MIL-STD-1642(TD)
20 August 1977

MILITARY STANDARD

DESIGN CRITERIA FOR

PERSONNEL LOW PRESSURE CHAMBERS

FSC 6930

DEPARTMENT OF THE NAVY

NAVAL TRAINING EQUIPMENT CENTER

ORLANDO, FLORIDA

Design Criteria for Personnel Low Pressure Chambers

MIL-STD-1642(TD)

1. This standard has been approved by the Naval Training Equipment Center, and is published to establish general criteria for the development of personnel low pressure chambers. Its purpose is to present general design and test criteria for the structural construction and testing of personnel low pressure chambers.

2. Recommended corrections, additions, or deletions should be addressed to the Commanding Officer, Naval Training Equipment Center, Code N-411 (Standardization), Orlando, Florida 32813.

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DESIGN CRITERIA FOR

PERSONNEL LOW PRESSURE CHAMBERS

1. SCOPE

1.1 Scope - This standard establishes general criteria for the development of personnel low pressure chambers.

1.2 Purpose - The purpose of this standard is to present general design and test criteria for the structural construction and testing of personnel low pressure chambers.

1.3 Application - This standard shall be applied to the design of the structural system of personnel low pressure chambers. Nothing in this standard shall be construed as limiting the selection of hardware, materials, or processes to the specific items described herein.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on the date of invitation for bids or request for proposal form a part of this standard to the extent specified herein:

SPECIFICATIONS

Military

MIL-T-23991	Training Device, Military; General Specification for
MIL-C-81511	Connector, Electrical, Circular, High Density, Quick Disconnect, Environment Resisting and Accessories; General Specification for
MIL-G-174	Glass, Optical

PUBLICATIONS

Military

MIL-HDBK-472	Maintainability Predictions

Naval Training Equipment Center (NAVTRAEQUIPCEN)

Bulletin 31-1	Design Documents for Aviation Training Devices
Bulletin 40-1	Integrated Logistic Support for Training Devices

(Copies of specifications, standards, drawings and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME Boiler and Pressure Vessel Code, Section VIII, Rules for the Construction of Pressure Vessels
ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications

(Application for copies should be addressed to American Society of Mechanical Engineers, 345 E. 47th Street, New York, N. Y. 10017.)

NATIONAL FIRE PROTECTION ASSOCIATION

NFPA No. 56E Hypobaric Facilities

(Application for copies should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA. 02210.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM A36 Structural Steel; Specification for

(Application for copies should be addressed to American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA. 19103.)

3. DEFINITIONS

3.1 Hypobaric - A hypobaric environment is one in which the pressure is less than one atmosphere.

3.2 Fail-Safe Design - Design such that a failure will not adversely affect the safe operation of the system, equipment of facility.

4. GENERAL REQUIREMENTS

4.1 Objectives - The Personnel Low Pressure (Hypobaric) Chamber is a training device that shall simulate high altitude environmental conditions as well as rapid decompression. It provides a controlled method of training flight crew members physiological adjustment to changing altitude environments, use of standard Navy oxygen breathing equipment and recognition of the symptoms of hypoxia at high altitudes.

4.2 Fail-Safe Design - A fail-safe design shall be provided in those areas where failure can disable the chamber or cause catastrophe through damage to equipment, injury to personnel or inadvertent operation of crucial equipment.

4.3 Safety - Major consideration shall be given to safety factors. The requirements of NFPA No. 56E shall apply.

5. DETAIL STATEMENTS AND REQUIREMENTS

5.1 Materials, parts and processes - Parts and processes shall conform to MIL-T-23991.

5.1.1 Materials - The chamber shall be fabricated of construction grade steel ASTM A36 or higher.

5.1.1.1 Nonflammable and self-extinguishing materials - All materials which will be exposed to the chamber atmosphere shall be either nonflammable or self-extinguishing when ignition is attempted in an atmosphere consisting of 305.1 mm Hg oxygen and 455.09 mm Hg nitrogen.

5.1.1.1.1. Gaskets - The selection of nonflammable and self-extinguishing gaskets shall be consistent with the above requirements for function in an environment of 305.1 mm Hg oxygen and 455.09 mm Hg nitrogen.

