (c) DISCONNECT SUIT LINES FROM STANDBY SUIT SERVICE LINE AND CONNECT THEM TO THE SUIT SERVICE BUNDLE FLANGE. (d) THE INNER SUIT SERVICE SLEEVE IS TAPED TO THE ADAPTER COVER MOUNT, SIMILAR TO FIGURE II, BY THE ATTENDANT. (e) THE OUTER SUIT SERVICE SLEEVE IS THEN SPLICED TO THE TOP ADAPTER COVER (SEE FIGURE 10) AND SEALED (SEE FIGURE II).

2. (a) THE SUITED MAN NOW STEPS INTO THE EXIT BAG AND A NEW ENTRY-EXIT BAG IS THEN INSTALLED ON ACCESS PORT BY BARRIER ATTENDANT. (b) THE ADAPTER COVER AND SERVICE SLEEVE FROM PREVIOUSLY USED OUTER SUIT IS REMOVED FROM SERVICE LINE TUBE BY PULLING THE ZIPPER TAPE RUNNING ALONG THE INVAGINATED SERVICE SLEEVE & ADAPTER COVER (SEE FIGURE 9). (c) THE REINFORCING TAPE AROUND THE BAG EXIT INCISION IS THEN REMOVED AND THE USED OUTER SUIT IS SEPARATED FROM THE BAG.

3. (a) THE SUITED MAN STEPS THROUGH THE EXIT BAG INCISION OPENING INTO THE WORK AREA AND PLACES THE DISCARDED SUIT INTO THE MATERIAL DISPOSAL PORT. (b) HE THEN REMOVES, WITH THE HELP OF THE BARRIER ATTENDANT, THE EXIT BAG AND PLACES IT IN THE DISPOSAL PORT. HE IS NOW READY FOR WORK.

PROCEDURE FOR SUCCESSIVE ENTRY INTO ENCLOSURE

FIGURE 16

AFTER COMPLETING THE EXIT PROCEDURE, AND SUBSEQUENT TO ANY FARTHER ENTRIES, A NEW ADAPTER ASSEMBLY MUST BE INSTALLED. (A) THIS IS DONE BY PULLING BACK THE USED PRIMARY ADAPTER COVER, THAT HAS BEEN TURNED INSIDE OUT BY THE EXIT, CLEARING THE ADAPTER COVER MOUNT AND EXPOSING THE FIRST FLAP OF THE ADAPTER CHANGING ATTACHMENT.

(b) THE FOUR FLANGE SCREWS ARE THEN WITHDRAWN AND THE ADAPTER COVER MOUNT IS REMOVED FROM THE FLANGE. (C) THEN SLIDE THE NEW ADAPTER ASSEMBLY INTO POSITION OVER THE FLANGE TO MATCH THE SCREW LOCATIONS AND ATTACH TO FLANGE BY REPLACING THE SCREWS.

(d) TAPE THE FOREMOST FLAP OF THE ADAPTER CHANGING ATTACHMENT TO THE NEW ADAPTER COVER MOUNT, USING THE CIRCUMFERENTIAL SEALING METHOD SIMILAR TO FIGURE 11.

THE NORMAL ENTRY PROCEDURE, SEE FIGURE 16, CAN NOW BE USED.

NOTE: DURING ENTRY THE USED INVAGINATED SERVICE SLEEVE IS REMOVED AS USUAL, HOWEVER IN THE CASE OF THE PRIMARY ADAPTER COVER THE END TAPE, ATTACHING THE SERVICE TUBE, IS LEFT ADHERED TO THE FLAP.

SUCCESSIVE REPLACEMENT OF ADAPTER ASSEMBLY

FIGURE 18

ALLOWING THE REMOVAL OF THE SUIT SERVICE BUNDLE AND WHEN ALL EXCEPT THE LAST FLAP OF THE ADAPTER CHANGING ATTACHMENT HAVE BEEN USED, IT IS NECESSARY TO REPLACE THE ADAPTER ASSEMBLY. TO DO THIS REQUIRES THAT A NEW ADAPTER CHANGING ATTACHMENT BE ADDED.

THIS IS DONE BY PULLING BACK THE INVAGINATED SUIT SERVICE SLEEVE & PRIMARY ADAPTER COVER, SO THAT THE ADAPTER COVER MOUNT IS CLEARED AND THE LAST FLAP ON THE ADAPTER CHANGING ATTACHMENT IS EXPOSED.

