Sizing and Fitting Procedure for the SOLR® Oxygen Mask

Crew and Thermal Systems Division

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March 4, 2024

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Change Record

Rev	Date	Originator	Description
Basic	July 20, 2023	Rajiv Kohli	Initial Release
A	March 4, 2024	Rajiv Kohli	Added missing data in Table 2. Reformatted Table 1 in Appendix A. Added a reference. Included Appendix C in the text in Section 9. Incorporated changes to several steps.

Table of Contents

Tables and Figures

1.0 Purpose

This document describes the sizing and fitting process for the SOLR® 100% oxygen mask (subsequently referred to as “oxygen mask” in the document) to be used by personnel in EC human-rated test facilities. A secondary objective is to train prospective crew members on personal equipment function, how to identify a good mask to face seal, and proper don/doff procedures. This procedure shall be performed on a TPS (Task Performance Sheet).

2.0 References

TM0063-4 Airborne Systems Operator Level 1 Instructions SOLR® 100% Oxygen Mask 60410X

STB-F-054 Personal Equipment Inspection, Maintenance, and Operating Procedure

STB-F-868 EC SOLR® Mask Maintenance Procedure

TM0063-2 OPERATOR & MAINTENANCE LEVEL 2 INSTRUCTIONS FOR SOLR® 100% OXYGEN MASK 60410X

3.0 Required Personnel

This procedure requires the following personnel:

Up to two Test Subjects or Crew Members, in "buddy pairs"

Cognizant EC4 Test Director

Up to two (2) Personal Equipment Technicians (trained for oxygen mask and associated equipment fitting)

A representative from the PI (Principal Investigator)/Science Team

4.0 Equipment and Materials

SOLR® oxygen mask with drink port

Skull caps

SOLR® oxygen bottles

Oxygen bottle harnesses

SOLR® oxygen mask hoses

H-harnesses

Breathing air cart C0401002

Breathing air umbilicals

Communication equipment (cap) including cap rings, yellow cap oxygen hose straps, Velcro/string ties, as needed. Note: While this equipment is optional, it should be readily available during the fit sessions so the technicians can offer it and the test subjects can try it out.

Powder-free nitrile gloves

Polyester clean wipes for cleaning mask surfaces

Isopropyl alcohol (IPA)

#2 Phillips bit and torque driver (12 in-lb)

#2 Phillips screwdriver

Caliper with millimeter units

5.0 Description

The oxygen mask (Figure 1) comprises a demand regulator, anti-suffocation valve, drink port and exhaust valve. The mask provides oxygen throughout the full range of pressures from sea level through an oxygen source.

6.0 Specifications

Model……...60410X, MI0002

Environmental pressure range……3.46 to 14.7 psia

Lowest operational temperature…… - 65^0F

Maximum exposure temperature……160^0F

Recommended maximum long-term storage temperature……..90^0F

Table 1 SOLR® Oxygen Mask Components, Controls and Indicators

Component	***Function***
SOLR® Oxygen Mask	Oxygen from facility supply or SOLR® oxygen bottles. Allows radio communication through integrated microphone

