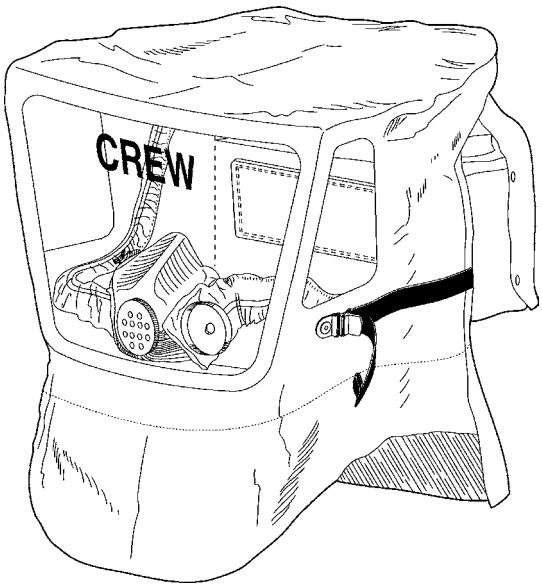
CREWMEMBER PROTECTIVE BREATHING EQUIPMENT GUIDELINES FOR INSTALLATION, USE, AND SERVICE



PN 119003 SERIES - Crewmember Protective Breathing Equipment and PN 119063 SERIES - PBE Stowage Box

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B/E AEROSPACE
GUIDELINES FOR INSTALLATION, USE, AND SERVICE
CREWMEMBER PROTECTIVE BREATHING EQUIPMENT AND PBE STOWAGE BOX
PN 119003 SERIES AND PN 119063 SERIES

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GENERAL INFORMATION

This guideline has been prepared to fulfill customer requirements.

All procedures established in this manual have been performed and verified acceptable by trained personnel at B/E Aerospace, Inc.

Procedures are provided for the full range of use and maintenance, and include all the work functions that could or may be done to the unit throughout its entire service life.

The following abbreviations may be used in this guideline:

ABBREVIATION	MEANING
C	Celsius
CAGE	Commercial and Government Entity
Cl_2	Chlorine
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EFF	Effectivity
F	Fahrenheit
FAA	Federal Aviation Administration
FIG	Figure
G	Gravities
HCl	Hydrochloric Acid
ID	Identification
$KHCO_3$	Potassium Bicarbonate

ABBREVIATION	MEANING
KOH	Potassium Hydroxide
KO_2	Potassium Superoxide
LH	Left Hand
NaCl	Common Salt
$NaClO_3$	Sodium Chlorate
NO	Number
PBE	Protective Breathing Equipment
PN	Part Number
REQ	Required
RF	Reference
RH	Right-hand
TSOA	Technical Standard Order Accessory
TTL	Total

1. DESCRIPTION

The Protective Breathing Equipment (PBE) is a closed circuit breathing apparatus designed to help protect the wearer's eyes and respiratory tract in an atmosphere containing smoke and fumes by isolating the eyes and breathing functions from the environment. Isolation is achieved by a hood system that envelops the head of the wearer. A breathable atmosphere is maintained by a demand-based chemical air regeneration system that supplies oxygen and removes carbon dioxide and water vapor. This equipment is certified in accordance with the requirements of TSO-C116.

2. PURPOSE OF EQUIPMENT

The PBE is specifically intended to meet Federal Aviation Regulations Part 121.337 that requires a certificate holder to furnish approved PBE that can supply breathable atmosphere to protect crewmember from the effects of smoke, carbon dioxide or other harmful gases and oxygen deficiency caused by other than an airplane depressurization, while attempting to locate and/or extinguish (combating) an in-flight fire

on board an airplane. In addition to the FAA requirements, the PBE is designed for peak workload response that may be required for evacuation purposes, and it is further designed to continue functioning in the event of a rapid decompression.

3. GENERAL FEATURES

The PBE is a hood device that completely encloses the head of the wearer and seals at the neck with a thin elastic membrane. The large internal volume of the hood accommodates glasses and long hair while the elastic membrane neckseal enables fitting over the broad population range representative of aircraft crewmembers. The chemical air regeneration system is based on the use of potassium superoxide (KO_2). Operation of the PBE is silently and reliably powered by the exhalation of the wearer into an oronasal mask cone located within the hood. The low moisture content of the oxygen gas generated by the KO_2 bed in the canister reduces the wet bulb temperature, improving wearer comfort, and controlling misting or fogging of the visor, side windows, and/or glasses. The complete device is secured to the head to minimize restrictions to mobility. The large optically clear visor and side windows provide a wide field of vision while maintaining their relative position with the head. A neck shield extends downward from the back of the hood to protect the collar and upper shoulder area of the user from direct flame contact. A speaking diaphragm is installed in the oronasal mask cone to enhance communication. The unit is vacuum-sealed in a bag for long storage life and installed in a protective stowage box within the aircraft cabin.

4. TECHNICAL DATA

A. Breathable Gas - Chemically supplied oxygen (approximately 50 liters on demand)

B. Duration - 15 minutes or longer when used in accordance with FAA specified work rates, depending on the size of the user.

C. Weight (as worn) - 4.9 pounds (2.2 Kg) maximum.

D. Starter Candle - Not less than one hood volume (eight liters) of oxygen within 20 seconds of initiation.

E. Rebreathing Volume - Nominal eight liters.

F. Inhaled CO_2 Concentration - Less than 4% at the FAA specified work rate.

G. Inhaled Gas Temperature - Less than 104°F (40°C) wet bulb at the FAA specified work rates.

H. Materials of Construction

(1) Components For Crewmember PBE PN119003, 119003-01, 119003-90, and 119003-91

(a) External Exposed Components Materials

Hood - Double sided Teflon® impregnated fiberglass fabric
Visor - Optically Clear Polycarbonate
Adjustment Strap - Nomex®
Adjustment Buckles - Nickel-plated die cast zinc
External Thermoplastic Components - Ultem®
Speaking Diaphragm - Kapton® and glass filled nylon
External Elastomers - Silicone rubber

(b) Internal Components Materials

Neckseal - Latex film
Exhalation Circuit - Polyurethane film
Canister Discharge Circuit - Teflon® film
Oronasal Mask - Silicone rubber
Chlorate Candle - Stainless Steel and Brass
KO_2 Canister - Tin Plated Carbon Steel
Canister/Candle Insulation - Ceramic Fiber Blanket and Foil Laminated Ceramic Fiber

(2) Components For Crewmember PBE PN 119003-11

(a) External Exposed Components Materials

Hood – Silicone impregnated fiberglass fabric
Visor and Side Windows - Optically Clear Polycarbonate
Adjustment Strap - Nomex®
Adjustment Buckles - Nickel-plated die cast zinc
External Thermoplastic Components - Ultem®
Speaking Diaphragm - Kapton® and glass filled nylon
External Elastomers - Silicone rubber

(b) Internal Component Materials

Neckseal - Silicone film
Exhalation Circuit - Polyurethane film
Canister Discharge Circuit - Teflon® film
Oronasal Mask - Silicone rubber
Chlorate Candle - Stainless Steel and Brass
KO_2 Canister - Tin Plated Carbon Steel
Canister/Candle Insulation - Foil Laminated Ceramic Fiber

5. <u>OPERATION</u>

A. General Operation

(1) During the donning sequence, the chlorate candle is actuated when the adjustment straps are pulled to secure the oronasal mask cone against the face. The lanyard to the pull pin on the chlorate candle is attached to the right hand adjustment strap.