(b) A NEW ADAPTER CHANGING ATTACHMENT IS ADDED BY POSITIONING IT SO THAT, WITH THE FLAPS ON THE INSIDE, THE REAR FLAP OF THE NEW ATTACHMENT MATCHES WITH THE UNUSED LAST FLAP ON THE USED ATTACHMENT. USING A PLIER TYPE SEALER THE FLAPS OF THESE TWO ATTACHMENTS ARE SEALED AROUND THEIR MUTUAL CIRCUMFERENCE.

NEW ADAPTER CHANGING ATTACHMENT - SHOWN IN POSITION FOR ATTACHING TO NEW ADAPTER ASSEMBLY COVER MOUNT

- (c) THE NEW ADAPTER CHANGING ATTACHMENT IS NOW FOLDED BACK OVER SO THAT ALL ITS FLAPS ARE ON THE OUTSIDE.
- (d) THE ADAPTER CHANGING ATTACHMENT IS THEN FOLDED PARTIALLY FORWARD. THE FRONT END CAN NOW BE ATTACHED TO A NEW ADAPTER ASSEMBLY COVER MOUNT AS DESCRIBED IN FIGURE 17-d.

INSTALLING ADDITIONAL ADAPTER CHANGING ATTACHMENTS

FOLLOWING SUIT EXIT WHERE A LONGER SERVICE LINE TUBE IS REQUIRED FOR THE NEXT ENTRY; (a) DISCONNECT THE SERVICE LINE AT A SECTION JOINT NOT COVERED BY THE CONTAMINATION SEAL COVER.

(b) INSERT AN ADDITIONAL SECTION OF SERVICE LINE TUBE AND RECONNECT THE LINES AT EITHER END. (c) PULL THE SERVICE LINE COVER OF THE NEW SECTION OVER THE CONNECTIONS AND OVERLAP THE COVERS OF THE ADJOINING SECTIONS. THE TWO COVERS AT THE SECTION JOINT THAT WILL BE COVERED BY THE CONTAMINATION SEAL COVER, ARE THEN TAPED TOGETHER TO FORM A SEAL. (d) USING TAPE, OR A PLIER TYPE SEALER, BUTT SEAL THE LEAD END OF THE NEW CONTAMINATION SEAL COVER TO THE FREE END OF THE CURRENTLY-IN-USE CONTAMINATION SEAL COVER WHILE IT IS STILL ATTACHED TO THE PORT RING.

(e) BRING THE O-RING OF THE NEW CONTAMINATION SEAL COVER OVER AND AROUND THE ACCESS PORT RING AND RELEASE THE O-RING INTO THE REAR SLOT OF THE RING. THEN SLIDE THE OLD O-RING OFF THE FRONT SLOT AND MOVE THE NEW ONE INTO ITS PLACE. CHECK FOR CONTAMINATION. THE ADDED LENGTH OF SERVICE LINE TUBE CAN NOW BE INTRODUCED INTO THE WORK ENCLOSURE.

ADDING TO LENGTH OF SERVICE LINE TUBE

FIGURE 19

AFTER THE LAST EXIT, OR WHENEVER FOR ANY REASON A REPLACEMENT OR INSPECTION OF THE SERVICE LINES OR THE SERVICE LINE SEAL COVER IS DESIRED, (a) PULL THE SERVICE LINES OF THE SERVICE LINE TUBE BACK THROUGH THE SERVICE LINE ACCESS PORT UNTIL ALL SLACK IS REMOVED FROM INSIDE OF THE ENCLOSURE. ALLOW THE CONTAMINATION SEAL COVER OF SERVICE LINE TUBE TO TURN INSIDE OUT AS THE LINES ARE WITHDRAWN. (b) REMOVE THE FOUR SCREWS FROM THE COVER MOUNT OF THE ADAPTER ASSEMBLY, BY WHICH IT IS ATTACHED TO THE SERVICE TUBE FLANGE. SLIDE THE ADAPTER ASSEMBLY BACK SEVERAL INCHES TO EXPOSE THE SERVICE LINE CONNECTIONS TO THE FLANGE. DISCONNECT THE SERVICE LINES AND REMOVE THE FLANGE.