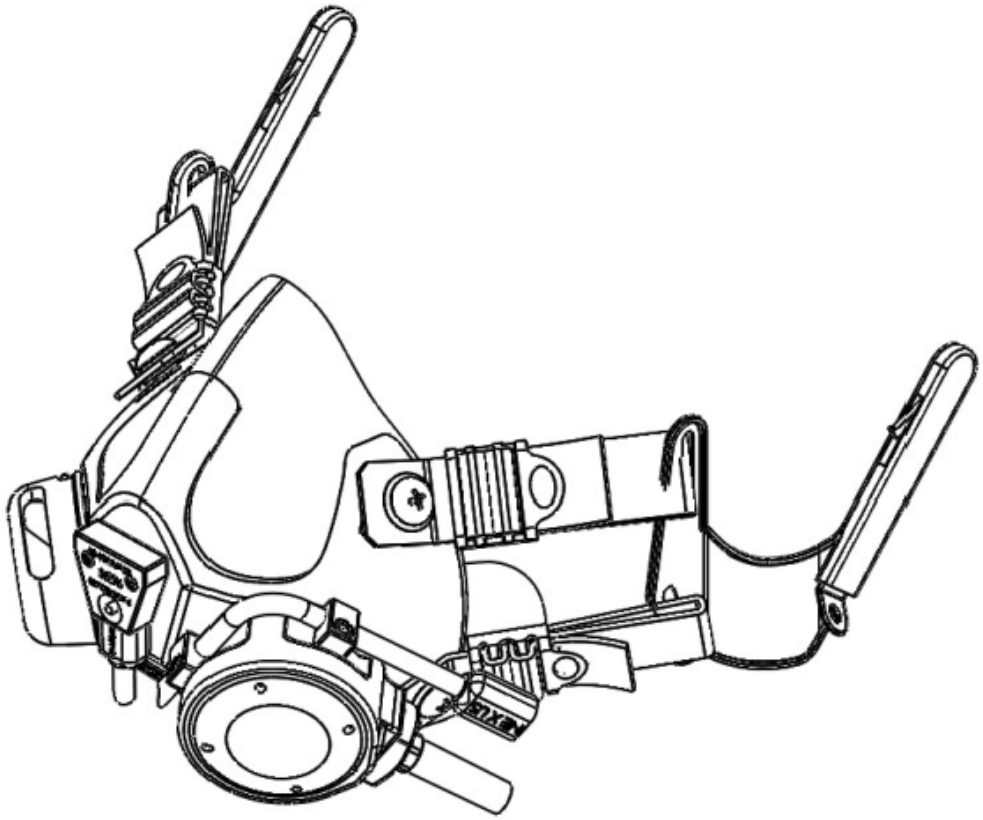

Figure 1 SOLR® Oxygen Mask

7.0 Requirements

Level 1 Routine Maintenance

Unit level service consists in checking that the unit is in good working condition.

- Before every use, the trained personal equipment technician checks for broken or heavily damaged components, ensures that the system holds and delivers oxygen and that there is no free-flow condition.
- The cleanliness of the system is ensured by wiping with dilute IPA (3-5% IPA in deionized water).
- Any defective unit is quarantined.

Functional Check

After each use, the personal equipment technician performs a functional check of the mask.

Level 2 Post-Test Maintenance

Maintenance consists of a thorough inspection of the system to ensure it meets manufacturer's specifications.

- Takes place after every test use.
- The trained technician checks for broken or heavily damaged components, checks for leaks, and checks for performance of the system.
- Some damaged subassemblies can be replaced (regulator, dilution module, microphone, etc.) if needed.
- The system is thoroughly cleaned.

Level 2 maintenance shall be performed on masks and oxygen cylinders by a trained technician after each test use per the manufacturer's Level 2 maintenance instructions TM0063-2 and the maintenance procedure STB-F-868.

The mask is always used with a certified pressure system that meets manufacturer's specifications.

The oxygen mask should be used with the manufacturer's bailout bottles (SOLR®/PHAOS) or pre-breathers (SOLR®/PHAOS) as secondary oxygen supply sources.

8.0 Principles of Operation

The oxygen mask has been designed to provide oxygen to the test subject. Because the mask is providing oxygen only when the test subject inhales, it is called an "ON DEMAND" oxygen mask. The mask is equipped with an anti-suffocation valve that will automatically open whenever the source of oxygen is depleted or lost. This will allow an unconscious test subject to be able to keep breathing once the bailout bottle is empty (Appendix C).

9.0 Handling and Use

It is important to always preserve the oxygen cleanliness of the oxygen mask, even though it has been designed to be operated under extreme environmental conditions. Before each use it is important to always ensure that no dust, grease, oil or other contaminates are introduced inside the system.

After use, a clean plastic cap should always be placed onto the regulator inlet fitting. The oxygen mask should then be cleaned to Level 2 standards per the maintenance procedure STB-F-868 after each test use, or after every 6 months, whichever comes first. The mask should be cleaned to Level 1 standards after each fitting and training session. Store in a clean plastic bag (Appendix C).

