U.S. Department
of Transportation
**Research and
Special Programs
Administration**

DEC 18 1998

400 Seventh Street, S.W.
Washington, D.C. 20590

DOT-E 11375
(FOURTH REVISION)

EXPIRATION DATE: November 30, 2000

(FOR RENEWAL, SEE 49 CFR 107.109)

1. GRANTEE: Oceaneering Space Systems
Houston, TX

2. PURPOSE AND LIMITATIONS:

a. This exemption authorizes the manufacture, marking and sale of a non-DOT specification pressure vessel (breathing apparatus) to be used for the transportation in commerce of air, refrigerated liquid. This exemption provides no relief from any regulation other than as specifically stated herein.

b. An exemption authorization to manufacture, mark, sell, and transport only represents certification of safety for a package when it is an article of commerce in transportation. The safety analyses performed in development of this exemption only considered the hazards and risks associated with transportation in commerce. The safety analyses did not consider the hazards and risks associated with consumer use, use as a component of a transport vehicle or other device, or other uses not associated with transportation in commerce.

3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171-180.

4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR 173.316(c) in that the prescribed packaging is not listed as an authorized packaging, and portions of 178.57 as specified herein.

5. BASIS: This exemption is based on the application of Oceaneering Space Systems (OSS) dated November 20, 1998, submitted in accordance with 49 CFR 107.109.

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6. HAZARDOUS MATERIALS (49 CFR 172.101):

Hazardous materials description -- proper shipping name	Hazard Class/ Division	Identi- fication Number	Packing Group
Air, refrigerated liquid	2.2	UN1003	N/A

7. PACKAGING(S) and SAFETY CONTROL MEASURES:

a. PACKAGING - Packaging prescribed is a non-DOT specification pressure vessel(breathing apparatus) consisting of an injection molded plastic inner vessel supported within a metal outer vessel. The inner vessel contains the air, refrigerated liquid and must be designed with a burst pressure of no less than 2.5 times the service pressure. The container must be in conformance with §178.35 and with the DOT-4L cylinder (§178.57) except as follows:

§178.35(c) Duties of inspector

(1) * * *

(2) Verify physical properties of each lot of raw material by analysis or by obtaining certified analysis: Provided that a certificate from the manufacturer thereof, giving sufficient data to indicate compliance with requirements, is acceptable when verified by check analyses of ASTM D638 Standard Slabs molded concurrently with the inner vessel.

(3) Verify compliance with all specification requirements. Obtain samples for all tests. Obtain samples for check physical properties, where required. * * *

(4) Furnish complete test reports required by this exemption to the maker of the inner vessel and, upon request, to the purchaser. * * *

§178.35(d) Defects.

Materials with seams, cold slugs, cracks, laminations, or other detrimental defects, not authorized. No defect acceptable that is likely to weaken the finished vessel appreciably; reasonably smooth and uniform surface finish required.

§178.35(e) Pressure relief devices and pressure control valves.

Each finished assembly must be equipped with pressure relief devices and pressure control valves as prescribed in 49 CFR §173.34(d) and 173.316. Additionally the vessel shall be equipped with a rotating pick-up and vent assembly that maintains the vent in the ullage space regardless of vessel orientation.

§178.57(a) Type, Size, Service Pressure, and Design Service Temperature

(1) Type and size. Inner vessel halves must be glued, and outer vessel halves must be fusion welded. Size must not be over 9.5 pounds water capacity.

(2) The service pressure must be 40 psig maximum.

(3) The design service temperature is -320°F.

§178.57(b)Material.

(1) Inner containment vessel. Designations and limiting physical properties of the liquid crystal polymer (LCP) authorized by this specification shall be as shown in §178.57(o)(1) Table 1 of this exemption.

(2) Outer jacket. Any metal may be used subject to the requirements of §178.57(o)(2) of this exemption.

§178.57(d) Manufacture.

