NAVAL SEA SYSTEMS COMMAND
AND
NAVAL FACILITIES ENGINEERING COMMAND

PROCESS INSTRUCTION

NAVSEA/NAVFAC-00C3-PI-006 REV B

Inspection and Extension of Service Life of Windows/Viewports in Hyperbaric Systems

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1. Purpose: The purpose of this Process Instruction (PI) is to provide operational viewport inspection procedures and flaw recognition when performing Planned Maintenance System (PMS) inspections. This PI shall also be used for inspections to extend the initial service life* of Pressure Vessel for Human Occupancy (PVHO) viewports/windows. It applies to flat, conical frustum, and double bevel disc acrylic windows, designed using PVHO-1 requirements and used in a Protected Service Environment* (PSE). This PI is for use on windows installed in Navy, USMC, and Special Operation Forces (SOF) hyperbaric systems certified IAW SS521-AA-MAN-010. The following are key terms used in this PI.

*Service Life: In general a PVHO-1 designed acrylic window has an initial ten-year service life from the date of manufacture or 10,000 pressure cycles, whichever occurs first. For the purpose of this PI, a cycle is defined as any measurable pressurization of the chamber.

*Protected Service Environment (PSE): The stored and operational environments where the windows were not subject to unusually long periods of temperatures exceeding 150° F, minimal exposure to ultra-violet light, X-ray radiation, chemicals and abrasion. Exposure to UV light is not always an eliminating factor as most windows are protected by an acrylic cover, which absorbs UV radiation. Most chambers stored and operated inside an enclosed space fall into this category.

*Severe Service Environment (SSE): Defined as any condition of temperature extremes, pressure, radiation (i.e. UV light, x-ray) and pressurization medium or contamination that the designer would anticipate to shorten the service life of the window (PVHO-2 Sect. 2 definitions). The service life of windows installed in a PVHO operated in a severe service environment may not be extended beyond the design life on the basis of visual inspections alone. In order to extend the service life of these windows, additional requirements found in PVHO-2 must be followed. You must contact the NAVSEA or NAVFAC SCA when planning to extend the service life of SSE windows. Most chambers stored and/or operated out in the direct sunlight should be considered to operate in a SSE. Commands considering whether to extend the service life of windows in a chamber that has seen this type of service shall contact the appropriate System Certification Authority (SCA) for assistance in making this determination.

WARNING: The chamber may not be operated if the window temperature at time of operational use exceeds 125^0 F.

NOTE: Saturation System Deck Decompression Chambers (DDC) and Personnel Transfer Capsules (PTC) are considered to be in a Severe Service Environment.

NOTE: This Process Instruction is applicable only to those windows that were designed and built to ASME PVHO-1 standards. The process follows the core in-service guidelines established by the American Society of Mechanical Engineers (ASME) PVHO-2-2003 “In-Service PVHO Acrylic Windows Guidelines”.

2. Qualifications: Personnel conducting visual inspections shall be qualified, at a minimum, as a DLSS Maintenance Technician with 20/20 natural or corrected near distance visual acuity. When window or seal flaws are found, record the flaw and location and contact the appropriate SCA for further evaluation and possible corrective action.

2.1 Training on viewport inspections with examples of window damage is provided in the PI-006 Supplement - Viewport Inspection Training. This supplement may be accessed both on the NAVSEA 00C secure web site at https://secure.supsalv.org under 00C4 Certification Publications and the NAVFAC SCA website at http://www.navfac.navy.mil/products_and_services/ci/products_and_services/naval_ocean_facilities_program/hyperbaric_certification.html under technical library.

3. Documentation: The inspection of each window shall be documented using the Viewport Visual Inspection Form, Appendix A of this instruction. Each periodic inspection Viewport Visual Inspection Form shall be retained with the REC or controlled work procedure as appropriate for the service life of the window. A visual inspection of the chamber windows shall be performed prior to pressurization and included in the pre-dive checklist. In addition, originals or copies of the Window Design Certification, Material Manufacture's Certificate for Acrylic, Material Testing Certification for Acrylic and Pressure Testing Certificate (PVHO Forms) shall be retained for the service life of the window.

4. Tools:

4.1 Calibrated scratch and gouge comparator blocks are available from the respective SCA: NAVSEA for portable/afloat systems and NAVFAC for ashore systems. In preparation for the inspection, it is advisable to obtain a scratch comparator from the SCA. If a scratch or gouge is found during the inspection and is suspected of exceeding allowable limits, the SCA shall be contacted. The comparator block shall be handled with extreme care since each block is calibrated and serialized.

