INCH-POUND

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DETAIL SPECIFICATION

TANKS, FUEL, OIL, COOLING FLUIDS, INTERNAL, REMOVABLE NON-SELF-SEALING

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers internal, removable, non-self-sealing tanks, including tank fittings for use on aircraft.

1.2 Classification. The tanks are of the following general types, as specified (see 6.2).

1.2.1 Types. The types of tanks are as follows:

Type I - Metallic.

Type II – Non-metallic, bladder, flexible cell construction.

Class A – Continuously supported.

Class B – Continuously supported tear resistant.

Class C – Intermittently supported.

Type III – Non-metallic, rigid/non-flexible, self-supporting cell construction.

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 4L8000B120-3, Highway 547, Lakehurst, NJ 08733-5100 or emailed to michael.sikora@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at http://assist.daps.dla.mil.

AMSC N/A FSC 1560

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARDS

FED-STD-791	-	Lubricants, Liquid Fuels, and Related Products; Methods Of Testing

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-680	-	Degreasing Solvent
MIL-DTL-85470	-	Inhibitor, Icing, Fuel System, High Flash, NATO Code S-1745

DEPARTMENT OF DEFENSE STANDARD

MIL-STD-801	-	Inspection and Acceptance Standards for Fuel Cells and Fittings

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AEROSPACE INDUSTRIES ASSOCIATION (AIA)

NASM20470	-	Rivet, Solid, Universal Head, Aluminum Alloy and Titanium Columbium Alloy

(Copies of this document are available from the Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3901 or http://www.aia-aerospace.org.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME-Y14.100	-	Engineering Drawing and Related Documentation Practices
ASME-Y14.8	-	Castings and Forgings

(Copies of this document is available from the American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900 or http://www.asme.org.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM-B766	-	Cadmium, Electrodeposited Coatings of
ASTM-D381	-	Fuels by Jet Evaporation, Gum Content in
ASTM-D412	-	Rubber, Vulcanized and Thermoplastic Elastomers - Tension
ASTM-D413	-	Rubber Property-Adhesion to Flexible Substrate
ASTM-D471	-	Rubber Property - Effect of Liquids

(Copies of these documents are available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or http://www.astm.org.)

RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)

RTCA/DO-160	-	Environmental Conditions and Test Procedures for Airborne Equipment

(Application for copies should be addressed to the Radio Technical Commission for Aeronautics, 1828 L Street, NW, Suite 805, Washington, DC 20036 or http://www.rtca.org.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) INTERNATIONAL

SAE-AMS2175	-	Casting, Classification and Inspection of
SAE-AS8879	-	Screw Threads, UNJ Profile, Inch Controlled Radius Root With Increased Minor Diameter

(Copies of these documents are available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or http://www.sae.org.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Tank performance. The tank(s) shall be capable of performing, without failure, during all phases and environments of aircraft use as specified by the procuring activity.

3.2 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.2.

3.3 Tank components.

3.3.1 Type I and III tanks. These tanks shall consist of a fluid reservoir, typically referred to in this specification as a cell or bladder, complete with all fittings and attachments.

3.3.2 Type II tanks. A tank shall consist of a cell or a group of interconnected cells to form a complete tank or reservoir, complete with all fittings and attachments.

3.4 Materials. The materials used in the manufacture of non-self-sealing tanks shall be for the purpose intended. The use of magnesium is prohibited.

3.4.1 Metals. Metals shall be of the corrosion-resistant type or treated to resist corrosion due to fuels, salt fog, or atmospheric conditions likely to be met in storage or normal service.

3.4.1.1 Dissimilar metals. Unless protected against electrolytic corrosion, dissimilar metals shall not be used in intimate contact with each other.

3.4.2 Metallic castings. Castings shall be in accordance with ASME-Y14.8.

3.5 Design.

3.5.1 General. Tanks shall be compatible with the fuel for which they are intended and shall perform in conjunction with the containing structure to avoid load concentration on splices, seams, fittings, or concentrated flexure locations. The tank assembly and aircraft structure in which it is mounted shall possess the necessary strength to provide for the stresses caused by the following:

a. Flexing resulting from vibration.

b. Impact loads incident to take-off, taxiing, and landing (including catapulting and arresting).

c. Positive and negative pressures associated with fluid surge incident to all dynamic conditions of flight, including catapult and arrested landing, if applicable.

d. Pressure loads imposed by:

   1. Hydrostatic head of fluids during level flight or maneuvers.

   2. Pressurizing or inerting gases.

   3. Proof and ultimate pressures as designated by the procuring activity.

   4. Fluid surge incident to gunfire, where type II, class B, tank constructions are used.

e. Handling loads associated with removal, transportation and installation.

3.5.2 Capacity. The capacity of the tank(s) shall be such that the aircraft is capable of completing the requirements as specified by the procuring activity. The capacity of types I and III cells shall be within 1.5 percent of the total volume of the average capacity of the first 10 production cells manufactured after design approval of the cells. For cells in production, the fuel level versus volume curve shall be within 1.5 percent of the calibrated fuel level versus volume curve.

3.5.3 Weight. Emphasis shall be placed on creating the lowest weight cell that will meet the requirements of this specification. The weight of production cells shall be within the following percentages of the average weight of the first 10 production cells manufactured after design approval of the cell:

a. Type I cells: ± 2 percent

b. Types II and III cells: ± 5 percent

If, during the production of cells, the weight is consistently greater than the tolerance on one side of the production weight, the procuring activity shall be informed, and all pertinent data shall be supplied including a recommendation for a new production weight, the reason for exceeding the weight tolerances, and a log of the tank or cell weight for review and establishment of a new production weight.

3.6 Construction.

3.6.1 Installation mountings. Provisions shall be made for installation mounting of the tank(s) with the following interfaces:

3.6.1.1 Bosses. Fittings shall conform to best commercial practices consistent with meeting design requirements of the tank. Tanks shall not leak.

3.6.1.2 Sealing torque. The fitting(s) shall provide a fluid tight seal with application of the appropriate tightening torque as specified in table I.

3.6.1.3 Threaded holes. All threaded bolt holes shall be blind and shall incorporate replaceable or repairable self-locking steel inserts.

3.6.1.4 Inserts. Each insert shall be provided with a locking device. The locking device shall not damage the fastener or insert. The insert and locking device shall be capable of a minimum of 50 installation and removal cycles before replacement is required. The fitting and insert shall be designed so that damage beyond repair to the fitting or insert shall not occur when the maximum allowable torque as specified in table I is applied on a bolt that is bottomed out against the bottom of the bolt clearance hole or tapped hole or when applied against a bolt that is shanked out against the top thread of the bolt.

3.6.2 Screw threads. Screw threads shall be in accordance with SAE-AS8879.

3.6.2.1 Pipe threads. The use of pipe threads is prohibited.

3.6.2.2 Locking of threaded parts. All threaded parts shall employ self-locking features. Staking and the use of lock washers shall not be permitted.

TABLE I. Torque values (inch pounds).

Thread size	Maximum allowable bolt torque	Locking Device				
		Free Spinning			Prevailing torque	
		Tightening torque	Breakaway torque		Maximum Installation	Minimum Breakaway
			Minimum	Maximum		
0.2500-28_______	100	60	30	90	30	3.5
0.3125-24_______	225	120	60	180	60	6.5
0.3750-24_______	390	175	85	260	80	9.5
0.4375-20_______	840	475	240	715	100	14.0
0.5000-20_______	1,100	585	290	875	150	18.0

3.7 Interchangeability. All parts having the same manufacturer's part number shall be physically and functionally interchangeable without the need for modification of such parts.

3.8 Finish.

3.8.1 External surfaces. The external surfaces of type II and III tanks shall be ozone and ultraviolet light resistant or protected against the action of ozone, ultraviolet light and the fluid for which the tanks are intended.

3.8.2 Steel parts. Exposed steel parts shall be of corrosion resistant steel or shall be protected to satisfy a 120-hour salt fog test conducted in accordance with RTCA/DO-160, Section 14. For parts not exposed to fuel in normal use, cadmium plating in accordance with ASTM-B766 may be used. Parts exposed to fuel in normal use shall not be cadmium plated.

3.8.3 Aluminum-alloy parts. Aluminum-alloy parts shall meet a 120-hour salt fog test conducted in accordance with RTCA/DO-160, Section 14. If required for electrical bonding, the protection may be removed locally.

3.9 Temperature range. Tanks shall operate throughout an ambient temperature range of -65 to +160 ºF (-54 to +71 ºC) and fuel temperature ranges of -65 to +135 ºF (-54 to +57 ºC) unless otherwise directed by the procuring activity.

3.10 Installation torque. As specified by the procuring activity, the proper torque values for installing the tank in the aircraft and for attachment of fuel lines, interconnects, vent lines, fuel pumps, valves, access doors, and other fuel system components shall be durably and legibly marked on or adjacent to each fitting or fuel system component involved, on the side to which the torque wrench is applied. In tanks where all torque values are the same, the proper torque value shall be stenciled in a conspicuous space.

3.11 Age. Cells shall be not greater than 2 years old from date of initial cure to delivery to the procuring activity.

3.12 Cleaning. No cell shall contain rubber particles, dirt, sand, metal chips, welding flux, or any other foreign material prior to shipment.

3.13 Markings. Each assembly part shall be marked with its part number which shall be the same as the drawing number of that part or assembly. (An assembly consists of parts that are permanently fastened together.) Exceptions to this marking requirement are those parts that do not have a suitable or sufficient surface for a part number.

3.13.1 Location of part numbers. The part number shall be visible to read after assembly of the complete unit and legible during the life of the part.