5.1.2 Processes

5.1.2.1 Welding - Welding of the chamber shell and all fabricated components subjected to pressure stresses shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

5.2 Design - The design shall be in accordance with MIL-T-23991 and 5.2.1 through 5.2.3 of this standard.

5.2.1 General - The design shall be for fixed installation in a building provided by the Government.

5.2.2 Altitude chamber - The altitude chamber shall be a right parallel-piped configuration. The altitude chamber shall be constructed of steel plates with reinforcing members. The structural design and welding design shall be in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, excluding Section U-1. The complete altitude chamber, doors, windows, and all compartments within the chamber shall be designed to operate at 50% of the yield point of the materials used at a pressure of 1033.2 g/cm^2 evenly distributed over the outside surface of the chamber and evenly distributed over the outside surface of the compartments.

5.2.2.1 Structural reinforcing (Fully restrained members) - All joints shall be welded through so that no air can be trapped in the joints. Plates forming the flat surfaces of the chamber shall be butt welded. Structural reinforcing members of the chamber shall be welded to the outside surface of the chamber only and shall have no cutouts (coping). Structural reinforcing members shall not cover any plate weld. Primary reinforcing members shall be either "W" sections or Structural "T's". The inside of the chamber shall be smooth and continuous. All butt welds shall be ground flat and smooth. The compartment partition bulkhead shall be constructed of one sheet of steel plate with reinforcing members. The structural reinforcing members of the partitions shall be located furthest from the main compartment i.e., on the outside face of the main compartment partition. (See figure 1.)

5.2.2.2 Chamber penetrations - Welded penetrations shall be in accordance with the design specified in the ASME Boiler and Pressure Vessel Code, Section VIII, excluding Section U-1. Through bulkhead type connectors shall conform to the requirements of Class H of MIL-C-81511.

5.2.2.3 Vacuum retention (Leakage) - The altitude chamber shall be constructed to retain the level of decompression with the vacuum pump isolated from the system according to the following schedule (leakage rate). In each case, the conditions indicated shall be attainable with the doors to interconnecting compartments open and with only one door closed to seal the compartment.

Initial Pressure Altitude (1000 meters)	Final Pressure Altitude Limits (1000 meters)	Time of Pressure Retention (minutes)
30.5	more than 29.5	10
24.4	more than 24.1	10
12.2	more than 12.0	10
4.6	more than 4.4	10

5.3 Detail of components

5.3.1 Personnel doorways and doors - Doorways and doors for personnel access shall be provided at the end of the chamber, and in each partition which separates interior compartments. Doorways shall be in line. Doorways shall provide an unobstructed passage 6 feet (1.83 m) high by 2 1/2 feet (.76 m) wide. Door sills shall be 2 inches (5.08 cm) in height above the floor level of each compartment. The right hand door jamb of each doorway shall be in line with the innermost ends of the trainee consoles which extend from the chamber wall into the chamber. All doors shall swing toward the front of the altitude chamber and shall swing on the left hand door jambs. There shall be clear passage through the doorway when the door is opened to a position of 90° from the closed position.

5.3.1.1 Door gaskets - Resilient gaskets protected from oxidation shall be mounted on the facing of each doorway. Gaskets shall seal each compartment against a static pressure of 1.55 g/cm^2.

5.3.1.2 Door stop - A door stop shall be provided for each door. Door hinges shall be located to prevent lateral movement between door gaskets and the door when the door is closed (see figure 2). The door shall be hung so as to open 5 to 10 degrees whenever the door is not retained by a latching mechanism or differential compartment pressure. Door travel shall stop at the 90^o position when opened to afford unobstructed viewing through the window adjacent to the door. The door shall open beyond the 90^o opened position when the stop is manually released.

5.3.1.3 Door latch - A pressure operated latching device shall be provided for each door. The latching device shall disengage to the unlatched condition whenever a differential pressure no greater than 130 mm Hg is attained. A manually operated device shall be provided to enable manual disengagement of the latching device from the outer side of the door in the event the differential pressure has not been applied or has not caused the latch to automatically release.