4.2 A high intensity white light should be used when performing the window inspection.

5. Inspection Periodicity:

5.1 36-Month: An in-place visual inspection of each chamber viewport shall be accomplished every thirty-six months. The first inspection should fall 36M from the view port manufacture date. The inspection shall follow the procedures of this PI (except for window removal) and shall be documented using the Viewport Visual Inspection Form, Appendix A. The window should only be removed when damage is suspected or the window is not completely accessible for a thorough inspection.

5.2 10-Year/10,000 cycles: The window shall be removed and inspected in accordance with this PI when extending the service life, during overhaul, or painting.

6. Inspection Procedure:

6.1 All tools and materials required to inspect, clean, and replace the window shall be obtained prior to proceeding with the window removal and inspection.

> **Note:** If any of the below steps result in replacement of one or all viewports on the chamber the operator should add the PVHO widow numbers either to the system drawing or another visible location on the mounted window to ease in identification of the viewport for future PMS and inspections.

6.2 Prior to removal of the window, it shall be marked with masking tape on the exterior window face (this is the non-pressurized side of the window) at the 12 o'clock position. If the window cannot be marked on this face, then it shall be marked with masking tape on the interior face, (pressurized side) at the 12 o'clock position. The masking tape label shall state the face side with an arrow pointing to the 12 o'clock position. (Figure 1)

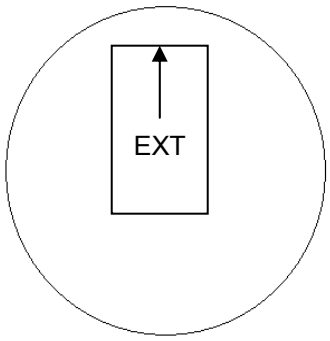

FIGURE 1

6.3 Immediately upon removal of the window, the window edge shall be marked with an indelible ink felt tip pen (E.g., Sharpee®) at the 12' o'clock position, and shall include an arrow pointing to the exterior of the chamber, with the words "Exterior Face at 12 o'clock" as shown in Figure 2. The masking tape shall be removed from the viewport face after the edge is marked.

> **CAUTION:** Ensure that a clean non-abrasive flat surface is used to place the viewports on after they have been removed. Use several layers of lint-free rags or similar soft material to prevent damage to the viewports.

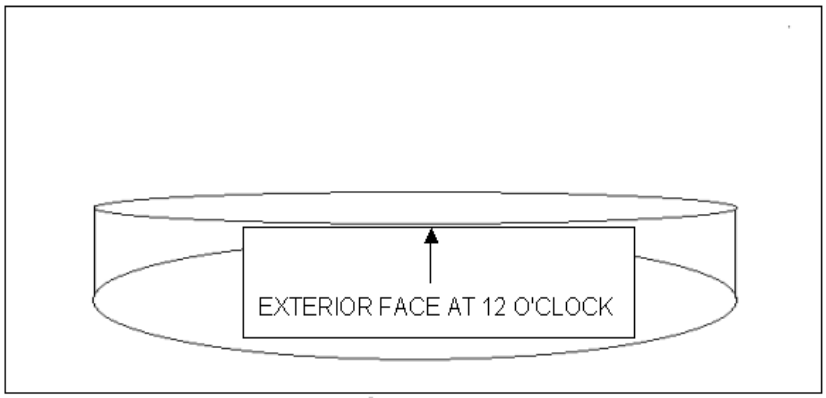

FIGURE 2

6.4 Visually check both faces and the edge of the window for crazing, discoloration, cracks, pits, gouges, chips, blisters and scratches by using a strong hand-held light moved to various angles as necessary. Crazing is defined as a micro feature (consisting of voided and orientated material formed at crack tips or inclusion particles) that is associated with the fracture and failure of polymers. Crazing and discoloration shall render the window failed and it must be replaced. Chambers containing one or more failed windows shall be reported to the appropriate NAVSEA or NAVFAC SCA in the format of a Suspension of System Certification IAW SS521-AA-MAN-010. Reinstatement of System Certification will be authorized only after the window has been replaced and the SCA has reviewed the Objective Quality Evidence (OQE) for the new window.

> **WARNING:** Commands are reminded that any time a chamber window is replaced; they must submit the OQE for the new window to the SCA for review prior to installing the window. Windows which have not been designed and fabricated IAW the stringent ASME PVHO-1 Code may catastrophically fail, causing severe injury or death to personnel. Refer to paragraph 3 for documentation to be included as OQE.

6.5 Physically inspect visually detected pits, gouges, and scratches by dragging your fingernail across the surface of the window. Any scratch, pit, gouge or chip that can be physically detected by catching the tip of a fingernail when drawn across the surface shall be reported to the appropriate SCA. The window shall not be placed back into service unless authorized by the SCA.

6.5.1 If a scratch or gouge has been detected, the comparator block shall be obtained from the SCA and used to compare the detected damage with the allowable damage.