3.13.2 Identification of product. Each cell assembly shall be marked for identification and shall include:

a. Re-order by part number (insert current aircraft contractor part number).

b. Federal stock number.

c. Aircraft model(s) and cell location.

d. Cure date (month and year).

e. Construction number.

f. Cell manufacturer and CAGE code.

g. Cell manufacturer part number.

h. Weight, empty (actual).

i. MIL-DTL-6396F, Type, Class (if applicable).

j. Contract or order number.

3.13.2.1 Identification. Identification (e.g., nameplate, stencil, etc.) shall be located on the cell in such a position that when the cell is installed in the aircraft, identification is visible with the minimum possible disruption of the cell installation. Identification shall be durably and legibly marked onto the tank.

3.13.3 Access door covers. Unless otherwise specified, the exterior surface of all access door covers shall be durably and legibly marked “OUTSIDE”.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.2 First article inspection. Inspection shall consist of phase I and phase II tests.

4.2.1 Phase I: First article inspection (Type II and III tanks only). Phase I inspections shall be those tests performed on construction samples (see 6.4.1) to be used in tank manufacture and listed in table II. The phase I test samples are listed in 4.2.1.1 and testing is described in 4.5.

4.2.1.1 Phase I: Test samples (Type II and III tanks). Phase I test samples shall consist of:

a. The number of phase I test cubes (tanks) required for each type and class are:

Type and Class	Number of Test Cubes
Type II, Class A	2
Type II, Class B	3
Type II, Class C	2
Type III	2

b. Each Type II (all classes), phase I test sample shall have the following characteristics:

1. Test cubes with outer dimensions of 24 by 30 by 30 inches and necessary fittings as specified by the procuring activity.

2. Eight side panels constructed to simulate the aircraft structure.

3. One sample of inner layer ply, without barrier, approximately 900 square inches in area including seam.

4. Two samples of 6 by 6 inch inner layer ply, without barrier.

5. Three permeability samples consisting of the inner liner and fuel barrier (if required).

6. One sample of 12 by 12 inch outer layer ply.

c. Each Type II, Class B, phase I test sample shall also include eight sheets of backing material 27 by 30 inches and two sheets of backing material 30 by 30 inches.

d. Each Type III, phase I test sample shall include a test cube with outer dimensions of 24 by 30 by 30 inches with the necessary fittings and shall also include three 12 by 12 inch samples of type III composite tank construction.

e. Phase I test samples of all types and classes shall not be altered or pre-plasticized prior to testing.

TABLE II. Phase I tests (Type II and III tanks).

Tests	Para. No.	Oil	Fuel	Water-Alcohol
Leakage 1/	4.5.1.5	X	X	X
Aging	4.5.5	X	-	-
Slosh	4.5.8	X	X	X
Stand test (phase I)	4.5.9	X	X	X
Humidity	4.5.10	X	X	X
Fuel resistance of exterior surface	4.5.11	X	X	X
Permeability	4.5.12	-	X	-
Fuel contamination	4.5.13	-	X	-
Oil dilution resistance 2/	4.5.14	X	-	-
Inner liner strength	4.5.15	X	X	X
Seam adhesion	4.5.16	X	X	X
Puncture resistance	4.5.17	X	X	X
Impact resistance 3/	4.5.18	X	X	X
Gunfire (phase I) 4/	4.5.19	X	X	-

X Indicates test applicable
\- Indicates test not applicable

1/ Upon completion of the leakage test, tests may be run in any order desired.
2/ Applies only to oil tanks to be used on aircraft employing an oil dilution system.
3/ This test applicable to Type III tanks only.
4/ This test applicable to Type II, Class B tanks only.

4.2.2 Phase II: First article inspection (Type I, II, III tanks). Phase II tests shall consist of these tests accomplished on full-scale tanks. The first article inspections are listed in table III. Unless otherwise specified, the tests shall be conducted in the sequence listed.

4.2.2.1 Phase II: Test samples (Type I, II, III tanks). Using metal fittings with an outer diameter of 2 to 5 inches, a minimum of three test samples shall be used to verify each different fitting flange interface design and each tank attachment method (see 4.5.28.2 and 4.5.28.3).

TABLE III. Phase II tests.

Tests	Para No.	Tank Types		
		I	II	III
Examinations	4.5.1	X	X	X
Handling (Type II tanks only)	4.5.20	-	X	-
Installation	4.5.21	X	X	X
Capacity	4.5.4	X	-	X
Simultaneous slosh and vibration 1/	4.5.6	X	X	X
Vibration	4.5.7	X	-	X
Slosh 2/	4.5.8	-	X	-
Low temperature leakage	4.5.22	X	X	X
Stand test	4.5.23	-	X	X
Accelerated loads test	4.5.25	X	X	X
Proof pressure (Type I and III tanks)	4.5.26	X	-	X
Burst pressure (Type II and III tanks)	4.5.27	X	-	X
Fitting tests	4.5.28	X	X	X
Gunfire	4.5.24	-	X 3/	-

X Indicates test applicable
- Indicates test not applicable

1/ Simultaneous slosh and vibration tests not mandatory for Type II tanks, Classes A and B.
2/ Slosh test not required when simultaneous slosh and vibration test is conducted.
3/ Type II, Class B tanks only.

4.2.3 Variation of basic construction. Variation of basic construction, which has been granted first article inspection phase I approval, shall be indicated by a dash number or lettering system. Details of each phase I variation shall be submitted to the procuring activity which, at its discretion, may extend phase I approval to the variation.

4.3 Conformance inspection. Conformance inspections shall consist of:

a. Individual tests (see 4.3.1).

b. Sampling plans and tests (see 4.3.2).

4.3.1 Individual tests. Each tank shall be subjected to the following tests and examinations:

a. Examination of product 4.5.1.1

b.	Workmanship	4.5.1.2
c.	Dimensional check	4.5.1.3
d.	Weight	4.5.1.4
e.	Leakage	4.5.1.5

4.3.2 Sampling tests.

4.3.2.1 Type I and III tank sampling. Unless otherwise specified by the procuring activity, one tank shall be selected from the first 100 tanks or less, plus one tank from each 1,000 tanks thereafter or fraction thereof, and shall be subjected to the following sampling inspections:

a.	Capacity	4.5.4
b.	Proof pressure	4.5.26
c.	Burst pressure	4.5.27
d.	Simultaneous slosh and vibration	4.5.6
e.	Low temperature leakage	4.5.22

4.3.2.2 Type II tank sampling. Production tanks shall be subjected to the stand test in accordance with 4.5.2. Each part number shall be treated as a separate order in determining the applicable sampling requirement. If failures occur, corrective action shall be taken to correct the discrepancy (see 4.3.2.4). The procuring activity shall establish sampling requirements.

4.3.2.3 Dissection test sampling (Type II and III tanks only). The procuring activity shall specify whether the dissection test is to be a periodic sampling test or a contingency option.

4.3.2.3.1 Dissection test (sampling plan). The dissection test shall be designated as a mandatory sampling test for tanks incorporating newly developed materials or manufacturing processes. For this test, tanks selected at random and at a frequency specified by the procuring activity shall be dissected in accordance with figure 1 and subjected to the dissection test of 4.5.3.

4.3.2.3.2 Dissection test (contingency option). During cell acquisitions in which the dissection test is not required as part of a periodic sampling plan, the procuring activity shall invoke a dissection test as a contingency option in the event that other acceptance tests or service use discloses chronic deficiencies in materials or manufacturing processes (see 4.3.2.4), or when questions regarding the acceptability of tanks cannot be resolved by non-destructive tests. Tanks selected by the procuring activity shall be dissected as shown on figure 1 and tested as required in 4.5.3.

4.3.2.4 Defect investigation and retest. When a defective test sample unit occurs, the procuring activity shall be promptly notified and acceptance of all units after the last group of accepted units shall be withheld until the extent and cause of failure have been determined and corrected. Sampling shall then return to a rate specified by the procuring activity. In the event that chronic deficiencies are disclosed, the contingency option of 4.3.2.3.2 shall be invoked to assist in resolution of the problems.

4.4 General test conditions.

4.4.1 Test fluids. Test fluids used in the design process shall include, but not be limited to, those described in ASTM-D471 (Ref Fuels A and B), and MIL-PRF-680, Type II, JP-5 and JP-8 aviation fuel.

4.4.2 Tank mounting structure.

4.4.2.1 Type II tanks. The mounting structure shall be either the applicable portion of the actual aircraft structure or a simulated structure. If a simulated structure is used, it shall duplicate the shape and dimensions of the tank supporting structure in the aircraft. The preferred structure is an aircraft structure, however, the procuring activity can allow the use of a simulated structure fit for the intended use.

4.4.2.2 Type I and III tanks. The mounting structure shall be either the applicable portion of the actual aircraft structure or a simulated structure. If a simulated structure is used, it shall duplicate the shape, dimensions, and material of the tank supporting structure in the aircraft. The necessary stops, cushions, hangers, and pads, identical with those used in the finished aircraft, for mounting and supporting the tank, shall be provided. The test tank shall be capable of being installed and removed in the mounting structure in an identical manner to that used in the actual aircraft installation.

4.4.3 Support jig. The jig shall support the tank mounting structure as specified in 4.4.2 to simulate the actual aircraft installation. The support jig shall be strong enough to carry the mounted sample tank and designed for bolting to the vibrator and rocker assembly. The jig framework shall be rigid enough to prevent the possibility of additional stresses being imposed on the mounted tank due to flexure of the jig framework.