(c) TO PERMIT REINSERTION OF THE SERVICE LINES, IF THIS IS DESIRED AFTER THEIR REMOVAL, ATTACH A RETRIEVAL PULL CORD AROUND THE END OF THE SERVICE LINES. RETRACT THE SERVICE LINES FROM THE CONTAMINATION SEAL COVER BY PULLING THEM THROUGH THE SERVICE LINE PORT. DETACH THE RETRIEVAL CORD FROM THE SERVICE LINE ENDS AS THEY EMERGE FROM THE END OF THE INVAGINATED CONTAMINATION SEAL COVER, UNLESS INSPECTION OR WORK STATUS INDICATES THE LINES MAY BE REINSERTED. THE LINES ARE NOW AVAILABLE FOR REUSE, STORAGE OR OTHER DISPOSAL. (d) IF UPON INSPECTION OR REVIEW FOLLOWING REMOVAL OF SERVICE LINES, IT IS DECIDED TO REINSTALL THE LINES FOR CONTINUED USE, ATTACH PULL CORD AROUND END OF LINES IF IT HAS BEEN DETACHED. BY PULLING ON CORD FROM THE ADAPTER ASSEMBLY END OF THE SEAL COVER, REINSTALL THE SERVICE LINES INTO THE SEAL COVER. RECONNECT THE LINES TO THE SERVICE TUBE FLANGE AND ATTACH FLANGE TO ADAPTER COVER MOUNT. PROCEED WITH NEXT ENTRY.

RETRIEVAL OF SERVICE LINES FOR REUSE

AS SOON AS PERSONNEL OUTSIDE OF THE ENCLOSURE HAVE BECOME AWARE OF ANY EMERGENCY WARRANTING NEED FOR RESCUE OF A PERSON IN-SUIT FROM WITHIN THE ENCLOSURE, PROCEED AS FOLLOWS :
(a) PERSON MAKING RESCUE ENTERS TUNNEL SUIT BY STEPPING INTO LEGS OF THE SUIT. HE THEN REMOVES THE RESTRAINT ANCHORS THAT HOLDS THE TUNNEL SUIT TO THE ENTRY PORT.

(b) THEN WALKING INTO THE ENCLOSURE, HE ALLOWS TUNNEL TO EXTEND AND INFLATE BEHIND HIM AND TO FLOAT OVER AND ABOVE THE LENGTH OF THE VICTIM'S BODY, SO THAT A COVERED ADHESIVE STRIP, LOCATED ON THE EXTERIOR BOTTOM SURFACE OF THE TUNNEL & BETWEEN THE TWO ROWS OF GLOVED ARMS, EXTENDS ALONG THE LENGTH OF THE VICTIM'S BODY. (c) ALONE, OR WITH ASSISTANCE BY OTHERS WORKING THROUGH THE GLOVES ALONG THE BOTTOM OF THE TUNNEL, REMOVE THE COVERING FROM THE ADHESIVE STRIP ON THE TUNNEL. (d) PRESS THE ADHESIVE STRIP TO THE SURFACE OF THE OUTER SUIT FROM HELMET DOWN THE BACK OF ONE LEG, OR WHEREVER ON THE SUIT THE CONTACT CAN BEST BE MADE CONSIDERING THE POSITION OF THE VICTIM. (e) CUT DOWN THE CENTER OF THE ADHESIVE STRIP IN THE SAME MANNER AS IN THE NORMAL ADHESION EXIT, (SEE FIGURE 15) EXPOSING THE INNER SUIT OF VICTIM. (f) CONNECT AIR HOSE TO INNER SUIT JACKET EMERGENCY AIR COUPLING (SEE FIGURE 2) IF REQUIRED AND REMOVE VICTIM FROM TUNNEL. REMOVE INNER SUIT AND PROVIDE FIRST AID AND HOSPITALIZATION AS NEEDED.

FIGURE 22

AFTER RESCUE HAS BEEN COMPLETED, REPAIR TUNNEL FOR REUSE AS FOLLOWS : (g) RETRIEVE THE SERVICE LINES FROM THE SERVICE LINE TUBE OF VICTIM'S OUTER SUIT WHICH IS ATTACHED TO THE RESCUE TUNNEL INCISION. (h) BRING EDGES OF INCISION TOGETHER AND RESEAL TUNNEL BOTTOM BY APPLYING TRANSPARENT PLASTIC TAPE ACROSS THE CUT AND ALONG TOTAL LENGTH OF INCISION. (i) WORKING THROUGH GLOVES IN TUNNEL BOTTOM, DETACH THE VICTIM'S OUTER SUIT FROM TUNNEL. (j) TUNNEL IS THEN PULLED BACK TO ITS PREVIOUS ACCORDIAN STATE OF RETRACTION & ANCHORED BY THE RESTRAINT ANCHOR HOOKS.

EMERGENCY RESCUE FROM ENCLOSURE OF AN INCAPACITATED PERSON-IN-SUIT