(2) When the neckseal is properly positioned, the oxygen generated by the chlorate candle will inflate the hood, providing adequate initial breathing volume, and accomplish some purging of the hood with excess gas generation.

Oxygen Generation

$$2\,KO_2 + H_2O \longrightarrow 2\,KOH + \tfrac{3}{2}\,O_2$$

$$2\,KO_2 + CO_2 \longrightarrow K_2CO_3 + \tfrac{3}{2}\,O_2$$

Carbon Dioxide Removal

$$2\,KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$

$$KOH + CO_2 \longrightarrow KHCO_3$$

KO_2 Chemical Reaction
Figure 1

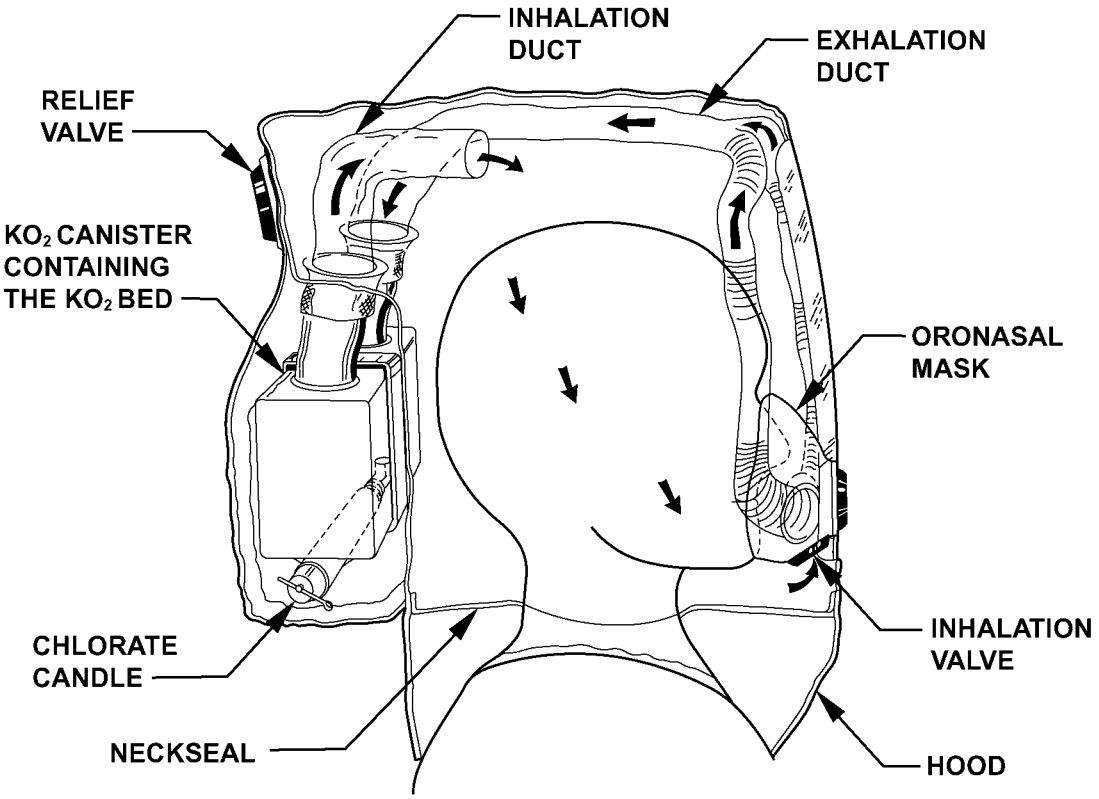
(3) When the wearer begins to breathe normally through the oronasal mask cone, the exhaled breath is directed through the KO_2 canister. The KO_2 canister removes water vapor and carbon dioxide and adds oxygen before the gas is returned to the interior of the hood for inhalation (refer to Figs. 1 and 2).

(4) This breathing cycle will continue until the KO_2 canister is exhausted. Exhaustion of the canister results in a loss of active oxygen generation capability, coupled with a rapid increase in internal temperature and release of moisture from the KO_2 canister. The loss of oxygen generating capability results in a gradual reduction of the interior volume of the hood. As the hood collapses around the wearer's head, full inhalation becomes increasingly difficult, giving positive indication that the hood should be removed. This indication is reinforced by the rapid buildup in temperature within the hood.

B. Air Regeneration Cycle

(1) KO_2 reacts with moisture in the wearer's exhaled breath to liberate oxygen and form KOH.

(2) Although there is a minor reaction between KO_2 and CO_2 to form K_2CO_3 and liberate additional oxygen, the major reactions to remove CO_2 are with KOH to form K_2CO_3 or $KHCO_3$. A surplus of oxygen in excess of the wearer's metabolic requirements is produced by these reactions. The small amount of water produced in the formation of potassium bicarbonate is less than the amount of water initially reacted in the oxygen generation phase, so the overall result is the production of a drier gas than the exhaled breath of the wearer.



PBE Operation
Figure 2

C. PBE Operation (refer to Fig. 2)

(1) The hood encloses the head of the wearer and is sealed to the wearer by the neckseal. The enclosed volume of the hood represents approximately eight liters available rebreathing volume.

(2) Inhalation is accomplished directly from the interior of the hood through the inhalation valve located on the oronasal mask. The oronasal mask directs the exhaled breath containing CO_2 and water vapor through the KO_2 canister, where moisture and CO_2 are removed, and drier oxygen is added for return into the hood volume (refer to Fig. 2).

(3) A relief valve located at the back of the hood is used to prevent build-up of excessive pressure within the hood, and to provide emergency pressure relief in the event of a sudden reduction in cabin pressure (refer to Fig. 2).

(4) The chlorate candle mounted on the bottom of the KO_2 canister discharges through the canister into the hood.

$$2\ NaCl0_3 + heat \longrightarrow 2\ NaCl + 3\ O_2$$

Chlorate Candle Chemical Reaction
Figure 3

D. Chlorate Candle

(1) The chlorate candle is designed to deliver a fixed volume of approximately eight liters of oxygen in less than 20 seconds.

(2) The chlorate candle is contained in a small stainless steel cylinder mounted on the base of the KO_2 canister. Discharge from it is directed into the interior of the KO_2 canister.

(3) A spring-loaded plunger striking a small percussion primer initiates the chlorate candle when the lanyard attached to the right hand adjustment strap is pulled. The heat of the percussion primer is sufficient to start the decomposition reaction of the active $NaCl0_3$ (sodium chlorate) material, producing oxygen and forming common salt (NaCl) (refer to Fig. 3).

(4) A small amount of carbon monoxide (CO) is produced as a by-product of the reaction. A filter section at the discharge end of the candle contains an active catalyst to convert the CO to CO_2. Trace amounts of Cl_2 (chlorine) and chlorine derivatives also produced as the KO_2 bed in the canister effectively absorbs by-products of the reaction.

6. <u>INSTALLATION</u>

A. The PBE is installed as a two component system, per installation drawing 844033, consisting of: (1) a low moisture transmission aluminized vacuum-sealed bag installed in (2) a protective stowage box.

(1) Since the active air regeneration chemical (KO_2) is moisture sensitive, the primary function of the vacuum-sealed bag is to maintain an effective moisture barrier. Loss of vacuum resulting in slight inflation of the bag is an indication of the loss of the moisture barrier, requiring replacement of the unit.

(2) The stowage box provides a mechanical barrier to prevent accidental damage to the vacuum bag and provides resistance to accidental or intentional tampering. The stowage box can be fitted with a tamper indicator that must be broken to allow access to the bag.