4.5 Inspection methods.

4.5.1 Examinations.

4.5.1.1 Examination of product. Each cell shall be carefully examined to determine conformance to all the requirements of this specification for which no specific tests are described and to determine conformance with approved manufacturer's material, fabrication, inspection, and applicable drawings.

4.5.1.2 Workmanship. Each cell shall be inspected to determine that the workmanship conforms to MIL-STD-801 unless otherwise specified by the procuring activity.

4.5.1.3 Dimensional check. A check shall be made on each cell to ensure that all dimensions critical to the installation are within the dimensional tolerances. The cell tolerances specified for this test shall not conflict with the capacity requirements specified in 3.5.2.

4.5.1.4 Weight. The weight of each finished tank shall be checked to determine compliance with 3.5.3.

4.5.1.5 Leakage. Tanks shall pass leakage tests acceptable to the procuring activity.

4.5.2 Stand test (sampling). Type II tanks selected in accordance with 4.3.2.2 shall be collapsed and held strapped for 30 minutes in a position comparable to that required for installation in its respective aircraft cavity. The tank shall then be supported and filled with the applicable test fluid as specified in 4.4.1 and stand tested for 15 days or other agreed upon test conditions established with the procuring activity. A brown paper liner in the cavity and a staining agent in the test fluid shall be used for leak detection. A stand pipe shall be used to ensure that all internal surfaces are in contact with fuel. Upon completion of the test, the tank shall be examined for evidence of leakage or other failure.

4.5.3 Dissection test. If utilized, the sectioned portion of each tank selected as specified in 4.3.2.3 shall be examined for defects in accordance with MIL-STD-801.

4.5.4 Capacity. The capacity of the finished tank shall be checked to determine compliance with 3.5.2.

4.5.5 Aging.

4.5.5.1 Tank, normal system (275 °F) (135 °C). The tank shall be filled to its normal level with the test oil specified in 4.4.1 and table IV, and shall stand at 275 °F (135 °C) for 200 hours. At the end of this period, the tank shall show no signs of deterioration or other unsatisfactory condition as a result of the test.

4.5.5.2 Tank, hot oil system (325 °F) (163 °C). The tank shall be filled to its normal level with the test oil specified in 4.4.1 and table IV, and shall stand at 325 °F (163 °C) for 200 hours. At the end of this period, the tank shall show no signs of deterioration or other unsatisfactory condition as a result of the test.

TABLE IV. Test fluid temperature.

Test fluid	Temperature
Fuel	135 ±10 °F (57 ±6 °C)
Oil	275 ±5 °F or 325 ±5 °F (135 ±3 °C or 163 ±3 °C)
Water	Ambient
Water-alcohol	135 ±10 °F (57 ±6 °C)

4.5.6 Simultaneous slosh and vibration. (Mandatory for Types I and III, and Type II, Class C.)

4.5.6.1 Test conditions.

4.5.6.1.1 Vibrator and rocker assembly. These tests shall be conducted on a simultaneous vibrator and rocker assembly acceptable to the procuring activity.

4.5.6.1.2 Vibration speed. Unless otherwise specified by the procuring activity, for testing a tank intended for installation in an aircraft propelled entirely or partially by a reciprocating engine(s), the rotational speed of the eccentric weights shall be 87 to 90 percent of the normal rated crankshaft speed of the engine used. Unless otherwise specified by the procuring activity, for testing all other aircraft tanks, the rotational speed of the eccentric weights shall be 1,940 to 2,000 revolutions per minute.

4.5.6.1.3 Vibration displacement. Unless otherwise specified by the procuring activity, the throw of the eccentric weights on the vibration machine shall be adjusted to produce a total displacement of 0.032 to 0.042 inch, measured at points of inherent rigidity on the tank (such as points along the seams or near mounting points). Where the above frequencies and displacements are not applicable, the tank shall be vibrated at a frequency and displacement specified by the procuring activity.

4.5.6.1.4 Mounting axis. Unless otherwise specified by the procuring activity, the tank shall be mounted in such a manner as to simulate pitching in the actual aircraft. Special fixtures, such as baffles, may also be tested, if applicable, by mounting in another position for a portion of the test time.

4.5.6.1.5 Slosh rocking angle. Unless otherwise specified by the procuring activity, the slosh rocking angle shall be 30 degrees total, approximately 15 degrees on either side of the horizontal position.

4.5.6.1.6 Type I tanks. The test tank, complete with all caps, vents, gages, fittings and other parts or accessories that will be mounted on or in an aircraft, shall be mounted in the support jig and installed on the vibrator and rocker assembly. In addition, all lines attached to the tank in the actual aircraft installation shall be included. The minimum length of these lines shall be that length in the actual aircraft installation from the tank to the first support. (For testing of tanks which incorporate reticulated foam or similar materials, see 4.5.6.1.8.) The test specimen shall be filled two-thirds full with water and simultaneously slosh and vibration tested in accordance with applicable conditions specified in 4.5.6.1. The temperature of the test fluid shall be as specified in table IV. This test shall be conducted with the test specimen subjected to a pressure equivalent to the maximum operating pressure encountered in any prescribed flight conditions. At the conclusion of this test, the test specimen shall be filled with the applicable test fluid and thoroughly inspected for leakage or other evidence of failure such as sagged panels or buckled plates which shall be cause for rejection.

4.5.6.1.7 Type II, Class C and Type III tanks. The test tank, complete with all caps, vents, gages, fittings, and other parts or accessories that will be mounted on or in an aircraft, shall be mounted in the support jig and installed on the vibrator and rocker assembly. In addition, all lines attached to the tank in the actual aircraft installation shall be included. The minimum length of these lines shall be that length in the actual aircraft installation from the tank to the first support. The interior or each compartment shall be completely lined with brown paper and held in place with a suitable adhesive. (For testing the tanks which incorporate reticulated foam or similar materials, see 4.5.6.1.8.) The test specimen shall be filled two-thirds full with the applicable test fluid containing a suitable dye. The tank shall be simultaneously slosh and vibration tested in accordance with the applicable conditions specified in 4.5.6.1. The temperature of the test fluid shall be 135 ±10 °F (57 ±6 °C). This test shall be conducted with the test specimen subjected to a pressure equivalent to the maximum operating pressure encountered in any prescribed flight conditions. At the conclusion of this test, the test specimen shall be filled with the applicable test fluid as specified in 4.4.1 and table IV and thoroughly inspected for leakage or other evidence of failure.

4.5.6.1.8 Special baffling materials. Tanks incorporating reticulated foam or similar materials for fire and explosion protection shall have the material removed during the slosh, vibration, or slosh and vibration tests described herein. If deemed necessary by the procuring activity, a second slosh test with the foam installed shall be conducted.

4.5.6.2 Test duration. Unless otherwise specified by the procuring activity, test duration and procedure shall be:

a. Vibrate for 25 hours at 16 to 20 slosh cycles per minute (cpm); or

b. Vibrate for 25 hours at 10 to 16 slosh cpm with 15 hours of additional slosh at 10 to 16 slosh cpm.

4.5.7 Vibration (Type I and III tanks only). A tank shall be tested in accordance with the procedure specified in 4.5.6.1.6 or 4.5.6.1.7, as applicable, except:

a. The tank shall not be sloshed.

b. The tank shall be completely filled with test fluid.

The tank shall be vibrated for 10 minutes using the applicable test conditions specified.

4.5.8 Slosh.

4.5.8.1 Phase I slosh. A test cube (tank) shall be tested in accordance with the procedure specified in 4.5.6.1.7 except that this cube shall not be subjected to vibration. The cube shall be sloshed for at least 25 hours at 16 to 20 cpm. Type III cubes shall be supported in a manner specified by the contractor or procuring activity. Type II cubes shall be installed in the gun fire test structure with the test structure rigidly mounted to the slosh table. For Type II, Class C cubes, the backing board on the four sides shall be removed so that the sides of the cube are supported by the hat sections of the structure.

4.5.8.2 Phase II slosh (Type II, Class A and B tanks only). A tank shall be tested in accordance with the procedure specified in 4.5.6.1.7 except that the tank shall not be subjected to vibration. The tank shall be sloshed for at least 25 hours at 16 to 20 slosh cpm, or at least 40 hours at 10 to 16 slosh cpm or as specified by the procuring activity.

4.5.9 Stand test (phase I). The stand test shall be conducted on the second test cube. Type II test cubes (tanks) shall be installed in a test structure which has been lined with brown paper. For Class C cubes, the backing board for the four side panels shall be omitted so that the cube is draped across the hat section in this area. Type III cubes shall be covered with brown paper and tested in an unsupported condition. The cubes shall be filled with the applicable test fluid as specified in 4.4.1 and table IV containing a staining agent. After 90 days there shall be no evidence of leakage or other failure. An alternate method of detecting leakage is acceptable, if approved by the procuring activity.

4.5.10 Humidity. Samples of the composite construction, the inner liner ply and the outer ply shall be subjected to a relative humidity of 95 ±2 percent and a minimum temperature of 160 °F (71 °C) for 30 days. The following criteria shall be used to determine durability of the samples following the test:

a. Composite construction – There shall be no corrosion, peeling, cracking, warping, blistering, delamination or discoloration.

b. Inner liner and outer ply samples, allowable change from original properties:

tensile strength	- ±45 percent
elongation	- ±30 percent
shore A hardness	- ±15 percent

4.5.11 Fuel resistance of exterior surfaces. The tank shall be placed in a container large enough to permit immersion to one-half the depth of the cube using JP-8 or JP-5 aviation fuel. The tank shall be immersed for 72 hours at the ambient temperature. The tank shall then be removed and examined. The exterior surface of the tank construction shall show no unsatisfactory swelling, separation, blistering, dissolution, or other deterioration.