10.0 Sizing and Adjustment

Warning
Failure to follow this procedure could result in incorrect oxygen mask fit onto the subject's face which could lead to an accrued risk of decompression sickness or hypoxia. Failure to comply can result in serious injury to personnel.

Notice
Personal Equipment sizing and fitting can be an iterative process involving slight changes to achieve proper fit and sealing. The process cannot be rushed and is highly dependent upon open dialog amongst all involved personnel.

Note: If the test subject has been fit for the mask within the past 6 months, the initial fit session is not required, unless there have been configuration changes or there are test specific changes to the process that warrant it.

10.1 Sizing the Oxygen Mask

10.1.1 Prior to beginning oxygen mask sizing and fitting operations, Personal Equipment Technicians (PE Techs) and test subjects wash hands with soap for 20 seconds.

10.1.2 Record test subject or crew member name in Table 1 in Appendix A. Complete a separate Table 1 for each crew member or test subject.

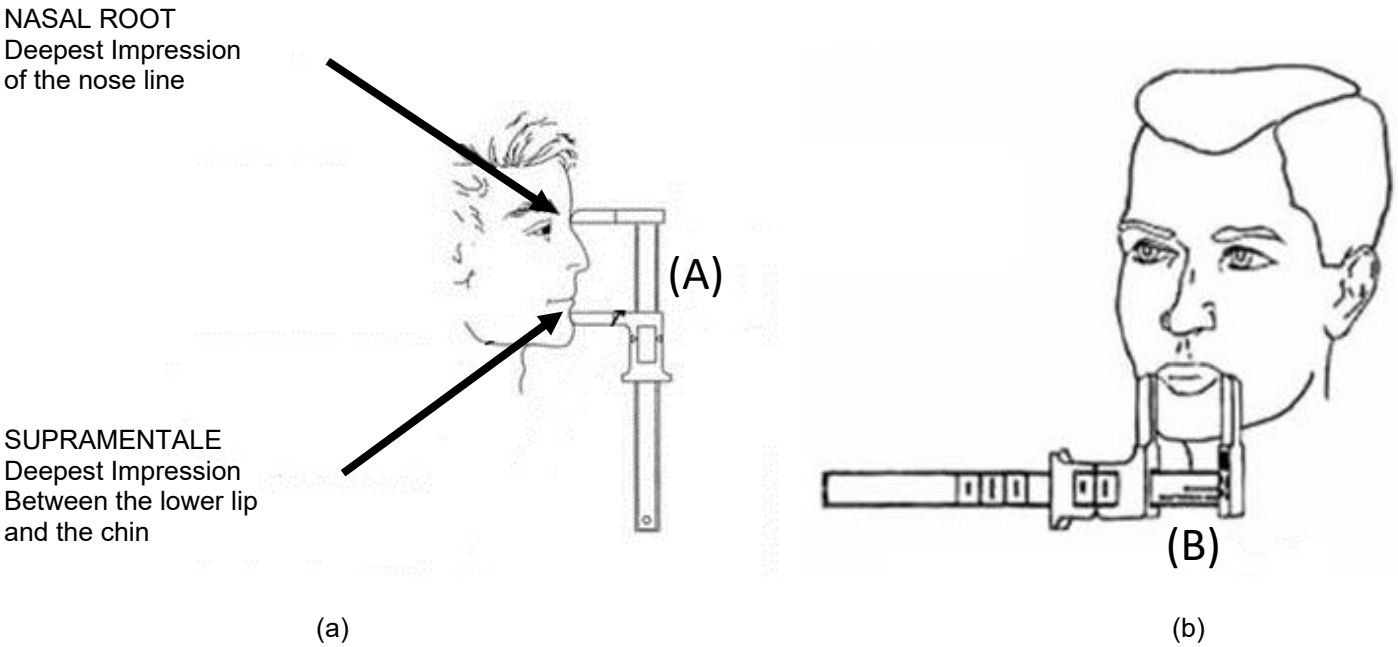

Figure 2 Oxygen Mask Sizing Measurements

10.1.3 In B7, R2024, ensure crew members are seated comfortably and remind them to:

- Sit still
- Relax body
- Mouth close with relaxed jaw
- Look straight ahead
- Maintain neutral facial expression
- Raise hand and/or announce if about to sneeze/cough

10.1.4 Using a caliper with millimeter units, measure the face length (Fig 2a) and mouth width (Fig 2b) on the subject's face. Record the information in Table 1 in Appendix A.