6.5.2 In general, if during the inspection crazing, cracks, blisters, discoloration, gouges, scratches or pits are detected, the window shall be immediately disqualified for further use, and the user shall contact the appropriate SCA and suspend use of the chamber.

6.5.3 A scratch that affects only the optical clarity of the window and not physically detected is defined as a "superficial scratch". No action is required other than noting its size and location on the inspection form and monitoring for changes thereafter.

6.6 Prior to reinstallation, the window shall be clean. The window should only be wiped with a soft rag or cloth wetted with warm water and an acceptable cleaning agent. The recommended cleaning agent to clean windows is a detergent solution in warm water not exceeding 120° F. Appendix B contains a partial list of Harmful Substances and Acceptable Products.

> **CAUTION**: Solvents of any type are harmful to the window and shall not be used for cleaning of windows or their seats. Refer to Appendix B for acceptable cleaners.

6.7 Prior to installation, the cavity seat in the flange shall be thoroughly cleaned. Seats shall be cleaned using the same procedures for windows. While conducting the operation inspection, the operational inspector shall look for signs of corrosion and pitting, paint chipping, or other bearing and sealing surface flaws. If surfaces are free of flaws, the operational inspector can note that on the form. If flaws are found then contact the appropriate SCA for further evaluation and corrective actions.

6.8 Prior to installation, examine the viewport assembly for signs of window flaws, seal cracks or extrusion, corrosion, damage or missing retainer bolts or changes from original drawings. If flaws are found then contact the appropriate SCA for further evaluation and corrective actions.

6.9 All soft goods shall be replaced in accordance with original design specification and drawing. If window seals are a flat gasket or elastomer type, then an adhesive sealant is used between the gasket and window seat (metallic) in the flange. The window shall not be installed until the adhesive sealant has cured in accordance with the manufacturer's recommendation, and should not be pressurized for a period of 24 hours. For O-ring seals, use a light application of lubricant. Refer to the system drawing for adhesives and lubricants. Appendix B provides additional approved adhesives and lubricants for systems where the drawings don't specifically call for them. Install the window in the same orientation as found during the removal. Lube is not recommended for use on flat gaskets as it will result in the gasket walking (extruding) out of place under both mechanical and pressure loads.

6.10 Viewport retaining ring fasteners shall be torqued IAW the system drawings.

6.11 Conduct chamber pressure test IAW USN Dive manual Figure 21-15. Submit REC package and system PSOB revision to the respective SCA for review and approval.

Viewport Visual Inspection Form

Command: _____

PVHO Identification (type, s/n): _____

Window Marking: _____-_____-PVHO-_____-_____-_____

Window Manufacturer: _____

Original Manufacturer Documents Available: □ Yes □ No

Purpose of inspection: □ Window Inspection □ Seat and Seal Inspection
□ Other (describe) _____

_____

Location of Window in PVHO: _____

Number of cycles on window: _____ or Years of Service: _____

Procedure: □ Window Removed □ Inspected In-Place (36M only)

Inspection Results:

Window: Are there flaws exceeding limits as described in this Instruction: □ Yes □ No
Recommended actions: □ No action required □ Polish out minor flaws
□ Send out for repairs □ Discard
Comments: _____

_____

Note location and describe any superficial damage as defined in paragraph 6.5.3

_____

_____

Window Seat/Flange: Is there damage, corrosion, etc: □ Yes □ No
Recommended actions: □ No action required □ Repair □ Replace
Comments: _____

_____

Window Seal: Is there damage, wear, etc: □ Yes □ No
Recommended actions: □ No action required □ Repair □ Replace
Comments: _____

_____

I certify that the statements made in this report are correct and that all details of this inspection conform to the requirements of this Process Instruction. I, the undersigned, have inspected the component described in this report and state to the best of my knowledge and belief the window subject of this report is suitable for continued service.

Signature: _____ Date: _____

Harmful Substances and Acceptable Products

B.1 Harmful Substances: Solvents of any type shall not be used for the cleaning of PVHO windows or their seats. The following will cause severe window damage, rendering it non-usable. The following is only a partial list.