B. The clear access door of the stowage box allows inspection of the enclosed vacuum-sealed bag to verify installation and the condition of the vacuum seal.

(1) If a tamper seal is employed, preflight inspection for the serviceability of the equipment is to verify the integrity of the tamper seal and observe the presence of the vacuum bag through the inspection port.

(2) If no tamper seal is employed, the preflight inspection is to visually determine that the vacuum-sealed bag is intact and is not inflated.

7. USEFUL LIFE

A. A rated useful life of the PBE is 5 years or 10** years dependant upon the unit's construction (refer to Table 1 for the rated useful life). Useful life corresponds to the total of shelf life plus installed life. This rated life assumes that the vacuum-sealed bag is intact, so that the air regeneration chemical is not degraded.

Rated Useful Life
Table 1

Part Number	Useful Life
119003	10*
119003-01	10*
119003-11	10**
119003-90	5
119003-91	5

*Units produced prior to Feb/02 were originally rated as having a 10 year useful life, before the issuance of Service Bulletin 119003-35-3. The Service Bulletin reduced the useful life of 119003 and 119003-01 to 5 years, but allowed an interval of 30 months for implementation. As a result, units built between Sept/94 and Jul/99 must be replaced by Aug/04 and units built after Jul/99 must be removed from service 5 years after their date of manufacture. New part numbers 119003-90 and 119003-91 were assigned for this design and all units marked with these new part numbers have a 5 year useful life.

**The 10-year useful life may be extended to 20 years, if the PBE has not been used and the unit is returned to B/E to perform a restoration at 10 years from the date of manufacture.

The stowage box is not life limited.

8. COMPARISON OF DESIGN FEATURES OF 119003 SERIES UNITS

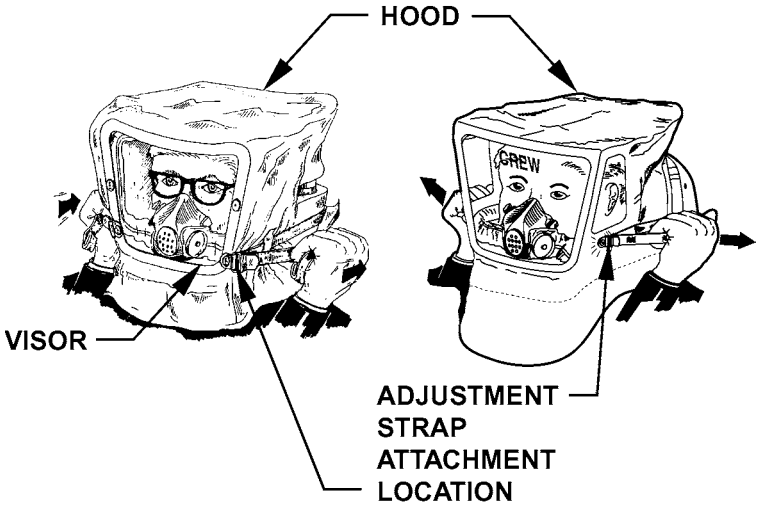
NOTE: Installation, training, and use of PBE hoods are not affected by the differences described in the following paragraphs.

A. The PBE hoods differ in design features including adjustment strap attachment to the hood, the arrangement of the release pin and lanyard for the chlorate starter candle, hood material, side windows, a reflector strip on the back of the hood, KO_2 canister pouch variations, neckseal material, and the length of hood below neckseal.

PBE Hood Variation Comparison
Table 2

Part Number	Strap Location	Major Physical Features
119003	Visor	Tan hood
119003-01	Side of Hood	Tan hood
119003-11	Side of Hood	Bright yellow hood, side windows, reflector, silicone neckseal, longer hood below neckseal
119003-90	Visor	Tan hood
119003-91	Side of Hood	Tan hood

NOTE: PBE hoods PN 119003 and 119003-90 are the same hood design. PN 119003-90 was assigned to the 119003 hood after reduction in the useful life from 10 years to 5 years (refer to Table 1). Similarly, PBE hoods PN 119003-01 and the 119003-91 are the same hood design with the useful life reduced from 10 years to 5 years.



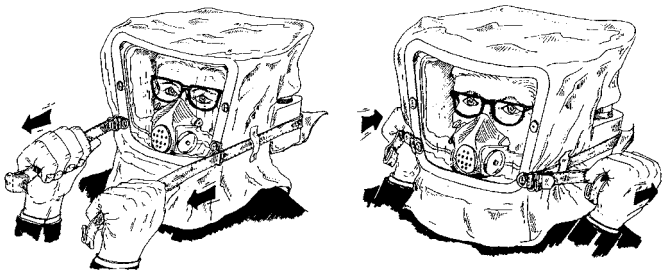
Strap Attachment Comparison
Figure 4

(1) The PBE hoods have adjustment straps attached either to the visor, or to the side of the hood (refer to Table 2 and Fig. 4).

(a) The PBE hoods PN 119003 and 119003-90 have the adjustment straps attached to the visor (refer to Fig. 4). On these units, two external straps are anchored to the sides of the visor, and tightening the straps causes the visor to press the oronasal mask cone snugly against the user's face.

(b) The PBE hoods PN 119003-01, 119003-11 and 119003-91 have the adjustment straps attached to the sides of the hoods (refer to Fig. 4). The two external straps terminate at anchor points on the side of the hood. A pair of internal straps begins inside the hood, at the anchor point on each side. The internal straps extend to attachment points on each side, top and bottom, of the edge of the oronasal cone. The oronasal mask cone is pulled into contact with the user's face by the four internal straps, rather than by being pushed into contact by the visor (and indirectly by the two external straps).

NOTE: An individual who has been trained with a PBE hood can don and use either variation without impairment.

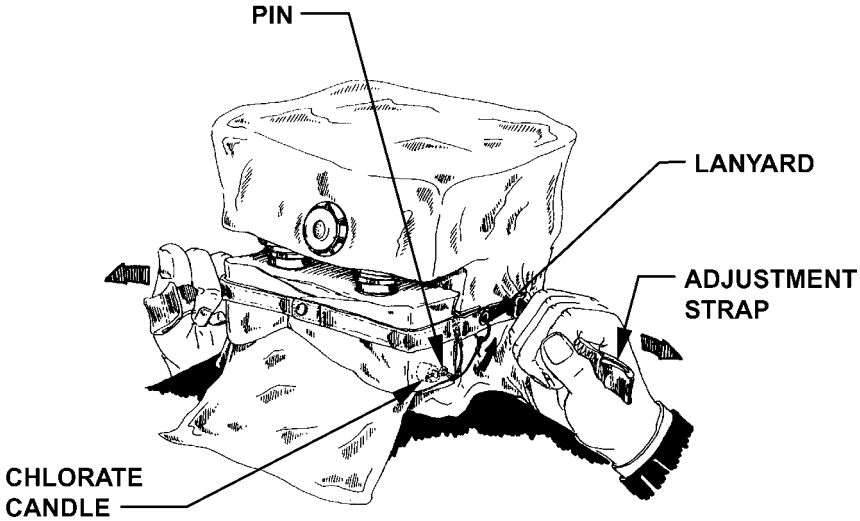


Strap Pull Procedure for Chlorate Candle
Figure 5

B. The arrangement of the release pin and lanyard differs among the PBE hoods.

(1) Recommended donning procedure for the PBE hoods is for the user to don the hood and pull the straps forward to start the oxygen flow and then draw them back to secure the mask. (Refer to Fig. 5).