4.5.12 Permeability.

4.5.12.1 Test apparatus. The test apparatus shall consist of:

a. A permeability cup and ring constructed as shown on figure 2.

b. A nylon solution to be used for sealing the test disk to the permeability cup.

4.5.12.2 Preparation of test specimen. The test samples shall be prepared utilizing a manufacturing method similar to production and shall be given a cure equivalent to that used in production. Two test samples consisting of the inner liner and fuel barrier (if required) or the total construction shall be used. The samples shall be conditioned 24 hours at 77 ±5 °F (25 ±3 °C) and a relative humidity of 50-65 percent prior to test. A nylon solution or other suitable sealing liquid may be applied to the face of the cup flange and sample edge. The inside or inner liner surface shall be exposed to the fuel.

4.5.12.3 Method of conducting test. Permeability cups prepared as specified in 4.5.12.2, shall be placed in a rack at a constant temperature of 77 ±5 °F (25 ±3 °C) and relative humidity of 50-65 percent. After allowing 1 hour for equilibrium, the cup shall be weighed to the nearest 0.005 gram and placed in the rack with the face of the cup facing upward. The cup shall be kept at the above constant temperature for 24 hours, then weighed to check for seal integrity. If necessary, the bolts shall be retorqued at this weighing and at subsequent weighings. The cup shall be inverted (test disk down) in a rack that permits free access of air to test disk. Cups shall be weighed at the end of the third, fifth, and eight day after inverting. Defective films or leaks caused by faulty assembly will usually be found when making the weighing on the third day. The diffusion rate calculation shall be made on the fifth- to the eighth-day period and expressed as fluid ounces per square foot per 24 hours. The permeability shall be less than 0.025 fluid ounce per square foot per 24 hours for each sample tested.

NOTE: Diffusion expressed in fluid ounces per square foot per 24 hours equals the gram loss of the test specimen per 24 hours multiplied by a factor K which is defined as:

$$K = \frac{144}{(sp.gr.)(29.573)(3.142)R^2}$$

Where sp.gr. = Specific gravity of test fluid at 77 °F (25 °C).
R = Inside radius of test cup expressed in inches.

Alternate test methods may be used if approved by the procuring activity. A test apparatus utilizing a grooved mounting flange with mating head in the retainer ring has been found to yield more consistent results for some materials.

4.5.13 Fuel contamination.

4.5.13.1 Non-volatile gum residue. A 5-gram sample of the inner layers, up to the barrier, shall be cut up into approximately 0.062 inch squares and placed in a flask containing 250 milliliter (ml) of test fuel conforming to ASTM-D471 Ref Fuel B, and allowed to stand for 48 hours at 77 ±5 °F (25 ±3 °C). The contaminated test fuel shall be decanted off and the non-volatile gum residue determined by FED-STD-791, Method 3302, and ASTM-D381 except that the total evaporation time shall be 45 minutes. The non-volatile material shall be not greater than 60 milligrams (mg) per 100 ml of the contaminated fuel.

4.5.13.2 Stoved gum residue. The beakers containing the non-volatile material shall be placed in an appropriate bath maintained constantly at a temperature of 572 ±9 °F (300 ±5 °C) for 30 minutes. After cooling in a closed container, the beakers shall be weighed. The stoved gum residue shall be not greater than 20 mg per 100 ml of the contaminated fuel, after necessary corrections have been made for preformed gums originally present in the test fuel.

4.5.14 Oil dilution resistance. Tensile and elongation tests, before and after immersion in the oil diluted 30 percent by volume with test fuel conforming to ASTM-D471 Ref Fuel B, shall be made on the inner layer ply in accordance with ASTM-D412. The test specimens shall be immersed for 48 hours at room temperature, 77 ±5 °F (25 ±3 °C). The tensile properties shall be not less than 40 percent from the original values, and the Shore A durometer hardness shall vary no greater than 15 points from the original value.

4.5.15 Inner liner strength.

4.5.15.1 Gum inner liner strength. The tensile strength of the gum inner layer ply, without barrier, shall be determined in accordance with ASTM-D412, before and after immersion in ASTM-D471 Ref Fuel B for 72 hours at a temperature of 135 ±3 °F (57 ±2 °C). The tensile strength shall also be determined before and after immersion in a solution of 25 percent MIL-DTL-85470 inhibitor and 75 percent water, by volume, for 72 hours at a temperature of 135 ±3 °F (57 ±2 °C). The tensile strength reduction shall be reported to the procuring activity. The strength shall be reduced no greater than 50 percent for fuel immersion and 20 percent for water immersion calculated on the basis of the original cross-sectional area.

4.5.15.2 Fabric inner liner strength. The tensile strength of the fabric inner layer ply, without barrier, shall be determined in accordance with FED-STD-191, Method 5100 before and after immersion in ASTM-D471 Ref Fuel B for 72 hours at a temperature of 135 ±3 °F (57 ±2 °C). Also, the tensile strength shall be determined before and after immersion in a solution of 25 percent MIL-DTL-85470 inhibitor and 75 percent water, by volume, for 72 hours at a temperature of 135 ±3 °F (57 ±2 °C). The tensile strength reduction shall be reported to the procuring activity. The tensile strength shall be not less than 20 percent for fuel immersion and 50 percent for water immersion calculated on the basis of the original cross-sectional area.

4.5.16 Seam adhesion (immersion). The seam adhesion of the inner layer ply to itself before and after immersion in ASTM-D471 Ref Fuel B for 72 hours at a temperature of 135 ±3 °F (57 ±2 °C) shall be tested within 4 hours along the length of the seam by the strip-back method, using a jaw separation rate of 2 inches per minute in accordance with ASTM-D413. Where the adhesion of the seam is less than the strength of the material, the adhesion shall be a minimum of 6 pounds per inch.

4.5.16.1 Seam adhesion. Seam adhesions of the inner layer ply to itself shall be tested by cutting a strip of inner layer material 1-inch wide, having a seam made in the same manner as is used in the tanks submitted under 4.2.1.1. This seam shall be perpendicular to and midway in the length of the strip. When a tensile load has been applied parallel to the length of the strip to break the strip, there shall be no failure of the seam.

4.5.17 Puncture resistance. A tank wall shall be fastened in a specimen holder in accordance with figure 3. A piercing instrument with its end conforming to figure 3 shall be forced against the tank wall at approximately the center of the area enclosed by the specimen holder. The travel rate of the piercing instrument shall be not greater than 20 inches per minute. The force required to puncture the tank shall be not less than 15 pounds.

4.5.18 Impact resistance. Mount a 2 x 6 inch strip of class A construction on the hammer wedge with the fuel side or inner liner side of the sample facing out. Center the 2 inch width about the approximate center of the point the hammer will impact the wedge. A line drawn down the center the 6 inch length will assist in locating the sample on the wedge (see figure 4).

a. Raise the hammer pendulum indicator to an appropriate starting mark indicated in inches on the test fixture. Release the hammer and allow the hammer to strike the sample only once. Repeat the process at the same mark 4 times, 5 total, moving the strip each time to allow impact with fresh material.

b. Remove the test strip from the tester. Using a sharp razor blade, slice a cross section through the center of each impact point. Inspect the cross section of each impact point under a microscope to determine the extent of damage. The fail criteria is the breaking of the nylon fuel barrier. Two fail results out of 5 impacts constitute failure of the material at the Damage Tolerance (DT) value tested (inches of hammer travel).

c. Repeat the above process with fresh class A material for increased/decreased distance the hammer travels to determine a pass/fail hammer test DT value for the construction. The DT value for a construction is the greatest hammer travel test that the material passes.

d. Repeat the above processes for Class B construction.

e. Repeat the above processes for conditioned Class A construction.

4.5.19 Gunfire (phase I). Type II, Class B sample cubes (tanks) shall be subjected to gunfire tests when installed in a jig as shown on figure 5. The temperature shall be measured by a thermometer or thermocouple immersed in the test fluid. The test cubes shall be mounted not greater than 75 feet from the gun. All rounds shall be fired at service velocity. All entrance rounds shall be fired into the cube space occupied by the test fluid. A non-metallic yaw plate may be used for tumbled entrances. The following gunfire schedule shall be used.

Round 1: One .50 caliber projectile 90 degrees to the cube surface, ¾-to full tumble.

Round 2: One .50 caliber armor piercing (AP) projectile 45 degrees to the cube surface, straight in, with exit.

Round 3: One 20 millimeter (mm) AP 90 degrees to the cube surface with exit.

4.5.19.1 Gunfire tests. Fuel tanks shall be subjected to normal temperature gunfire tests. Oil tanks shall be subjected only to a normal temperature gunfire test.

4.5.19.1.2 Normal temperature gunfire (fuel tank). The tank shall be filled with water. The temperature of the water at the time of test shall be 50 to 120 °F (10 to 49 °C).

4.5.19.2 Evaluation. Entrance and exit wounds shall be evaluated per the criteria listed below except for the 20 mm AP exit wound.

a. The normal temperature gunfire test shall produce no tear longer than 3 inches measured radially from edge of wound at each entry and exit point.

b. There shall be no tear that does not radiate from the bullet hole that cannot be accounted for by shrapnel or structure.

4.5.20 Handling (phase II) (Type II tanks only). Prior to installation of the tank in the test structure, it shall be folded and unfolded 40 times in accordance with standard procedure for installation. The tank shall then be installed and removed from the test structure, simulated aircraft structure or aircraft structure five times. Applicable installation procedure shall be followed for tank installation and removal. All fittings shall be fastened to corresponding structure and interconnect fittings upon each installation in the test structure. The tanks shall be in a satisfactory condition, in accordance with MIL-STD-801, upon completion of these tests and shall pass the leakage test specified in 4.5.1.5.