Note: Length is the most important measurement. Width can be manipulated to accomplish a better or more comfortable fit.

Note: Few people are sizes LW (Large Wide) or XSN (Extra-Small Narrow). Sometimes when the initial size is on the cusp of a LW, a MN/MW (Medium Wide/Medium Narrow) may be a better fit. Use an iterative approach when assessing the fit.

10.1.5 Using Table 2, determine which initial size of oxygen mask is recommended for the subject. Record the information in the table in Appendix A.

Table 2 Sizing for Oxygen Mask Selection

Mask Size Measurement (A)	*Face Length (A), mm*
Extra-Small Narrow ESN)	< 84
Small Narrow (SN)	84 to 87
Medium Narrow (MN)	87 to 100
Medium Wide (MW)	87 to 100
Large Wide (LW)	> 100

Mask Size Measurement (B)	*Mouth Width (B), mm*
Narrow (N)	< 62
Wide (W)	> 62

10.2 Oxygen Mask Fit

Note: The procedure shall be carried out by trained PE technicians. The crew member should be paired with a buddy to allow them to see how their buddy looks in their mask when properly fit. The buddy should actively participate in all phases of sizing and fitting to gain an understanding of proper fit and potential problem areas and how to correct the problem.

10.2.1 Pre-Donning

10.2.1.1 Apply Tegaderm (to be provided to the test subject) to abrasion prone areas of the crew member's face for mask fitting if it will be worn during the EVA (Extravehicular Activity).

10.2.1.2 Familiarize the crew members with the oxygen masks and skull caps.

Explain orientation of mask

Explain how to adjust strap clips

Explain straps will sit over ears

Explain that the goal is to have everything even

Explain how to don mask – chin to nose

Show and describe anti-suffocation valve, quick disconnect, and exhalation valve

Show the inner mask and explain it is to sit below the lower lip – never on the lip

Show drink hose and how to move it

Have crew member push microphone in before donning

Show where to check for tears and loose components

Have crew member hold mask while PE Tech assists with skull cap donning

Explain how to doff skull cap, grab pull tab and release the square clip on right side of subject's face by pulling away from the body

10.2.2 Skull Cap

Note: It was found that the SOLR® masks work best with Airborne Systems skull caps. EC4 is using skull caps instead of helmets.

Figure 3 Airborne Systems Skull Cap

10.2.2.1 Obtain Airborne Systems skull caps for each crew member and prepare to don the skull cap. See Figure 3.

Note: There is the option of lacing or customizing the skull caps for the crew member on a case-by-case basis.

10.2.2.2 Start with the straps evenly adjusted to aid in even mask strap adjustment and fit. Straps are evenly adjusted if the clips align. See Figure 4.

Figure 4 Skull Cap Strap Alignment

10.2.2.3 Have the crew member don the skull cap and ensure the prong end is on the left side of the person's face, the square end is on right side of the person's face, and the size tab is in the back

10.2.2.4 Start with the straps pulled tight and then loosen as needed during mask fitting.

10.2.3 Donning and Fitting the Mask

Note: All additional mask fit configuration adjustments - oxygen side straps, velcro, ear pads, screw tilt, etc. - should be offered to the test subjects and strongly encouraged to try them out instead of just mentioning it since most of the time the test subjects do not know what they need in the early stages of the training.

10.2.3.1 Using the recommended size of oxygen mask as per the sizing procedure, check the integrity of the sealing surface on the oxygen mask. Inspect the walls and ceiling in the vestibule and clean by wiping if the surface is visibly contaminated. Wiping shall be performed with 3-5% IPA (isopropyl alcohol in deionized water).