Experience in developing the PBE and in studying this issue indicates that one would often actuate the flow on PN 119003 by simply tightening the straps, even if the initial forward pull were omitted. Occasionally, however, a wearer could tighten the straps gently and gradually enough that the mask would snug down without moving the pin, if the forward pull were omitted. Considering that users should have been trained in the proper actuation method, we do not judge this to be a likely problem. However, in response to requests from customers, we devised an alternative that could be actuated with reduced pull force.



Lanyard Attachment
Figure 6

(a) The spring force of the striker mechanism was reduced.

(b) In PN 119003 and 119003-90(refer to Fig. 6), the end of the lanyard is attached to the end of the release pin. In PN 119003-01, 119003-11 and 119003-91 both ends of the lanyard are secured to the adjustment strap, after the lanyard is passed through the eye in the

end of the release pin. In both configurations, the lanyard is pulled, the pin is removed, and the chlorate candle is actuated upon pulling the adjustment straps forward.

(c) The actuation pin was shortened and slack in the lanyard was reduced to compensate for the doubled length of pull required to provide the mechanical advantage. In principle, this may allow an occasional incident where the generator would be actuated as the hood was placed over the user's head, although this has not been observed. Since there is typically about three seconds delay before the onset of major oxygen flow, most of the gas usually would be retained. If the initial oxygen charge was lost entirely, and the hood remained filled with ambient air, the device would still protect against penetration by external contaminants, because the neckseal performance would be unaffected. The KO_2 canister would still function to remove CO_2 and provide oxygen, fulfilling bodily needs.

(d) Change of actuation features is to improve an individual's successful initiation of oxygen flow from the chlorate candle, even if a forceful forward strap pull is omitted.

C. Physical features distinguish the two fundamental PBE hood designs, the 119003-11 versus the other hoods of the series (refer to Table 2).

(1) The bright yellow hood material of the PN 119003-11 increases visibility under most emergency conditions.

(2) The side windows on the PN 119003-11 PBE hood increase peripheral visibility.

(3) A reflector strip on the back of the PN 119003-11 PBE hood increases reflection of emergency lights.

(4) A variation in the cover flap of the KO_2 canister pouch results in increased protection of the KO_2 canister on the PN 119003-11 PBE hood.

(5) The extension of hood material below the neck seal on the PN 119003-11 PBE hood increases protection of exposed flesh.

USE OF EQUIPMENT

1. TRAINING

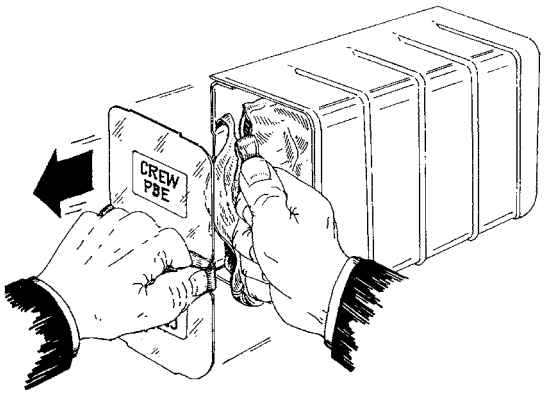
WARNING: **THIS EQUIPMENT IS INTENDED FOR USE ONLY BY CREWMEMBERS INSTRUCTED IN THE PROPER USE OF THE EQUIPMENT AND OPERATIONAL PROCEDURES.**

NOTE: The following illustrations show the PBE hood PN 119003-11 design. However, the procedure for use is the same for all PBE hoods in the 119003-Series.

NOTE: A training device (B/E Aerospace, Inc. PN 119002 Series) is available to provide familiarity with the procedures for donning, adjustment, actuation, and doffing of the equipment. Additional instruction on recognition of proper fit, normal operation of the equipment, and failure modes/limitations of the equipment is strongly recommended.

2. DONNING

A. The following steps are recommended for donning of the PBE hood.



Open the Stowage Box
Figure 7

(1) Open the stowage box (refer to Fig. 7).

(a) Grasp the red access handle on the stowage box firmly.

(b) Pull handle forcibly to disengage the door and break the tamper indicator (if installed).

(c) Remove the cover (refer to Fig. 7).

(d) After removing the cover, drop it.

(2) Remove the sealed bag containing the PBE hood from the stowage box.

(a) Reach into the stowage box and firmly grasp the vacuum-sealed bag at the center with the palm facing the stowage box mounting bulkhead (convenient positioning of the fingers for a good grip).

(b) Pull the sealed bag straight out of the stowage box.

NOTE: The unit in the sealed bag may be carried elsewhere for use.

Remove the PBE Hood from the Vacuum-Sealed Bag
Figure 8

(3) Remove the PBE hood from the vacuum-sealed bag (refer to Fig. 8).

(a) Grasp the bag firmly with one hand.

(b) Grasp the green or red ID tag and pull sharply with the opposite hand to tear open the bag.

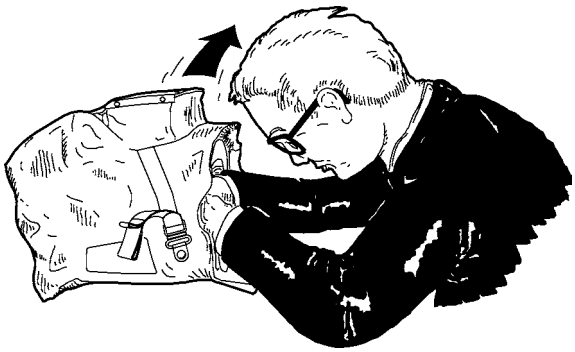
(c) After removing the PBE hood from the bag, drop the bag.

(d) Shake the hood to loosen the compressed material (refer to Fig. 8).

(4) Don the PBE hood (refer to Fig. 9 and 10).

Insert Hands into the Neckseal
Figure 9

(a) Slide both hands (with palms facing each other, thumbs on top) inside the neckseal opening (the neckseal is the translucent elastic membrane with a hole in its center) while the PBE hood visor is facing down, and the KO_2 canister is resting on top of the hands (refer to Fig. 9).

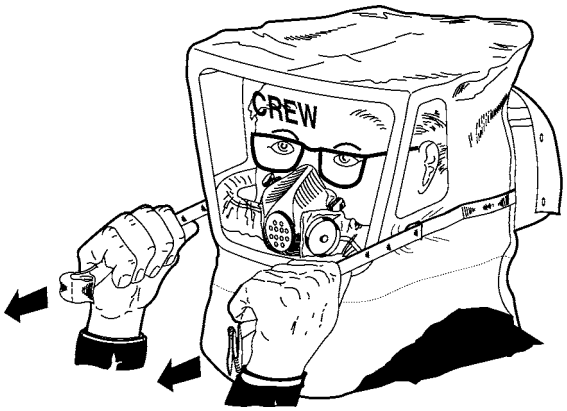


Insert Head Through the Neckseal
Figure 10

(b) Lift the hole in the neckseal of the PBE hood to about eye level (refer to Fig. 10).

(c) Bow the head forward at the neck, guiding the PBE hood neckseal over the top of the head and down over the face, using the hands to shield the face and glasses from the oronasal mask cone.

(d) Settle the PBE hood on the head, with the nose and mouth close to the oronasal mask cone.