5.3.2 Windows

5.3.2.1 Window requirements - The chamber windows shall be in accordance with MIL-G-174 excluding section 3.3.12.

5.3.2.2. Window configuration - The configuration of each window unit shall include two independently sealing window panes arranged so that either pane will independently, and without the presence of the other, meeting the requirements specified in 5.2.2.3. The window pane seals shall be such that the force of the pane against the seal will increase with an increase in chamber altitude (see figure 3). A replaceable dessicant shall be provided between the two window panes. The design of the window unit shall provide for ease of disassembly for dessicant replacement from the outside of the chamber.

5.4 Finish - The finish shall be in accordance with MIL-T-23991.

5.5 Workmanship - Workmanship shall be in accordance with MIL-T-23991.

6. QUALITY ASSURANCE PROVISIONS

6.1 General - The general quality assurance provisions shall be in accordance with MIL-T-23991.

6.2 Responsibility for inspection - Responsibility for inspection shall be in accordance with MIL-T-23991.

6.3 Inspection facilities - Inspection facilities shall be in accordance with MIL-T-23991.

6.4 Classification of inspections - Classification of inspections shall be in accordance with MIL-T-23991.

6.4.1 Examinations - Except for size, examinations shall be in accordance with MIL-T-23991.

6.4.2 Tests - The training device shall be subjected to the tests specified in MIL-T-23991. Recording and records shall be compiled for all tests.

6.5 Extent of testing and test conditions - Test conditions shall conform to the as-to-be-used ambient conditions for the training device.

6.5.1 Materials tests - All gaskets, paint, lubricants and the like that are subjected to the altitude chamber environment shall be tested to verify that the requirements of 5.1.1 are met. A Brinell Hardness Test shall be conducted on sample pieces of steel used in chamber to insure the requirements of 5.1.1 are met.

6.5.2 Weld tests - The inspections and tests shall be in accordance with Section IX of ASME Boiler and Pressure Vessel Code, Welding and Brazing Qualifications. Radiographic examination records shall be identifiable with the weld locations of the altitude chambers.

6.5.3 Vacuum retention tests - The vacuum retention shall meet the requirements of 5.2.2.3 in a minimum of 4 complete tests of all specified parameters. Pressure versus time recordings shall be taken.

6.5.4 Door tests - Personnel doorways and doors of 5.3.1 shall be tested to verify that the requirements for the door stop of 5.3.1.3 and the door latch of 5.3.1.4 are met.

6.5.5 Window tests - Windows shall be tested in accordance with MIL-G-174 to verify that the requirements of 5.3.2.1 are met.

6.5.6 Structural tests - The altitude chamber structure shall be tested to meet the working stress requirement of 50% of the yield point of the material used at a pressure of 1033.2 g/cm^2. The structural test shall consist of single direction of strain gages and dual direction, 90^{o} orientation, rosette strain gages located at indicated position on figures 4, 5, and 6.

6.5.7 Strain gages - Single direction strain gages and dual direction rosette gages shall be used to test the chamber.

6.5.7.1 Strain gage attachment - Strain gages shall be cemented to altitude chamber outside walls and partitions and protected against moisture surfaces on which gages shall be attached to, shall be completely free of paint. Base metal shall be chemically cleaned and polished before cementing gages. A fast cure adhesive shall be used to cement gages to base metal.

6.5.7.2 Strain gage recording - Strain gages shall be read and recorded in accordance with the following:

Altitude (1000 meters)

Main Compartment	0	3.05	6.1	12.2	15.2	21.3	30.5	30.5	30.5
Second Compartment	0	0	0	0	0	0	0	3.05	6.1
Third Compartment	0	0	0	0	0	0	0	0	0
Main Compartment	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
Second Compartment	12.2	15.2	21.3	30.5	30.5	30.5	30.5	30.5	30.5
Third Compartment	0	0	0	3.05	6.1	12.2	15.2	21.3	30.5

The strain gages shall be read and recorded with the main compartment at the above altitudes with all other compartments at sea level. At the main compartment maximum altitude, the strain gages shall be recorded while the second compartment is at the above altitudes with the remaining compartments at sea level. Additional compartments shall be tested in a like manner.

After establishing areas of relatively high stress 4 rapid recompression readings from 30,500 meters to sea level shall be recorded on a strip chart recorder. Once this is completed, 4 rapid decompression readings from sea level to 30,500 meters shall be recorded on a strip chart recorder.