10.2.3.2 Throughout the mask fitting session ask the crew member the following questions:

- Do you feel any air leaking out of the mask?
- Do you wish your mask was looser or tighter in certain spots?
- Do you feel your mask torquing/pulling to one side?
- Do you feel like there is even tension across your face or is the mask putting pressure in a specific spot?
- Do you feel any mask movement when doing your EVA motions?
- Where do you feel your inner mask sitting? Is it below your lip?

10.2.3.3 Check the presence of the dust cap on the regulator inlet fitting.

10.2.3.4 Don oxygen bottle harness, H-harness if applicable, Solar® oxygen bottle, and oxygen hose.

Explain how to set oxygen bottle regulator

Explain quick disconnect operation

10.2.3.5 Loosen the oxygen mask straps.

Have the crew member don the mask “chin to nose”. Donning in this manner helps achieve accurate placement of inner mask seal, which is between the lower lip and chin (supramentale).

Note: The inner mask seal should never sit on the lower lip (this will not allow for a proper seal).

10.2.3.6 Position the oxygen mask on the subject’s face and engage both clips into the receiver of the skull cap.

10.2.3.7 Center the oxygen mask on the subject’s face as shown in Figure 5.

Figure 5 Mask Centered on the Face of the Subject with Good Seal

10.2.3.8 Adjust the straps as shown in Figure 5.

10.2.3.9 Ensure the mask is snug on the subject’s face and that there is a good seal as illustrated in Figure 5.

The inner mask (Figure 6) is where the seal is achieved and is very important.

Figure 6 Inner Mask Seal

10.2.3.9.1 Ask the crew member where their inner mask is seated.

10.2.3.9.2 Ensure it is seated in the proper position, which is between the lower lip and chin (supramentale).

Note: Chin cup gap is not important for how the masks are being used. The seal is not accomplished with the chin cup portion of the mask.

Do not over-tighten the mask to compensate for a poor mask fit. It should be just tight enough to achieve a seal.

If the person has significant indentation on the bridge of their nose or complains of nose bridge pain after only a few minutes of mask wear, that is a sign that the mask is too tight and/or too small. Try a Wide vs. Narrow size to ease nose bridge pain. If that, along with all other iterative fit procedures do not work, then change the size and repeat the procedures.

10.2.3.9.3 Look for cues such as: nose bridge indentation, nose pain, and puffy cheeks above mask as signs the mask is over-tightened.

10.2.3.9.4 **Note:** If crew member desires a fit that is looser on top but tighter on bottom, the screw would be in the 1st position in the top of strap and the screw in the 2nd position on the bottom strap.

Check for even tension around the face for a good seal and mask fit.

If the mask is too small/or too tight, perform iterative fitting steps (such as trying a size up or a wider size, adjusting straps, adjusting mask screws (Appendix B), and tying up the oxygen hose slack) until even displacement of pressure and a good seal are accomplished.

Look for even marks around the face from the mask upon doffing. This shows the mask was evenly tightened. If marks are only seen on the bridge of the nose and nowhere else (like lines on the cheeks), that is a sign the mask is too small and/or too tight.

10.2.3.9.5 Teach the crew member to check for a good seal by covering the anti-suffocation valve with their thumb and covering the quick disconnect with their index finger. See Figure 7.

Figure 7 Seal Check using Anti-Suffocation Valve

10.2.3.10 Have the crew member inhale and confirm that no air is flowing inside the mask. If seated correctly, the mask will collapse creating a suction to the subject's face upon inhalation.

The inhalation seal check is the primary way to check for the seal and is most important.

10.2.3.11 Cover the exhaust valve opening and anti-suffocation valve opening and exhale normally (not forcefully). If seated correctly, no air should escape from the mask.

The exhale seal check is a secondary check.

10.2.3.12 If air is flowing to the mask at the time the subject blocked the anti-suffocation valve opening, perform iterative fitting steps (such as adjusting straps, tying up the oxygen hose slack (Figure 8), adjusting mask screws (Appendix B), and trying a size up or wider) until even displacement of pressure and a good seal are accomplished. Repeat steps 10.2.3.10 through 10.2.3.12.