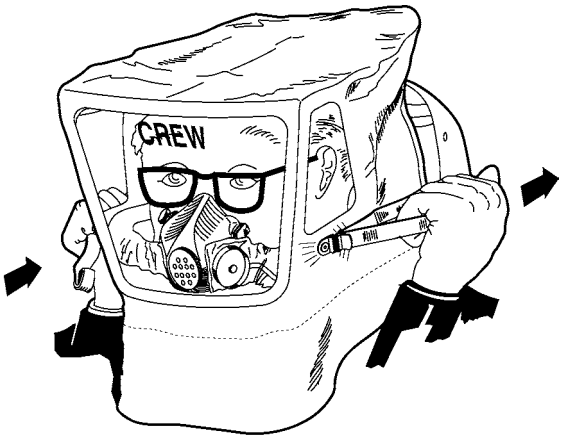
Start the Chlorate Candle
Figure 11

(5) Start the chlorate candle (refer to Fig. 11).

(a) Grasp the adjustment straps with both hands at the lower corners of the visor.

(b) Pull the adjustment straps forward to actuate the chlorate candle (refer to Fig. 11).

(c) Within one to five seconds, a rushing noise of oxygen entering the hood can be heard and inflation of the hood will be evident.



Place the Oronasal Mask Against the Face
Figure 12

(6) Place the oronasal mask against the face (refer to Fig. 12).

(a) Grasp the adjustment straps (refer to Fig. 12).

(b) Bend the head forward at the neck.

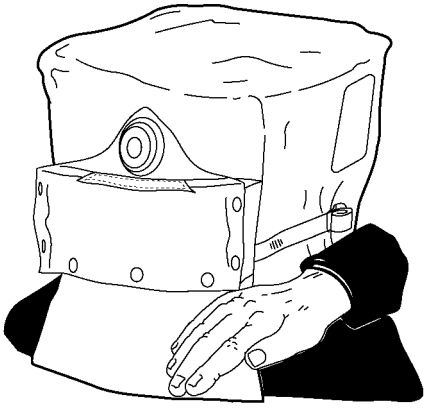
(c) Pull the adjustment straps back to secure the oronasal mask cone high on the nose for a tight seal.

Adjust Eyeglasses Through the Hood Material
Figure 13

(7) Adjust Eyeglasses Over the Oronasal Mask Nose Cone (refer to Fig. 13).

<u>WARNING</u>: DO NOT ATTEMPT TO ADJUST EYEGLASSES THROUGH THE NECKSEAL. INSERTING HANDS THROUGH THE NECKSEAL MAY ALLOW ENTRY OF SURRROUNDING ATMOSPHERE INTO THE INTERIOR OF THE PBE HOOD.

(a) If wearing eyeglasses, move the earpieces of the eyeglass frames through the hood material so the eyeglass lenses rest comfortably on top of the oronasal mask nose cone (refer to Fig. 13).



Adjust Hood Material below the Neckseal
Figure 14

(8) Adjust the PBE hood (refer to Fig. 14).

<u>WARNING</u>: HUMAN HAIR IS HIGHLY FLAMMABLE. HAIR THAT PROTRUDES THROUGH THE NECKSEAL COULD IGNITE IF BROUGHT INTO DIRECT CONTACT WITH FLAME.

(a) Adjust the neckseal position on the neck for comfort and a good seal.

(b) Rest the KO_2 canister on the nape of the neck.

(c) Remove hands from the PBE hood.

(d) Check for clothing and hair trapped in the seal.

(e) Adjust hair and clothing for an adequate seal.

(f) Adjust hood material hanging below the neckseal to protect the neck and shoulders (refer to Fig. 14).

3. NORMAL OPERATION

Following actuation, the hood will inflate over a 15-20 second period. After this period, the starter candle will cease flowing and the only sound will be slight rustling of the fabric on each inhalation and exhalation. Dependent upon breathing rate, there will be a slight exhalation resistance as the exhaled breath is forced through the KO_2 canister. Inhalation resistance will be almost unrecognizable since inhalation is directly from the interior of the hood through a diaphragm type check valve located at the base of the oronasal mask. The visor and side windows should remain clear of fogging or misting. Both the chemical air regeneration process and transfer of body heat produce heat during the rebreathing cycle. Heat build-up within the hood is normal and is dependent upon the amount of work performed. There should be no irritating or strong unusual odors within the hood. Operational duration is variable dependent upon the amount of work performed by the wearer.

If the PBE is worn to exhaustion of the chemical regeneration system, this will be evidenced by a gradual reduction in the expended volume of the hood until the point that the hood is collapsed tightly around the head at the end of a full inhalation. Additionally, there will be a rapid buildup of heat and moisture in the hood as the KO_2 bed loses its effectiveness. At this point, the wearer should immediately retire to a safe breathing area clear of flame and toxic fumes and remove the device.

4. ABNORMAL CONDITIONS OF OPERATION

CAUTION: THIS DEVICE PRODUCES OXYGEN THAT WILL VIGOROUSLY ACCELERATE COMBUSTION. DO NOT INTENTIONALLY EXPOSE THE DEVICE TO DIRECT FLAME CONTACT OR REMOVE IN THE IMMEDIATE PRESENCE OF FIRE OR FLAME. DUE TO OXYGEN SATURATION OF THE HAIR, DO NOT SMOKE OR BECOME EXPOSED TO FIRE OR FLAME IMMEDIATELY AFTER REMOVING.

A. Conditions signifying PBE hood malfunction.

(1) Failure of the chlorate candle.

(a) If the chlorate candle fails to actuate when the adjustment strap is pulled, an additional sharp pull on the strap may be sufficient to dislodge the lanyard pin and actuate the device.

(b) If the device fails to actuate, the hood will continue to function, although the initial purge capability is lost. Sticking the fingers into the neckseal to allow a large lung inhalation may be required to enable sufficient breathing volume until the chemical regeneration system begins producing a surplus of oxygen.

(c) If the perception of inadequate function persists in any of these or similar conditions, the wearer should immediately go to a safe area, remove the PBE hood, and don another unit.

(2) Inadequate oronasal mask seal.

(a) Absence of a tight seal of the oronasal cone to the face may result in excess leakage of the exhaled breath into the hood, so it does not circulate through the KO_2 canister.

This condition may result in a build-up of CO_2 within the hood. Excessive CO_2 is normally indicated by breathing distress such as rapid and labored breathing, accompanied by a general feeling of insufficient ability to get one's breath, although there is no restriction to breathing.

Adjust the adjustment straps and mask position until the chemical regeneration system begins producing a surplus of oxygen.

If the perception of breathing distress persists in any of these or similar conditions, the wearer should immediately go to a safe area, remove the PBE hood, and don another unit.

(b) Moisture or fogging on the visor or side windows, and the sensation of air escaping from the mask, particularly around the nose and eyes, are indications of a lack of proper fit.

Adjust the adjustment straps and mask position to stop leakage.

If the perception of escaping breath persists in any of these or similar conditions, the wearer should immediately go to a safe area, remove the PBE hood, and don another unit.

(3) Inadequate infiltration seal

(a) Smoke and toxic fumes generated by the combustion of most aircraft cabin interior materials contain many irritants. The persistent presence of strong irritating odors inside the hood resulting in eye and respiratory tract discomfort is an indicator of the lack of an effective infiltration seal.

(b) Verify that the neckseal is in contact with the skin of the neck and does not have clothing or jewelry trapped in the seal, or hair protruding between the seal and the neck.

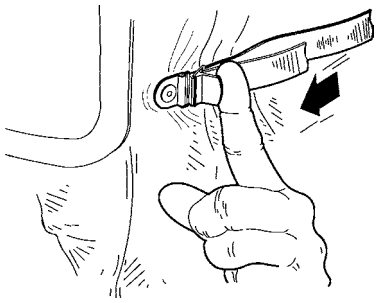
(c) If the condition persists, or there is evidence of a tear in the neck seal, the wearer should quickly go to a safe area and remove the PBE and don an alternate unit.