6.5.7.3 Stress calculations - The recorded strains of 6.5.7.2 shall be used to calculate the principal stresses. These stresses shall be compared to the maximum allowable stress of 5.2.2. All the stresses obtained shall be tabulated by location and magnitude. The maximum recorded stress shall not exceed the maximum allowable stress of 5.2.2.

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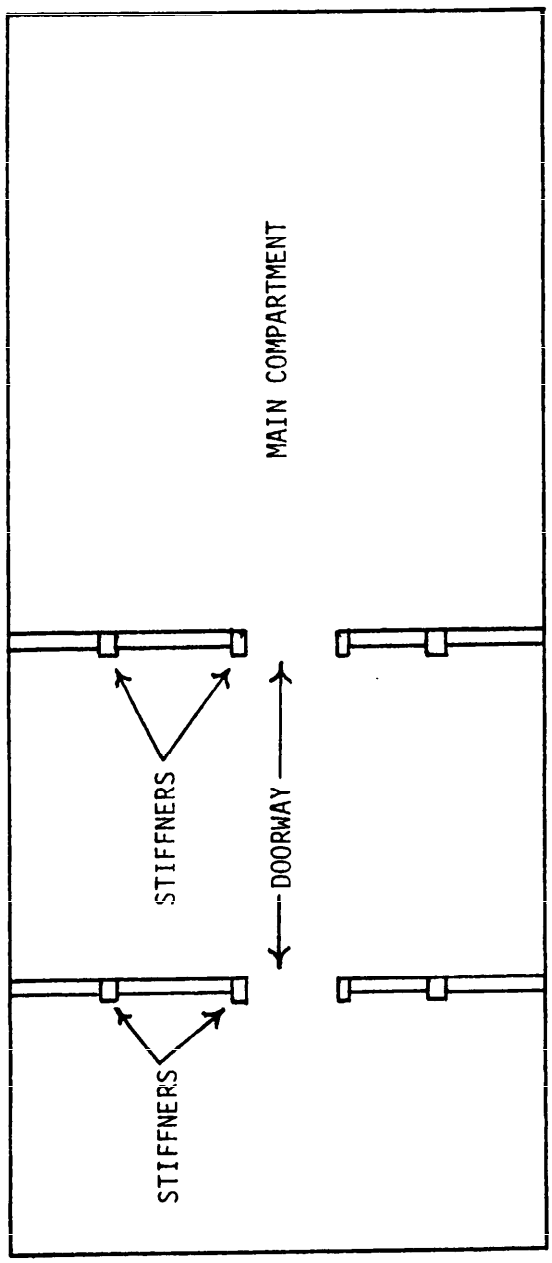
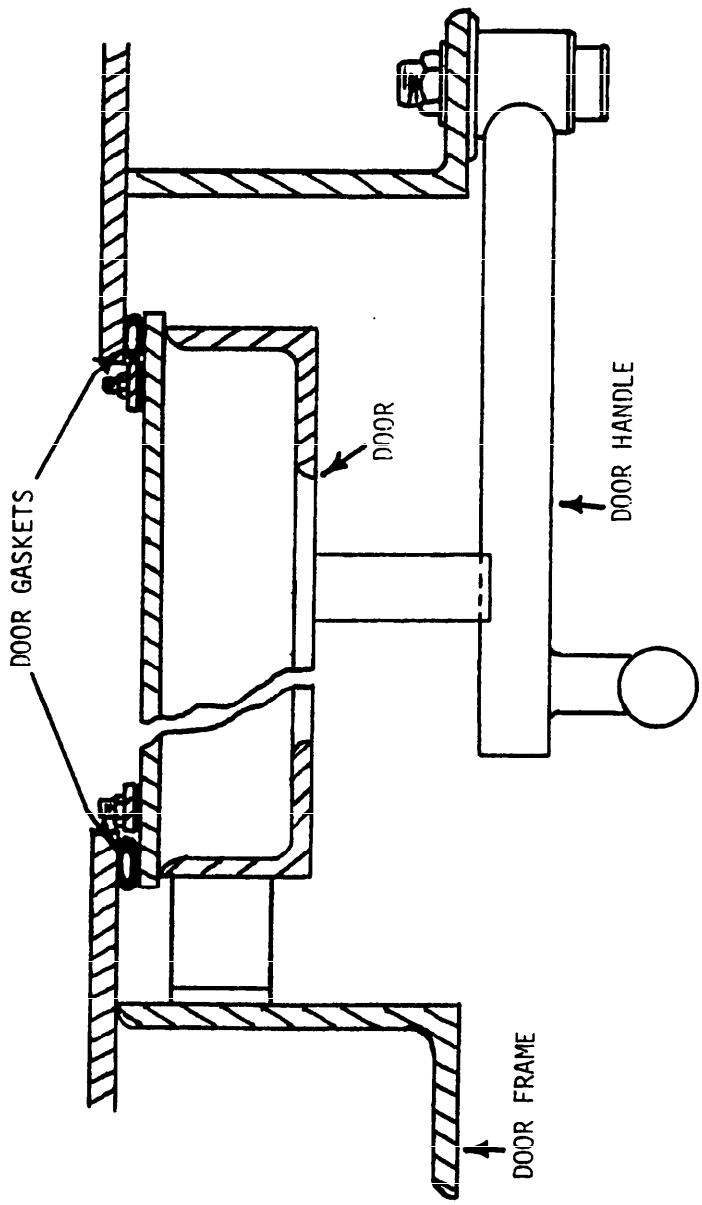