10.2.3.13 If air continues to flow, resize the oxygen mask and repeat steps 10.2.3.1 through 10.2.3.12.

10.2.3.13.1 If a good seal has been obtained, have crew member perform simulated EVA movements (like squatting, kneeling, bending over at the waist, looking down from a seated position, stepping up and down, and getting in and out of the cot) while checking for good seal as per above.

Some mask movement is to be expected, however, the inner mask should never come up onto the lip and air should not leak out.

10.2.3.14 Don oxygen bottle harness, H-harness if applicable, SOLR® oxygen bottle, and oxygen hose.

Explain how to set oxygen bottle regulator

Explain quick disconnect operation

10.2.3.15 Connect breathing air source (Breathing Air Cart C0401002) to mask via breathing air umbilical.

10.2.3.16 Have crew member inhale and verify breathing air flow to mask.

10.2.3.17 Don communication equipment (Figure 8).

Figure 8 Communication Equipment with Oxygen Hose attached to Mask

Once all Personal Equipment has been donned, have the crew member perform the PRICE check.

Pressure – O2 bottle gauge in GREEN zone

Regulator – O2 umbilical and O2 bottle in the ON position

Indicator – O2 flow indicator “blinker” IS moving

Connections – O2 hoses, mic cord, comm cord are connected

Emergency – O2 flow indicator “blinker” NOT moving: and Signs/Symptoms

10.2.3.18 Repeat fit checks while performing simulated EVA maneuvers.

10.2.3.19 Verify integrity of the seal by repeating steps 10.2.3.11 through 10.2.3.12.

10.2.3.20 Adjust mask fit and/or size, along with oxygen hose and oxygen bottle positioning as required to assure proper mask seal.

Note: If minor adjustments are still needed after all other iterative fit procedures have been completed, consider cinching/lacing the back of the skull cap to help remove minor leaks at the bridge of the nose or chin.

10.2.3.21 Record notes regarding the harness, oxygen bottle, and hose configuration in Table 1 in Appendix A for future reference.

Note: Tying up the oxygen hose slack (Figure 8) may relieve weight off the mask and decrease torque placed on the mask from the hose. To tie up oxygen hose slack, have subject articulate their head side-to-side, then tie up oxygen hose slack. Most common routing is along the side of the comm cap and attached to the back of the comm cap. Oxygen slack can also attach to the H-harness as well (if worn).

10.2.3.22 Have crew member self-don the skull cap, mask, H-harness, SOLR® oxygen bottle, and oxygen hose.

10.2.3.23 Have an available person perform a buddy check to assure proper fit and seal.

Pay special attention to proper mask placement, even strap adjustment, and even mask tension.

10.2.3.24 Doff H-harness and oxygen hose. Ensure the mask is snug on the subject's face and that there is a good seal as illustrated in Figure 5.

10.2.3.25 Remove the oxygen mask from the subject's face (Figure 8).

10.2.3.26 Disconnect microphone cables.

10.2.3.27 Record final skull cap, mask size, communication cap size, and oxygen bottle harness number for the crew member in Table 1 in Appendix A.

10.2.3.28 Ask crew member the following questions prior to completing mask sizing and fitting session:

- Do you feel confident in your ability to self-don and check for a good fit/seal?
- Do you feel confident in your ability to perform a buddy check?
- Do you understand your O2 equipment?
- Do you have any questions or concerns?

10.2.3.29 Record any crew member concerns in Table 1 in Appendix A.

10.2.3.30 Have crew member initial Acknowledgement in Table 1 in Appendix A.

10.2.3.31 Have Test Director (TD) of record initial TD Acknowledgement in Table 1 in Appendix A. The completed Appendix A must be attached to the TPS.

10.2.3.32 For initial fitting, return equipment to PE locker in Building 7, Room 2024.

10.2.3.33 For final, or refresher, fitting, label crew member's Personal Equipment package with their name, or other unique identifier and place in PE locker.

10.2.3.34 For final, or refresher, fitting, stow in pre-established location crew member's Personal Equipment established during the sizing and fitting session.

10.2.3.35 Depressurize breathing air cart.

10.2.3.36 Disconnect breathing air umbilicals from breathing air cart, place in Generally Clean bagging, and stow in B7, Room 2024 equipment locker.