5. <u>DOFFING</u>

A. The following steps are recommended for doffing of the PBE hood.

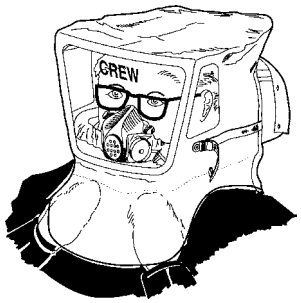
(1) Go to a safe area away from contact with fire, open flame, smoke, and toxic fumes.

(2) Reach with both hands for the adjustment strap connections on the each side of the PBE hood (either on both sides of the visor or on the sides of the PBE hood).



Release Tension in the Adjustment Strap
Figure 15

(3) Push the metal tabs on the adjustment strap buckles forward to release adjustment strap tension (refer to Fig. 15).



Insert Hands Beneath Neckseal
Figure 16

(4) Place both hands under the neckseal under the chin (refer to Fig. 16).

(5) Pull up on the PBE hood, guiding the oronasal cone and neckseal over the face and eyeglasses until the PBE hood is clear of the head.

(6) Place the expended PBE hood in a safe place to cool, away from fire or exposure to water.

NOTE: The steps for doffing PN 119003, 119003-01, 119003-11, 119003-90, and 119003-91 are the same.

6. HANDLING AFTER USE

WARNING: THE PBE CONTAINS OXIDIZING CHEMICALS AND SHOULD BE ISOLATED FROM OILS AND GREASE THAT MAY PRESENT A FIRE HAZARD.

A. An expended PBE hood contains unreacted oxidizing material and strong alkali materials. The PBE is intended for single use only and there are no reusable or repairable components. Disposal of the expended device according to applicable regulations and laws is required

B. Following use, after a sufficient cooling period, the expended PBE should be isolated in an airtight container for disposal.

C. At the completion of a flight, the expended PBE must be delivered to maintenance for authorized disposal.

PHYSIOLOGICAL FACTORS OF CLOSED CIRCUIT EQUIPMENT

1. DEFINITION OF CLOSED-CIRCUIT SYSTEMS

During a normal breathing cycle, an individual inhales air into the lungs. Within the lungs, oxygen from air is exchanged with carbon dioxide and the resulting breath is saturated with moisture at body temperature. When breath is exhaled, carbon dioxide and water vapor is swept out of the lungs. In a closed-circuit rebreathing system, the apparatus must provide the required metabolic quantity of oxygen for inspiration and remove the expired carbon dioxide. Additional control of the moisture and heat is desirable.

2. THE EFFECT OF WORK LEVEL ON EQUIPMENT

Through metabolism, the body uses oxygen in a quantity directly proportional to the amount of external work that is performed plus a basal quantity necessary for minimal body activity. As the work level of the individual increases, the normal response is to increase the minute ventilation rate (the total number of liters breathed in one minute) to bring more oxygen into the lungs. A corresponding quantity of carbon dioxide, roughly equivalent to the amount of oxygen consumed, is transferred back to the exhaled gases. Because of the direct contact with lung and tracheal membranes, the exhaled air is fully saturated with moisture and stabilized near the body temperature of 98.6°F (37°C). Since the quantity of moisture that is breathed out in the exhaled air is proportional to the minute ventilation rate, it provides a suitable mechanism to balance the production of O_2 by the KO_2 to match the demand.

3. VARIANCE OF WORKLOAD IN INDIVIDUALS

Although the oxygen requirement for work is directly proportional to the amount of external work performed, the capacity to accomplish work is subject to other constraints. As a rough approximation, the capacity of an individual to perform external work is directly proportional to the mass (or weight) of the individual. For example, a subject weighing 220 pounds will have the capacity to perform roughly twice the amount of external work as an individual weighing only 110 pounds. By the same example, the 220-pound individual will require twice the amount of oxygen as the 110-pound individual in order to accomplish the greater amount of work. From this description, it should be evident that the larger the individual, the greater the capacity for work, and the greater the demand that will be placed on the closed-circuit equipment. Since the equipment must be designed to accommodate the requirements of the most demanding situation, it is optimized to provide a minimum of 15 minutes duration for the heaviest workload. Conversely, use of the equipment by someone weighing approximately one-half the maximum should result in increased duration of the equipment by a factor of two.

4. EFFECT OF INHALED CARBON DIOXIDE

Carbon dioxide (CO_2) in the inhaled air acts as a stimulus to control the minute ventilation rate. An increase in the concentration of CO_2 under varying oxygen requirements will result in a significant increase in the ventilation rate.

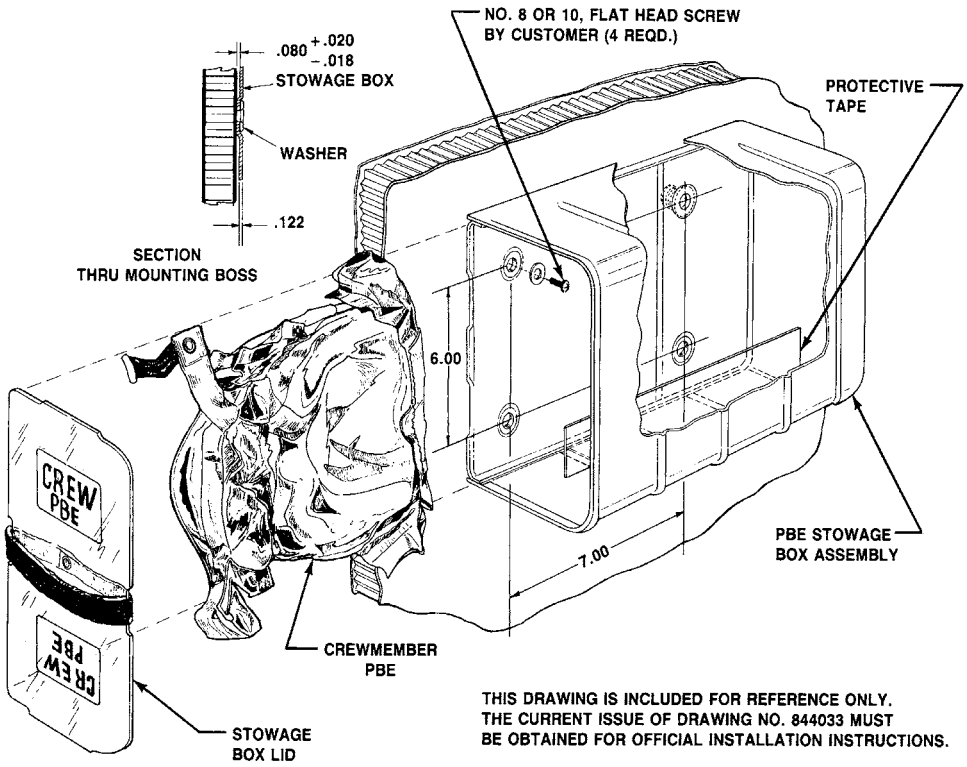
The effect of increased CO_2 concentrations on equipment operation is obvious. If inhaled CO_2 concentrations are high, the result will be increased ventilation rates and higher breathing flows through the equipment with associated distress to the wearer.

5. INHALATION GAS TEMPERATURE

The effect of inhaled breathing gas temperature on wearer comfort is significantly affected by the moisture content of the gas. Because dry gases have a lower specific heat capacity than saturated gases, they transfer less heat to the mouth tissues of the wearer. The use of wet bulb temperature for measurement of inhalation temperature levels provides an index that is dependent upon both the temperature of the gas and the moisture content of the gas.