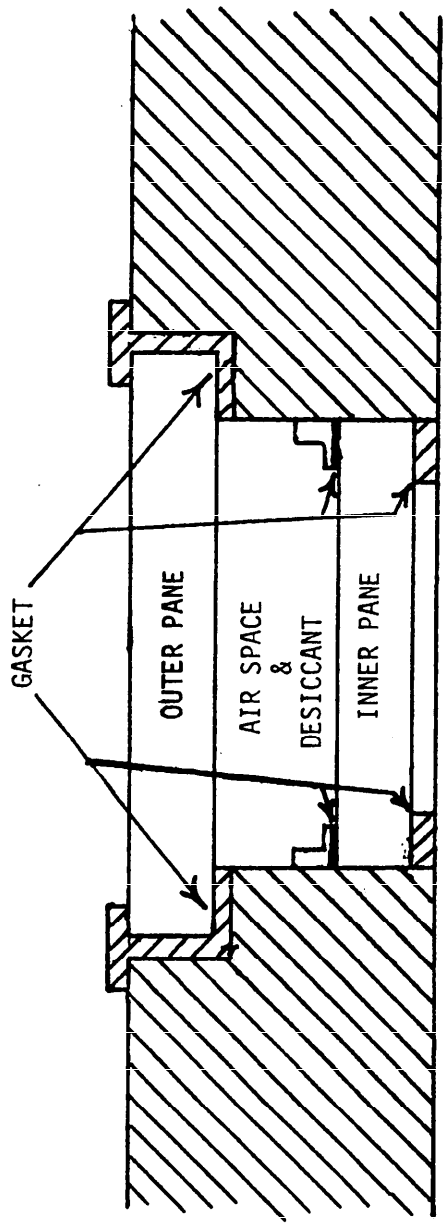
PLAN VIEW OF CHAMBER

FIGURE 1



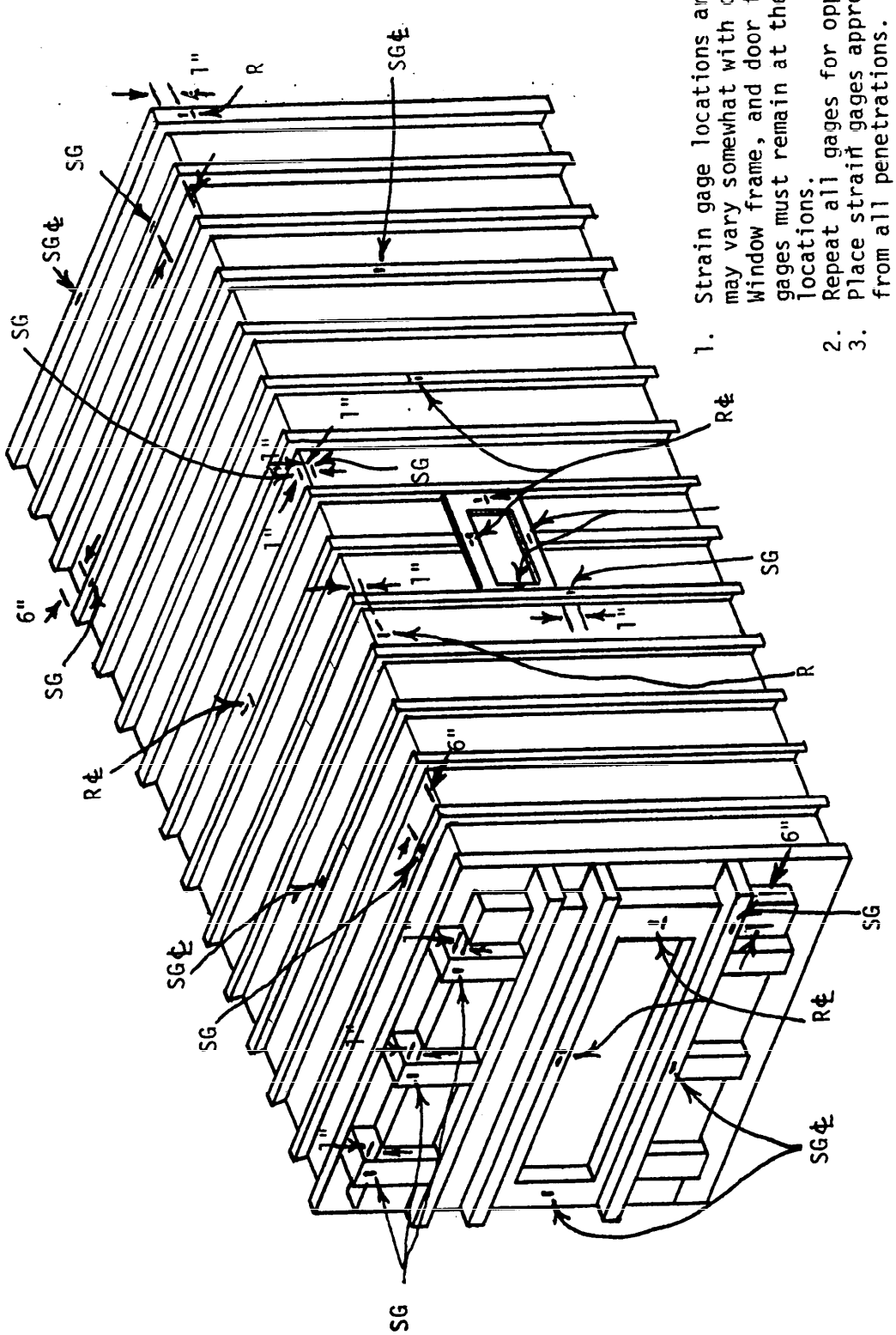
DOOR SECTION

FIGURE 2



TYPICAL WINDOW SECTION

FIGURE 3



1. Strain gage locations are typical and may vary somewhat with chamber size. Window frame, and door frame strain gages must remain at their indicated locations.
2. Repeat all gages for opposite bulkheads.
3. Place strain gages approximately 1" from all penetrations.