- (a) Ketones
  - (1) acetone [67-64-1]
  - (2) methyl ethyl ketone (MEK) [78-93-3]
  - (3) cyclohexanone [108-94-1]
  - (4) all other ketones
- (b) Chlorinated Solvents
  - (1) chloroform [67-66-3]
  - (2) methylene chloride [75-09-2]
  - (3) 1,1,2-trichloroethane (TCE) [79-00-5]
  - (4) all other chlorinated solvents
- (c) Aliphatic Acids
  - (1) formic acid [64-18-6]
  - (2) acetic acid [64-19-7]
  - (3) all other aliphatic acids
- (d) Alcohols
  - (1) methanol [67-56-1] in all concentrations
  - (2) ethanol [64-17-5] in high aqueous concentrations
  - (3) isopropanol [67-63-0] in high aqueous concentrations 35
  - (4) benzyl alcohol [100-51-6] in all concentrations
  - (5) other aliphatic and aromatic alcohols
- (e) Aromatic Solvents and Phenolics
  - (1) xylene [1330-20-7, 95-47-6, 108-38-3, and 106-42-3]
  - (2) toluene [108-88-3]
  - (3) phenol [108-95-2]
  - (4) cresols [95-48-7, 108-39-4, and 106-44-5]
  - (5) other aromatic solvents and phenols
- (f) Esters
  - (1) ethyl acetate [141-78-6]
  - (2) butyl acetate [123-86-4]
  - (3) amyl acetate [628-63-7]
  - (4) all other esters
- (g) Ethers
  - (1) diethyl ether (“ether”) [60-29-7]
  - (2) tetrahydrofuran (THF) [109-99-9]
  - (3) methyl tertiary butyl ether (MTBE) [1634-04-4]
  - (4) all other ethers
- (h) Aroma Chemicals
  - (1) pine oils [8002-09-3]

- (2) terpene [95327-98-3]
- (3) other citrus extracts such as d-limonene/ carvone [5989-27-5]
- (4) all other aroma or perfume chemicals

B.2 Acceptable Cleaners: The use of detergent in solution in warm water, less than 120^0 F is the recommended method. Navy Ionic Detergent (NID) is the recommended cleaner; however, a list of other suitable cleaners is below.

CAUTION: Do not apply cleaners when windows exceed 120º F, otherwise crazing may result.

- (a) Recommended Method. Mild, preferably non per- fumed detergent in warm water [120°F (50°C) max.]
- (b) Acceptable but Not Preferred Methods
  - (1) aliphatic naphtha [64742-89-8]
  - (2) n-hexane [110-54-3]
- (c) Windex: contains 4% isopropanol (considered an acceptably low level not to damage acrylic)
- (d) Simple Green: contains 2-butoxyethanol (EGBE), at under 4% (considered an acceptably low level)
- (e) Mer-maids Plexiglas/Plastic Cleaner & Polish: a

B.3 Polishes: After cleaning, windows may be polished with compounds specifically endorsed by the manufacturer for polishing acrylic. These compounds may also be used to remove "superficial" scratches, as described in Paragraph 6.5 of this instruction from the window surface.

- (a) Mer-maids Plexiglas/Plastic Cleaner & Polish [see subpara. V-3.1(e)]
- (b) Meguiar ’s 10-08 (previously Mirror Glaze and Plastic Polish Mirror Bright MGH-10)
- (c) Plastic Polish Novus #1 and #2
- (d) Fare´ cla 6 and Fare´ cla 3 polishing paste
- (e) or equivalent

B.4 Lubricants: The following is a list of acceptable O-ring seal and/or window cavity seat lubricants, which meet MIL-PRF-27617. Lubricant grade TYPE III and TYPE II (for certain cold weather applications) are the approved grades of lubricants from this standard per USN PMS requirements. Refer to the specific PMS card for appropriate grade of lubricant.

- (a) Apiezon Type H Vacuum Grease
- (b) Dow Corning High Vacuum Grease (formerly Dow Corning 976 or 976V High Vacuum Grease)
- (c) Dow Corning Molykote 3452 Chemical Resistant Valve Grease
- (d) Dow Corning #4 Electrical Insulating Compound

- (e) Dow Corning 112 High Performance Lubricant 36
- (f) DuPont Krytox LVP High-Vacuum Grease
- (g) Christo-Lube Oxygen Grease
- (h) Parker Super O-Lube
- (i) Castrol Braycote 601EF
- (j) or equivalent

B.5 Seal and Gasket Adhesives: In some cases it may be necessary to use an adhesive to bond neoprene or cork gaskets to the metal window seat surface. Gasket materials should be called out on system drawings – if not fleet should contact SCA for guidance. The following is a list of acceptable adhesives that are compatible with acrylic windows.

- a) Room- Temperature Vulcanizing Silicon Rubber Compounds
  - (1) Dow Corning 3145 RTV MIL-A-46146
  - (2) Dow Corning 995
  - (3) Dow Corning 795
  - (4) Dow Corning 832
  - (5) or equivalent
- b) Contact Cements
  - (1) cyanoactylate adhesives
  - (2) 3M Scotch-Grip Rubber and Gasket Adhesive 1300 or 1300L
  - (3) Eclectic Products Polyurethane Plumbers Goop Adhesive 150012
  - (4) or equivalent