(1) Inner vessel. By injection molding of vessel halves and glueing; mold sprue and flashing, dirt and scale to be removed as necessary to afford proper inspection. Molding must be in accordance with the procedures contained in application for exemption. The vessel halves (heads) must be seamless. The heads must be reasonably true to shape, and the skirts must be reasonably true to round. The inner vessel halves and the center hub assembly shall be glued in accordance with OSS Document 21200-70020 on file with the Office of Hazardous Materials Exemptions and Approvals.

(2) Outer vessel. The vessel halves (heads) must be seamless. By best appliances and methods; dirt and scale to be removed an necessary to afford proper inspection. When required, titanium shall be cleaned in accordance with ASTM B600 Standard Guide for Descaling and Cleaning Titanium and Titanium Alloy Surfaces.

(3) Insulation. The space between the inner vessel and the jacket shall be insulated. The insulating material must be fire resistant. If a vacuum is maintained in the insulation space, the evacuated jacket shall be designed for a minimum collapsing pressure of 30 psi differential. The construction must be such that the total heat transfer, from the atmosphere at ambient temperatures to the contents of the inner vessel, will not exceed 0.008 Btu per hour, per Fahrenheit degree differential in temperature, per pound of water capacity of the inner vessel.

§178.57(e) Welding.

(1) All seams of the outer jacket must be fusion welded. Only butt, edge, or joggle butt joints for the circumferential jacket seam are authorized. Transition penetrations or tube penetrations may be fillet welded. All joints in the outer vessel must be in reasonably true alignment.

(2) All attachments to the sidewalls and heads of the outer jacket must be by fusion welding and must be of a weldable material.

(3) For welding the outer jacket, each procedure and operator must be qualified in accordance with the sections of CGA Pamphlet C-3 that apply.

(4) Brazing and soldering are permitted only for joints not made directly to the outer jacket body.

§178.57(f) Wall thickness.

The minimum wall thickness of the inner containment vessel and the outer jacket shall be calculated using Finite Element Analysis (FEA). Using FEA the calculated wall stress at minimum required test pressure shall not exceed one-third of the minimum tensile strength of the base material as required in §178.57(o).

§178.57(g) Heat treatment.

(1) Inner vessel. Stress relief of the molded halves of inner vessel is permitted as necessary provided that the angle of the joining surfaces are within the drawing tolerances after heat treating (no distortions permitted).

(2) Outer vessel.

(i) Titanium. Titanium outer vessel may be vacuum annealed after chemical cleaning in accordance with ASTM B600 Standard Guide for Descaling and Cleaning Titanium and Titanium Alloy Surfaces.

(ii) Steel. Heat treatment after forming is not permitted.

(iii) Other metals. Heat treatment as appropriate.

§178.57(h) Openings in Vessels.

Inner vessel. Openings permitted in hub section only. The opening shall not exceed 0.19 square inches. Openings in the inner vessel shall access the center hub which shall be glued to the inner vessel. Attachments to the center hub may be made by welding, brazing, soldering, or mechanical attachment.

§178.57(i) Pressure test.

After assembly, each inner vessel, before insulating and jacketing must be examined under a pressure of at least two times the service pressure maintained for at least 30 seconds without evidence of leakage, visible distortion or other defect. Pressure gauge must permit reading to an accuracy of 1 percent.

§178.57(j) Physical test.

(1) Inner vessel. ASTM D638 Standard Slabs will be prepared from the same material and tested for physical properties to verify conformance with the minimum physical properties listed in §178.57(o)(1) Table 1. Determine flexural strength, flexural modulus, tensile strength, and elongation on 2 specimens selected from each lot of raw material and in the same condition as that of the completed vessel.

(2) Glue joint. Following the OSS gluing procedure, LCP Inner Vessel Epoxying Procedure, prepare two specimens using ASTM D638 Standard Slabs. The slabs shall be continuously glued over their entire width and overlap each other one inch. Samples will then be pulled to failure in the tensile test apparatus.

§178.57(k) Acceptable results for physical tests.

(a) Physical properties must meet the limits specified in §178.57(o)(1) Table 1 of this exemption for the LCP.

(b) Failure of the glued specimens must occur only in the base material.