SG - Denotes strain gages
(R) - Denotes rosette gage

FIGURE 4

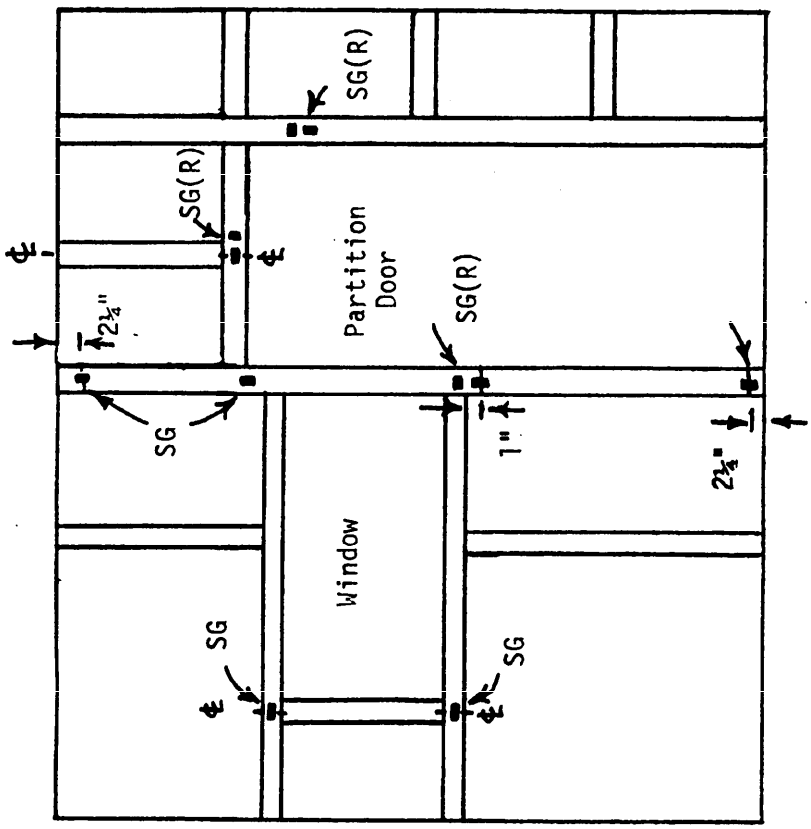
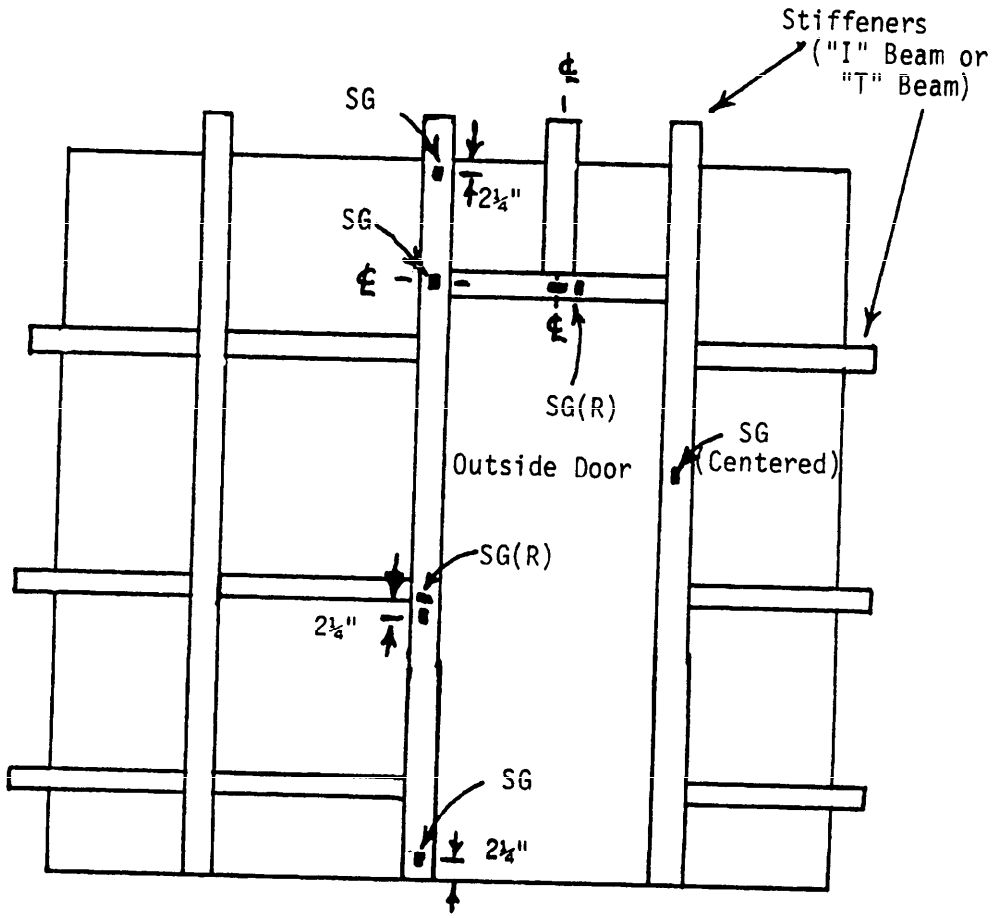


FIGURE 5



■ ← SG Strain Gage Location

(R) Denotes Rosette Strain Gage

FIGURE 6

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

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