4.5.21 Installation. The tank shall be checked in the applicable test structure, simulated aircraft structure or aircraft structure. The location of all fittings and the tank dimensions shall be within the allowable tolerances in accordance with MIL-STD-801.

4.5.22 Low temperature leakage.

4.5.22.1 Type I, II and III fuel and oil tanks. The procedure specified herein shall be used for Type I, II and III fuel and oil tanks, after the testing specified in simultaneous slosh and vibration (see 4.5.6). The tank shall be emptied and the interior of the cavity in which the tank is installed shall be lined with brown paper, except for Type I tanks which shall, instead, have all joints, seams, and fittings covered with brown paper to aid in determining leakage.

a. 135 °F (57 °C) soak: If the fitting installations were not disassembled at the conclusion of the test specified in 4.6.6, the soak time during the slosh and vibration test may be considered as part of this soak period. The tank shall be completely filled with applicable fluid containing a satisfactory staining agent and allowed to stand for 7 days at 135 ±10 °F (57 ±5 °C). Fuel tanks shall be filled with JP-8 or JP-5 aviation fuel; oil tanks shall be filled with the oil to be used in the service aircraft, except oil tanks employed in aircraft using an oil dilution system, where 30 percent by volume of ASTM-D471 Ref Fuel B shall be added to the oil.

b. 155 °F (68 °C) air dryout: The tank shall then be emptied and subject to an air dryout at 155 ±5 °F (68 ±3 °C) for 7 days.

c. -65 °F (-54 °C) soak: The tank shall then be completely refilled with the applicable fluid containing a satisfactory staining agent, cooled to -65 ±5 °F (-54 ±3 °C) and allowed to remain at this temperature a minimum of 3 days. The test fluid in contact with the inner liner and fittings shall have reached -65 °F (54 °C) prior to the 3-day period. The tank shall be instrumented to monitor the temperature of the fuel in the tank. For fuel tanks, the test fluid shall be JP-5 or JP-8 aviation fuel; for oil tanks, the fluid shall be the oil used in the service aircraft, except for oil tanks employed in an aircraft using an oil dilution system where 30 percent of ASTM-D471 Ref Fuel A shall be added to the oil.

d. The tank shall then be brought back to room temperature, drained, and examined internally and externally for any unsatisfactory conditions or indications of fluid leakage.

4.5.22.2 Type I, II, and III water alcohol tanks. The procedure specified herein shall be used for Type I, II and III water alcohol tanks after the testing specified in 4.5.6. The tank shall be emptied and the interior of the cavity in which the tank is installed shall be completely lined with brown paper, except for Type I tanks which shall, instead, have all joints, seams, and fittings covered with brown paper to aid in determining leakage.

a. 135 °F (57 °C) soak: The tank shall be refilled with the applicable test fluid specified in 4.4.1, containing a satisfactory staining agent, and allowed to stand for a period of 7 days at a temperature of 135 ±10 °F (57 ±5 °C).

b. 155 °F (68 °C) air dryout: The tank shall then be emptied and subject to an air dryout at 155 ±5 °F (68 ±3 °C) for 7 days.

c. -65 °F (-54 °C) soak: Following the air dryout, the empty tank shall be cooled to a temperature of -65 ±5 °F (-54 ±3 °C) and allowed to remain at this temperature a minimum of 3 days.

d. -15 °F (-9 °C) soak: The tank shall then be filled with the applicable test fluid specified in 4.4.1 and table IV, containing a satisfactory staining agent, cooled to a temperature of -15 ±5 °F(-9 ±3 °C) and allowed to remain at this temperature a minimum of 3 days. The outside layer of water alcohol shall have reached -15 °F (-9 °C) prior to start of the 3-day period.

e. The tank shall then be drained and examined externally and internally for any unsatisfactory conditions or indications of fluid leakage.

4.5.23 Stand test (phase II). Upon completion of the low temperature leakage test (4.5.22) for Type II tanks, the cavity shall be completely lined with brown paper. For Type III tanks, the tanks shall be prepared as specified by the procuring activity for the detection of leakage. The tank shall be emptied and refilled with the JP-5 or JP-8 aviation fuel, as specified in 4.4.1 and table IV, containing a satisfactory staining agent. The tank shall be allowed to stand at ambient temperature for a period of 30 days at which time the tank shall be drained and examined for any unsatisfactory condition or indication of fluid leakage. All joints, seams, and fittings shall be covered with brown paper to aid in determining leakage. An alternate method of detecting leakage during this test is acceptable, if approved by the procuring activity.

4.5.24 Gunfire (phase II). Only Type II, class B tanks that are greater than 150 gallons in capacity shall undergo the phase II gunfire test. For this test, the tank shall be mounted in the actual structure for which it is designed. The tank shall then be filled three-fourths-full with water. The number of rounds of .50 caliber AP ammunition to be fired shall be determined on the basis of one round for each 30 gallons of tank capacity up to a maximum of 6 rounds in which four shall be tumbled and two shall be straight in. In addition to the .50 caliber gunfire, one round of 20 mm AP shall be fired. All shots shall be so placed as to be compatible with the aircraft installation. There shall be no tear longer than 3 inches measured radially from edge of wound at each entry and exit point. No bursts shall be fired and the test shall be conducted at ambient temperatures. Any resulting tears shall be evaluated per 4.5.19.2.a and b except for the 20 mm AP exit wound.

4.5.25 Accelerated loads test. The tank assembly, consisting of the tank and tank structure shall be mounted in a support jig that provides support equivalent to the aircraft structure for which it is designed and subjected to the applicable dynamic load tests specified herein to simulate the aircraft design accelerations including the appropriate magnification factors. The tank shall be tested at a fill level of 75 percent of the rated capacity. Tanks of pressurized systems shall be subjected to the normal operating pressures for the condition being tested, except where unpressurized conditions are considered more critical. Deflections on various parts of the tank structure including the areas surrounding components within the cell shall be measured during the test.

4.5.25.1 Accelerated loads test to design limit load. The tank assembly shall be subjected to 100 percent design limit accelerations at the 75 percent fill level and applicable pressure to determine the most critical condition. There shall be no evidence of failure, leakage or chaffing of the cell or components. Further, the deflection of the cell shall be such that there will be no contact with the tank or aircraft component.

4.5.25.2 Accelerated loads test to design ultimate load. The tank assembly shall be subjected to one application of load at 150 percent of the design limit load at the most critical condition. There shall be no evidence of failure, leakage, or deflection that contacts the tank or aircraft components.

4.5.25.3 Accelerated loads test of carrier based aircraft to design limit load. Following the test of 4.5.25.1 and prior to the test of 4.5.25.2, the tank assembly shall be subjected to 100 percent design limit accelerations simulating catapult launched and arrested landings at the specified fill levels and pressurized conditions to determine the most critical catapult launch and arrested landing condition. The tank shall be subjected to load application(s) at the critical catapult launch condition and load application(s) at the critical arrested landing condition as directed by the procuring activity. There shall be no evidence of failure, leakage or chaffing of the cell or components. Further, the deflection of the cell shall be such that there will be no contact with the tank or aircraft components.

4.5.25.4 Accelerated load tests of carrier based aircraft to design ultimate load. The tank assembly shall be subjected to one application of load at 150 percent of the design limit load at both the most critical catapult launch and the most critical arrested landing condition. There shall be no evidence of failure, leakage or deflection that contacts the tank or aircraft components.

4.5.26 Proof pressure. After all air has been bled from the tank and the necessary ports plugged, hydrostatic pressure equal to 1.33 times the maximum operating pressure shall be applied to the sample tank and held for a minimum of 2 minutes. Any evidence of permanent set, distortion, or failure of any kind is cause for rejection. Water may be used for this test.

4.5.27 Burst pressure (Type II and III tanks). All air shall be bled from the tank and the necessary ports plugged. Hydrostatic pressure shall then be applied to the tank. This pressure shall be at least 2.0 times the maximum operating pressure. Evidence of permanent set or distortion shall be permitted, but any evidence of rupture is cause for rejection. Water may be used for this test.

4.5.28 Fitting tests.

4.5.28.1 Insert tests. Six inserts shall be used for each of the following tests. These tests may be conducted on fitting rings other than those used in tests specified in 4.5.28.2 and 4.5.28.3.

4.5.28.1.1 Bottoming. A bolt of sufficient threaded length to prevent shanking shall be lubricated with JP-5 or JP-8 aviation fuel and engaged with the insert until the bottom of the bolt is in contact with the bottom of the insert or tapped hole. The maximum allowable torque as specified in table I shall be applied to the bolt. The bolt shall then be removed and the insert and fitting shall be inspected for damage. Any evidence of damage to the insert or fitting or any rotation of the insert constitutes failure.

4.5.28.1.2 Shanking. A bolt with the threaded length short enough to prevent bottoming, shall be shanked out against the top thread of the insert and the maximum allowable torque as specified in table I applied. The insert shall not pull out nor rotate, and there shall be no damage to the insert threads.

4.5.28.1.3 Insert pull out. The insert shall be bridged by washers or other spacers in such a manner that an extracting force will be exerted on the insert when a bolt is inserted and tightened. The thickness of the spacer in relation to the bolt shall permit engagement of the bolt with the insert to a depth of approximately 1 bolt diameter. The bolt shall be tightened to the maximum allowable torque specified in table I. The insert shall not pull out nor rotate, and there shall be no damage to the insert threads.