10.2.3.37 Properly store any ancillary equipment used during the fitting session.

11.0 Procedure Complete

APPENDIX A. TABLE 1, SIZING THE OXYGEN MASK

Test Subject/Crew Member Name:		
Fitting Date:		
Test_____ Study_____		
Fitting TPS# and Title: Initial Fitting_____ Final Fitting_____ Other_____		
Measurements:	Face Length, mm	
	Mouth Width, mm	
	Theoretical Mask Size	
Final Equipment:	Mask Size	
	Screw Tilt	
	Ear Pad	
	Skull Cap Size	
	Lace Up	
	Communication Cap Size	
	Belt Configuration	
	Bottle Belt Size	
	Leg Extension Strap	
	Oxygen Bottle Harness Number	
	Oxygen Hose Tie Up	
Notes on final equipment configuration:		

Test Subject/Crew Member Name:			
Fitting Date:			
Test_____ Study_____			
Initial Fitting_____ Final Fitting_____			
Concurrence			
	Name	Initial	Date
Test Subject/Crew Member			
Test Director			
Performing Technician			
PI/Science Team Representative			

APPENDIX B. CHANGING MASK STRAPS

Note: The oxygen mask straps can be replaced/removed without full disassembly of the mask.

B1. Using the #2 Philips screwdriver, remove the screws that secure the straps to the hard shell of the mask (Figure 9).

Figure 9 Removing the Screws from the Straps

B2. Place the screws in a clear re-sealable bag or container.

B3. Once the correct straps have been selected, place straps on the mask hard shell studs.

B4. The subject may select either set of grommets on the mask straps for fit/comfort.

B5. Using a #2 Phillips bit and torque driver, secure the adjustment straps to the hard shell of the mask to 12-inch-lbs (Figure 10).

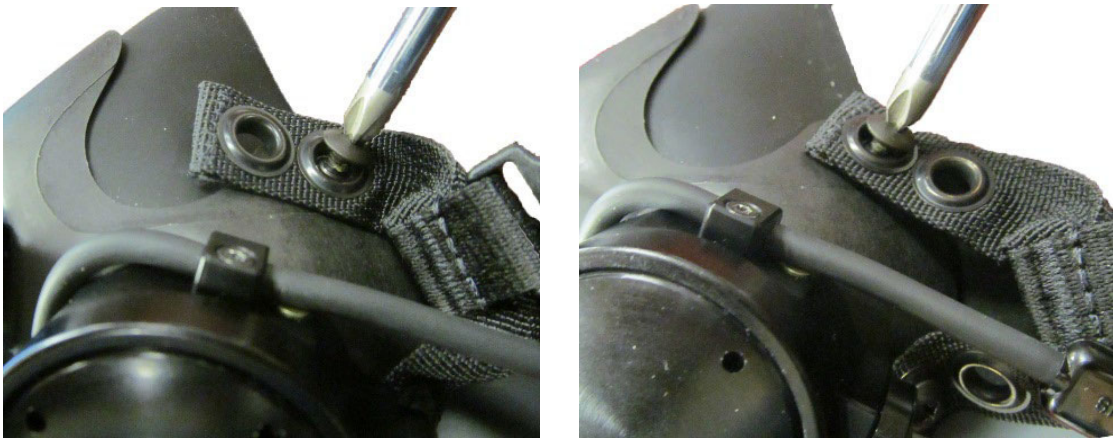

Figure 10 Securing the Straps to the Mask

APPENDIX C. POST-TEST HANDLING

Cleaning and Disinfection

C1. After each use, disinfect the mask by wiping the inside and outside using a wipe moistened with 70% IPA in deionized water, followed by a clean lint-free cloth. Allow the mask to dry completely.

C2. Perform Step 10.1 before the mask is issued for each service to the test subject.

Packaging and Stowage for Test

C3. Make sure the mask is completely dry after cleaning and disinfection.

C4. Pack the cleaned mask in a zip-top bag or in a clean polyethylene bag.

C5. The mask shall be stored in designated personal equipment lockers when not in use.

C6. Inspection and general maintenance of the mask are covered in STB-F-054.