§178.57(l) Tests of welds. Not required.

§178.57(o) Authorized materials of construction.

(1) Inner containment vessel. Liquid Crystal Polymer of uniform quality. Chemical analysis must conform to Hoechst Celanese Vectra A130. The following chemical analyses and physical properties are authorized:

TABLE 1 - AUTHORIZED MATERIALS

Designation	Chemical Analysis, Limits in Percent
Glass Fiber	29 to 31
Vectra Copolyester Resin Grade A950	Remainder

	Physical Properties
Tensile strength at break, psi (minimum)	24,000
Flexural strength, psi	37,000
Flexural Modulus, psi	2,100,000
Elongation at break, percent (minimum)	2.0

CHECK ANALYSIS TOLERANCES

Elements	Limit or maximum of specified range, percent	Permissible Variation in Product Analysis
Glass fiber	30	±1.0

(2) Outer vessel. Must be constructed of any metal that meets the structural requirements established by the finite element analysis (FEA) where the calculated wall stress shall not exceed one-third of the minimum tensile strength of the base metal. The minimum wall thickness of the outer jacket shall be determined based on the results of the FEA.

§178.57(p) Marking.

(1) * * *

(i) DOT-E 11375 in lieu of DOT-4L, followed by the service pressure.

* * *

b. OPERATIONAL CONTROLS - The service life of the prescribed container is limited to 15 years from the date of manufacture.

8. SPECIAL PROVISIONS:

a. In accordance with the provisions of Paragraph (b) of 49 CFR 173.22a, persons may use the packaging authorized by this exemption for the transportation of the hazardous materials specified in paragraph 6, only in conformance with the terms of this exemption.

b. A person who is not a holder of this exemption, but receives a package covered by this exemption, may reoffer it for transportation provided no modifications or changes are made to the package and it is offered for transportation in conformance with this exemption and the HMR.

c. A current copy of this exemption must be maintained at each facility where the package is offered or reoffered for transportation.

d. Each packaging manufactured under the authority of this exemption must be marked with a registration symbol designated by the Office of Hazardous Materials Exemptions and Approvals for a specific manufacturing facility.

e. A copy of this exemption, in its current status, must be maintained at each manufacturing facility at which this packaging is manufactured and must be made available to a DOT representative upon request.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor vehicle, rail freight, cargo vessel, and cargo aircraft only.

10. MODAL REQUIREMENTS: A copy of this exemption must be carried aboard each cargo vessel or aircraft used to transport packages covered by this exemption. The shipper shall furnish a copy of this exemption to the air carrier before or at the time the shipment is tendered.

11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this exemption and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. Section 5101 et seq:

    - All terms and conditions prescribed in this exemption and the Hazardous Materials Regulations, Parts 171-180.
    - Registration required by 49 CFR 107.601 et seq., when applicable.

    Each "Hazmat employee", as defined in 49 CFR 171.8, who performs a function subject to this exemption must receive training on the requirements and condition of this exemption in addition to the training required by 49 CFR 172.700 through 172.704.

    No person may use or apply this exemption, including display of its number, when the exemption has expired or is otherwise no longer in effect.

12. REPORTING REQUIREMENTS: The carrier is required to report any incident involving loss of packaging contents or packaging failure to the Associate Administrator for Hazardous Materials Safety (AAHMS) as soon as practicable. (49 CFR 171.15 and 171.16 apply to any activity undertaken under the authority of this exemption.) In addition, the holder(s) of this exemption must also inform the AAHMS, in writing, as soon as practicable of any incidents involving the package and shipments made under this exemption.

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Issued at Washington, D.C.

12/18/98
(DATE)

Alan I. Roberts
Associate Administrator
for Hazardous Materials Safety

Address all inquiries to: Associate Administrator for Hazardous Materials Safety, Research and Special Programs Administration, Department of Transportation, Washington, D.C. 20590. Attention: DHM-31.

The original of this exemption is on file at the above office. Photo reproductions and legible reductions of this exemption are permitted. Any alteration of this exemption is prohibited.

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