4.5.28.1.4 Endurance (self locking inserts only). For this test a bolt length shall be selected that will permit engagement of the bolt with the insert to a depth approximately equal to that for an actual aircraft installation. The bolt shall be installed and removed 50 times. At the beginning and at the end of the test, the torque values shall comply with table I.

4.5.28.2 Fluid resistance and extreme temperature. Two fitting assemblies for each basic design used in the tank being qualified shall be built into panels of the same construction as the tanks mounted in a vibration jig conforming to figure 6 and subjected to the fuel resistance and extreme temperature test as specified in tables V and VI. Brown paper or talc shall be used for the determination of fitting leakage. There shall be no visual evidence of deterioration, delamination or leakage. The panel may be reinforced with a fabric collar in the area of the clamping ring.

TABLE V. Fluid resistance of fittings (type II and III fuel tanks).

Cycle	Test Fluid	Temperature	Gage Pressure	Time	Vibration	Instructions
1	ASTM-D471 (Ref Fuel B)	+135 °F (+57 °C)	0	3 days	No	At beginning of test, fitting shall be torqued to installation torque. Retorquing shall not be permitted.
2	Air	+158 ±2 °F (+70 ±1 °C)	0	1 day	No	
3	ASTM-D471 (Ref Fuel B)	+135 °F (+57 °C)	1/	3 days	No	
4	Dry Air	+158 ±2 °F (+70 ± °C)	0	20 hours	No	
5	JP-4	Room	1/	1 day	No	
6	Dry Air	+158 ±2 °F (+70 ±1 °C)	0	120 hours	Yes	Vibrate for first 24 hours.
7	ASTM-D471 (Ref Fuel A)	-65 °F (-54 °C)	0	24 hours	No	
8	ASTM-D471 (Ref Fuel A)	-65 °F (-54 °C)	1/	48 hours	Yes	Vibrate for last 24 hours only.

1/ Proof pressure as defined by contract.

TABLE VI. Fluid resistance of fittings (type II and III oil tanks).

Cycle	Test Fluid	Temperature Normal	Temperature High Temp	Gage Pressure	Time	Vibration	Instructions
1	ASTM-D471 (IRM 901)	+215 °F (+102 °C)	+275 °F (+135 °C)	0	3 days	No	At beginning of test, fitting shall be torqued to installation torque. Retorquing shall not be permitted.
2	Air	+158 ±2 °F (+70 ±1 °C)	+158 ±2 °F (+70 ±1 °C)	0	1 day	No	
3	ASTM-D471 (IRM 901)	+215 °F (+102 °C)	+275 °F (+135 °C)	2/	3 days	No	
4	Dry Air	+158 ±2 °F (+70 ±1 °C)	+158 ±2 °F (+70 ±1 °C)	0	20 hours	No	
5	1/	Room	Room	2/	1 day	No	
6	Dry Air	+15 ±2 °F +70 ±1 °C)	+158 ±2 °F (+70 ±1 °C)	0	120 hours	Yes	Vibrate for first 24 hours only.
7	1/	-65 °F (-54 °C)	-65 °F (-54 °C)	0	24 hours	No	
8	1/	-65 °F (-54 °C)	-65 °F (-54 °C)	2/	48 hours	Yes	Vibrate for last 24 hours only.

1/ ASTM-D471 (IRM 901) diluted 40 percent with ASTM-D471 Ref Fuel A.
2/ Proof pressure as defined by contract.

4.5.28.3 Fitting pull-out test. A fitting shall be built into a flat panel that will sustain at least 190 pounds per linear inch. The system shall be mounted in a test jig and subjected to a tension load at the rate of 2 inches per minute. There shall be a minimum pull value of 190 pounds per inch of metal fitting circumference (based on the outside diameter). The test setup shall be similar to figure 7. There shall be no failure of any portion of the fitting or its means of attachment to the flat panel.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's systems commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Removable internal, non-self-sealing tanks are intended for use in aircraft as a means for carrying engine fluids such as oil, fuel, cooling fluids, or water injection fluids. Tank requirements are intentionally rigorous for military aircraft.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.

b. Name of tank manufacturer.

c. Part number, type, class of tank and fluid desired (see 1.2 and 4.4.1).

d. Model designation of the aircraft.

e. When first article is required (see 3.2).

f. Statement indicating if dissection test is to be imposed as a sampling test or as a contingency option (see 4.3.2.3).

6.3 First article. When a first article inspection is required, the item(s) should be a first article sample. The procuring activity should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitation for bids should provide that the procuring activity reserves the right to waive the requirements for first article inspection to those bidders offering a product which has been previously acquired or tested by the procuring activity, and that bidders offering such products, who wish to rely on such products or tests, must furnish evidence with the bid that prior procuring activity approval is acceptable for the pending contract. Information pertaining to first article inspection may be obtained from Commander, Naval Air Systems Command, Code 4.3.5.3, 48110 Shaw Road, Bldg. 2187, Patuxtent River, MD 20670-5304.

6.4 Definitions. For purposes of this specification, the following definitions are applicable.

6.4.1 Approved construction. Construction that has been granted phase I first article test approval and consists of a specified combination of materials, material arrangements, and manufacturing methods (mold/mandrel, joint designs, and other necessary techniques) that have been successfully demonstrated during phase I first article tests. Any change to qualified approved construction must be submitted to the procuring activity for approval.

6.4.2 Brown paper. Paper used to identify fuel leaks during tests.

6.4.3 Construction. This term means a specified combination of materials, material arrangements, and manufacturing methods (mold/mandrel, joint designs, and other necessary included techniques).

6.4.4 Contractor. This term refers to the aircraft contractor.

6.4.5 Manufacturer. This term and the terms tank manufacturer and supplier are used interchangeably to indicate the particular plant where the tank is manufactured.

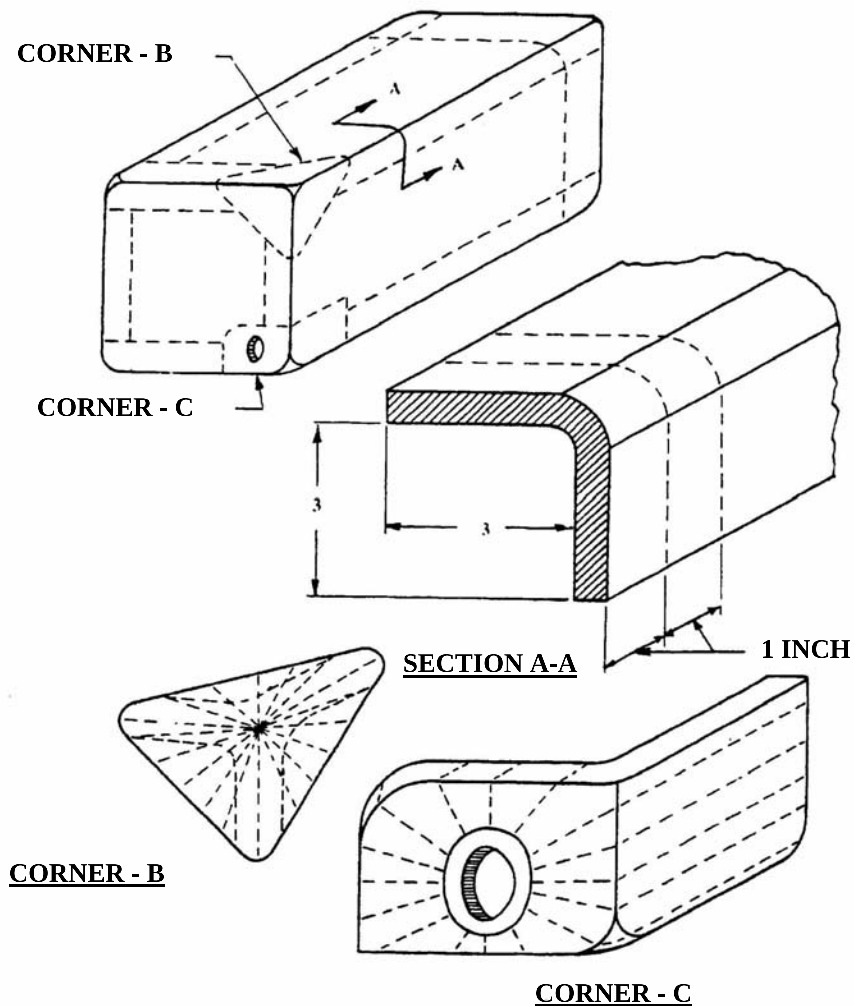
6.4.6 Procuring activity. This term means the United States Government or any of its agencies, and original equipment manufacturers or any other party that chooses to procure to the requirements set forth in this specification. Also this term refers to any acquisition activity.

6.4.7 Tank. A tank consists of a fuel cell or fuel bladder (referred to herein as “cell(s)”) or a group of interconnected cells, and the components attached directly thereto, to form a complete tank or reservoir.

6.5 Subject term (key word) listing.

Dissimilar
Flexible
Hydrostatic
Reservoir
Volume

6.6 Changes from previous issues. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.



DIMENSIONS IN INCHES.
CUT ON DOTTED LINES.

FIGURE 1. Location of cuts for dissection sample.