MAINTENANCE OF EQUIPMENT

1. INSTALLATION



PBE and Stowage Box Installation
Figure 17

A. The FAA approved the PBE (PN 119003 Series) for installation only with the appropriate stowage box (PN 119063 Series).

B. Installation should be in accordance with the current version of Drawing Number 844033 that specifies the procedures and limitations for installation (refer to Fig. 17).

C. This unit is eligible for installation on all type certified aircraft providing approval has been obtained for installation on that aircraft. Aircraft installation approval is the responsibility of the end user.

CAUTION: DO NOT MOUNT THE STOWAGE BOX ON AN EXTERNAL CABIN SURFACE WITH THE OPENING FACING DOWN OR TOWARD THE FRONT OF THE AIRCRAFT. EXPOSURE TO HIGH G LOADS FROM LANDING OR CRASH CONDITIONS COULD ALLOW THE PBE TO BE EJECTED FROM THE STOWAGE BOX.

D. Mount the stowage box on an external cabin surface using recommended fasteners, with the opening facing up or toward the back of the aircraft.

E. Insert the PBE into the stowage box.

CAUTION: INSERT THE VACUUM-SEALED BAG INTO THE STOWAGE BOX WITH CARE TO AVOID DAMAGE TO THE FOIL POUCH AND THE VACUUM SEAL.

(1) The curved side of the foil pouch should face the mounting bulkhead of the stowage box.

(2) The green or red ID tag should be near the opening of the stowage box.

(3) Insert the vacuum-sealed bag into the stowage box.

(4) Slide the bag completely into the stowage box, moving aside the ID tag and bag edges to clear the opening and the retaining groove for insertion of the access door.

NOTE: The PBE hood is designed to fit snugly in the stowage box to minimize movement of the unit.

D. Remove tamper indicators from the door and stowage box.

(1) The areas of the door and stowage box where an optional tamper indicator will be attached should be clean and free of residues.

NOTE: The optional TSOA Tamper Indicator (B/E Aerospace, Inc. PN 4406001-001) may be used to provide indication that the PBE has been disturbed. The tamper indicator provides additional door retention protection from 3 G side loads. Locally provided tamper indicators may be applied to indicate disturbance of the PBE, but no assertion can be made for their ability to retain the door under high G loads.

(2) Cleaning with a soft cloth and a quick drying solvent, such as denatured alcohol, is recommended.

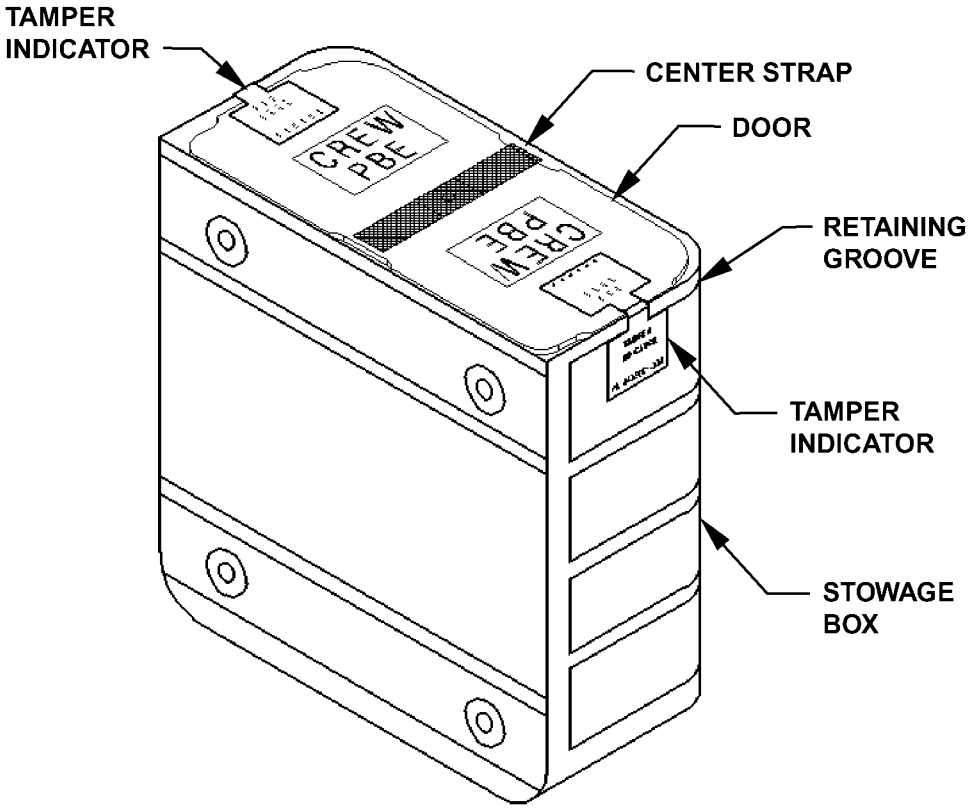
E. Insert the door into the stowage box.

(1) Grip the center strap of the access door.

(2) Use both hands to flex the door to make it shorter in length.

(3) Insert the top and bottom (short side) ends of the door into the retaining groove of the stowage box.

(4) Release the door so that it is wedged into the retaining groove of the stowage box.



PBE Stowage Box
Figure 18

F. Install the optional TSOA tamper indicator (B/E Aerospace, Inc. PN 4406001-001) (refer to Fig. 18).

(1) The optional TSOA Tamper Indicator (B/E Aerospace, Inc. PN 4406001-001) may be used to provide indication that the PBE has been disturbed.

(4) The optional TSOA Tamper Indicator (B/E Aerospace, Inc. PN 4406001-001) provides additional door retention protection from 3 G side loads.

(5) Locally provided tamper indicators may be applied to indicate disturbance of the PBE, but no assertion can be made for their ability to retain the door under high G loads.

(6) The indicators should be placed directly opposite each other to balance the load, and to hinder disturbance of contents (refer to Fig. 18).

(7) Remove backing from one half of indicator to place it on the stowage box.

(8) Center and align the indicator along the rib on one side of box nearest the opening of the stowage box (refer to Fig. 18).

(9) Press the indicator into place on the box.

(10) Remove the other half of the backing.

(11) Swing indicator over onto door with the edge of the indicator nearest the box edge coming into contact with the door first.

(12) Press the indicator into place on the door.