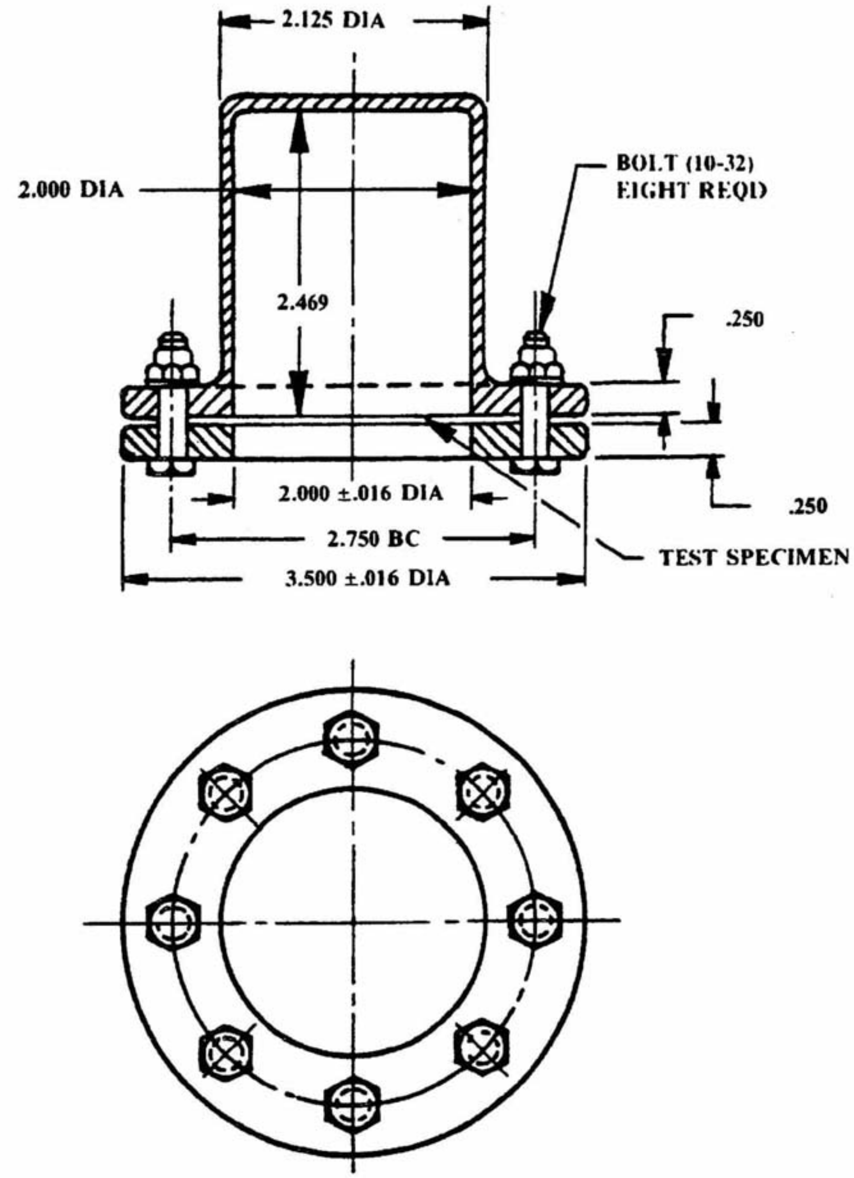
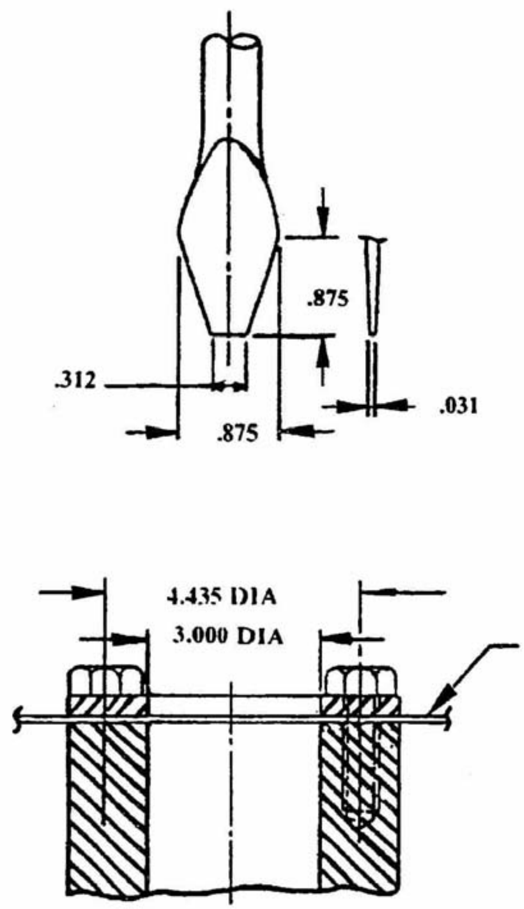
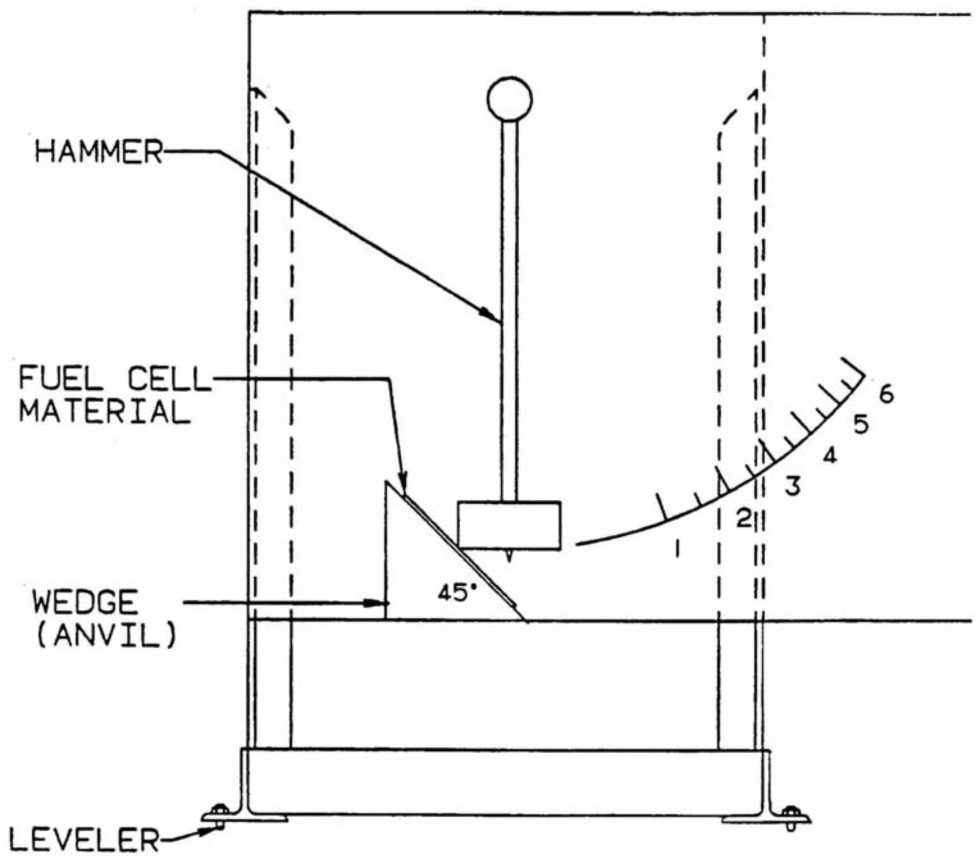


FIGURE 2. Permeability cup assembly.



DIMENSIONS IN INCHES.

FIGURE 3. Piercing instrument and specimen holder.



Minimum Allowable DT Values
Unconditioned Class A = 4in Hammer Freefall
Unconditioned Class B = 6in Hammer Freefall

Conditioned Class A = 1.5in Hammer Freefall

(Details of Test Fixture to be Furnished by Contractor)

FIGURE 4. Hammer impact tester.