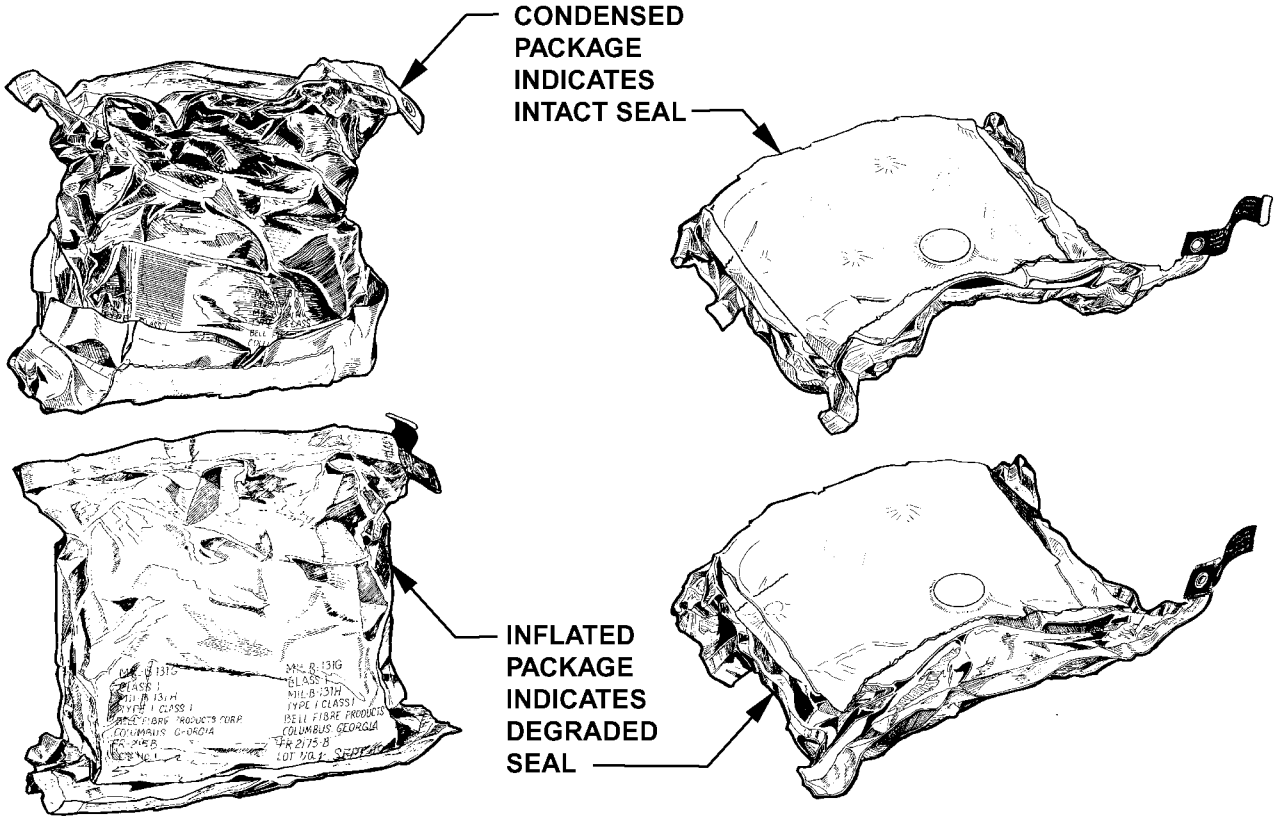
(13) Repeat this process for installation of the tamper indicator the other side of the door.

2. CLEANING

CAUTION: THE PBE BAG SHOULD NEVER BE CLEANED SINCE EXCESSIVE HANDLING OF THE FOIL POUCH MAY DEGRADE THE INTEGRITY OF THE VACUUM SEAL.

A. The external surfaces of the stowage box and the door may be cleaned with normal commercially available detergents.

B. The foil pouch containing the PBE provides a hermetic seal from the environment for the PBE.



PBE Pouch Seal Indications
Figure 19

3. INSPECTION

A. There are two levels of inspection for the PBE: (1) Preflight check by the flight crew, and (2) Normal maintenance inspections.

(1) The flight crew must check the PBE prior to flight to determine serviceability for the flight.

(a) The flight crew normally ensures that the unit is in the stowage box by inspection through the clear access door.

(b) Verify that the door tamper seals (if installed) are in place.

(c) Verify that the condition of the vacuum seal of the foil pouch appears satisfactory. Under normal conditions, the foil pouch should appear tightly compressed, and a pronounced recess will be evident where the foil pouch is pulled down into the back of the oronasal mask cone (refer to Fig. 19).

(2) Normal maintenance inspection should be accomplished on a minimum of a monthly basis, or to correspond with the operator's “A” checks, where the condition of the vacuum seal integrity should be verified.

(a) Verify that the door tamper indicator seals (if installed) are in place.

(b) Verify that the condition of the vacuum seal of the foil pouch appears satisfactory. Under normal conditions, the foil pouch should appear tightly compressed, and a pronounced recess will be evident where the foil pouch is pulled down into the back of the oronasal mask cone (refer to Fig. 19).

B. Foil Pouch Seal Indication (refer to Fig. 19).

(1) If the foil pouch appears inflated, instead of condensed and constricted, the potential exists for moisture intrusion that can decompose the KO_2 and reduce the effectiveness of the device (refer to Fig. 19).

(2) The PBE is a non-repairable item, so it should be replaced with new vacuum-sealed unit.

(3) If the pouch has been punctured, it is possible the PBE hood has also been punctured, rendering it unusable. For this reason, a PBE that has lost its vacuum must immediately be considered non-serviceable.

4. DISPOSAL

A. The PBE is intended for single use only and there are no reusable or repairable components. Disposal of the expended device according to applicable regulations and laws is required

WARNING: THE PBE CONTAINS OXIDIZING CHEMICALS AND SHOULD BE ISOLATED FROM OILS AND GREASE THAT MAY PRESENT A FIRE HAZARD.

(1) Following use, after a sufficient cooling period, the expended PBE should be isolated in an airtight container for disposal.

(2) The expended unit should be delivered to the individual responsible for disposal of hazardous waste within the maintenance organization of the company, to insure that the contents are handled in compliance with applicable laws and regulations.

B. An individual both knowledgeable and qualified to handle chemicals may neutralize chemical reactions within the PBE.

(1) After the expended unit is cool, residual activity of the oxidizing chemical may be neutralized.

CAUTION: THE KO_2 CANISTER POUCH CONTAINS INSULATION MATERIAL. CONTAIN THE INSULATION MATERIAL AND AVOID CONTACT WITH SKIN AND EYES.

CAUTION: APPROPRIATE SAFETY AND PROTECTIVE EQUIPMENT SHOULD BE USED, INCLUDING SKIN AND EYE PROTECTION.

(2) Open the KO_2 canister pouch on the back of the PBE hood.

(3) Remove the metal KO_2 canister by cutting the silicone connectors with a knife.

(4) Submerge the KO_2 canister in a container or pail of water until all gas evolution activity ceases.

(5) The resulting solution of KOH should be neutralized with a dilute solution of HCI (Hydrochloric acid) prior to disposal.

(6) In all cases, chemical materials should be disposed of in a safe manner conforming to applicable laws and regulations. Safe disposal is the customer's responsibility.

C. An individual both knowledgeable and qualified to handle chemicals may neutralize chemical reactions within an unused PBE.

(1) Dispose of unused PBE units and KO_2 canisters.

(a) The unused chlorate candle should be actuated.

(b) Allow the device to cool, before processing any of this material.

(c) Open the KO_2 canister pouch on the back of the PBE hood.

(d) Remove the metal KO_2 canister by cutting the silicone connectors with a knife.

(e) Unused KO_2 canisters contain a relatively large amount of reactive material, since none has been consumed by breathing. In principle, the same methods of disposal for the used PBE are suitable for the disposal of an unused PBE, but the reaction with water will be quite vigorous.

(f) Submerge the KO_2 canister in a container or pail of water until all gas evolution activity ceases.

(g) The resulting solution of KOH should be neutralized with a dilute solution of HCI (Hydrochloric acid) prior to disposal.

(h) In all cases, chemical materials should be disposed of in a safe manner conforming to applicable laws and regulations. Safe disposal is the customer's responsibility.

WARNING: A PBE WITHOUT A COMPLETE AND OPERATIONAL AIR REGENERATION SYSTEM POSES A SAFETY HAZARD. WHEN DISPOSING OF A PBE, DESTROY THE HOOD TO PREVENT UNAUTHORIZED USE.

D. Shred the hood material of the disassembled PBE.