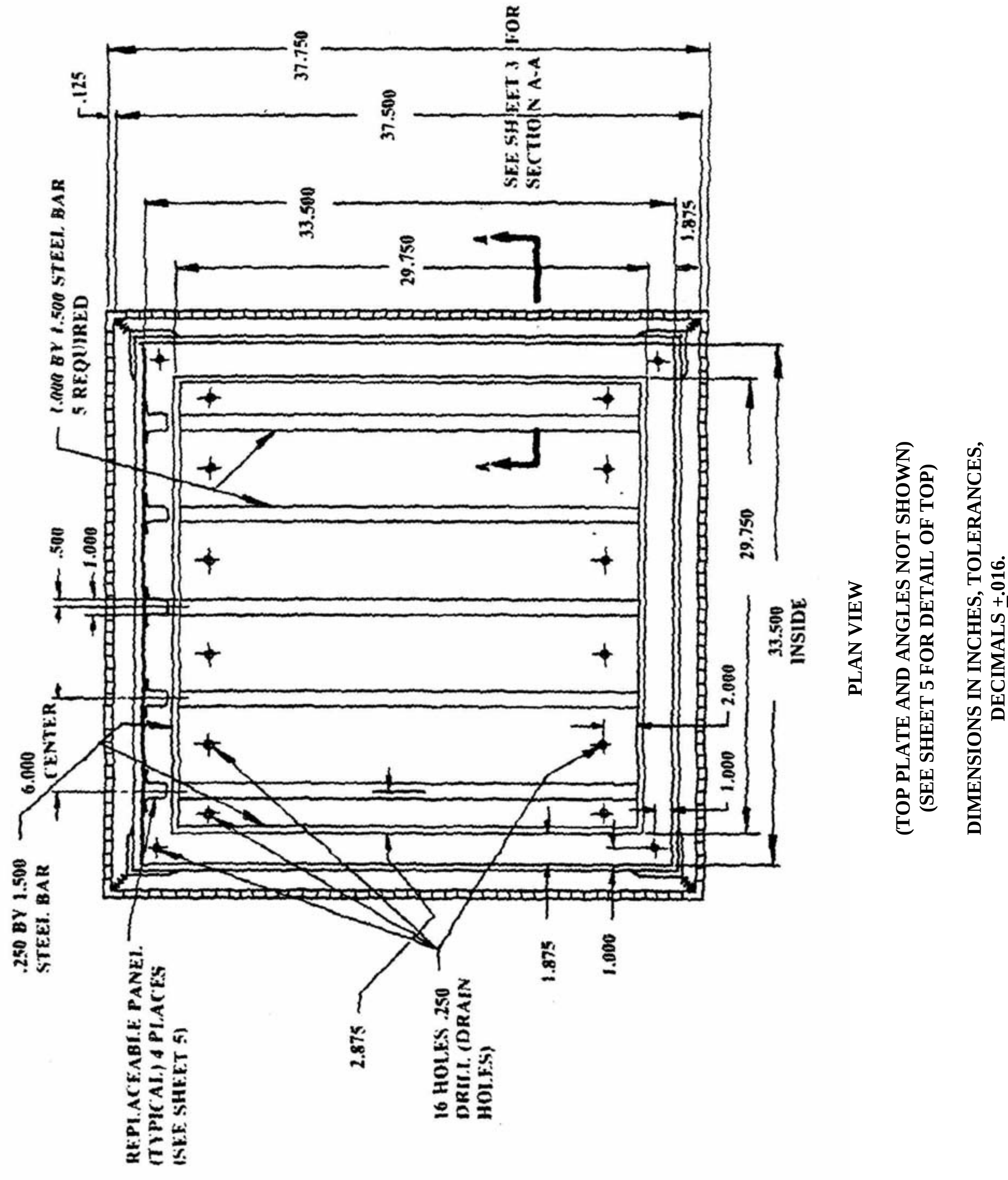


FIGURE 5. Gunfire test structure (sheet 1 of 5).

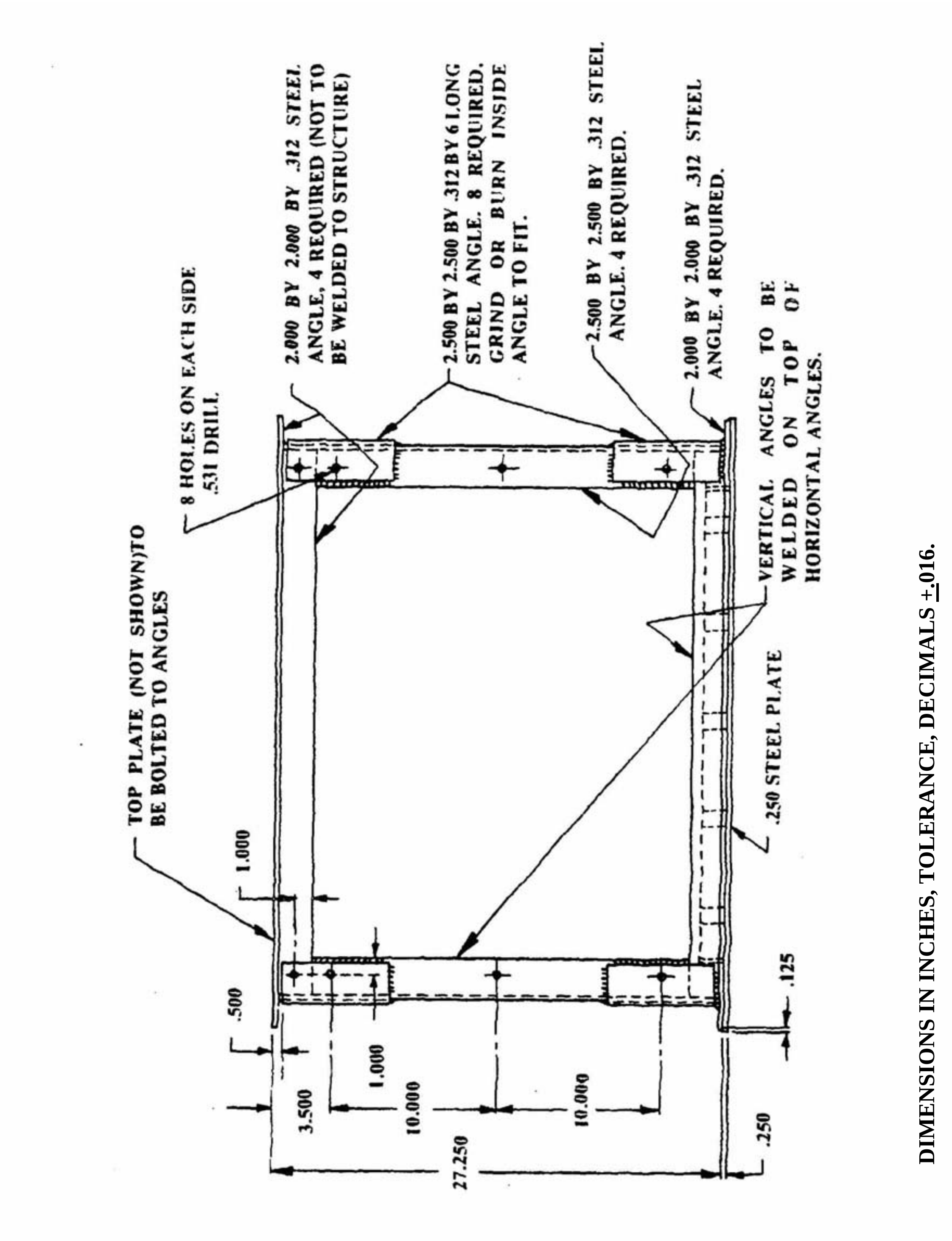


FIGURE 5. Gunfire test structure (sheet 2 of 5) - Continued.

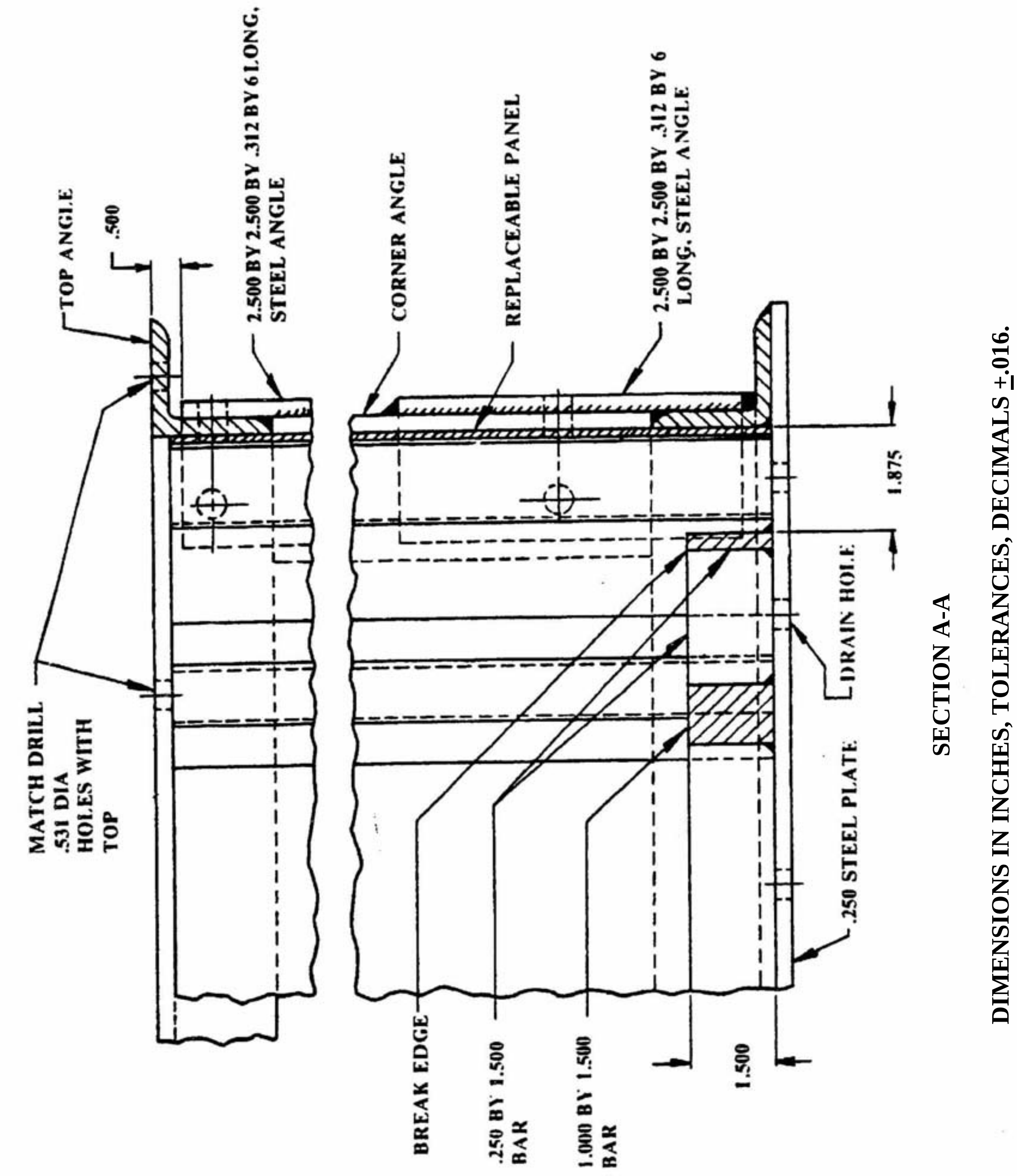


FIGURE 5. Gunfire test structure (sheet 3 of 5) - Continued.

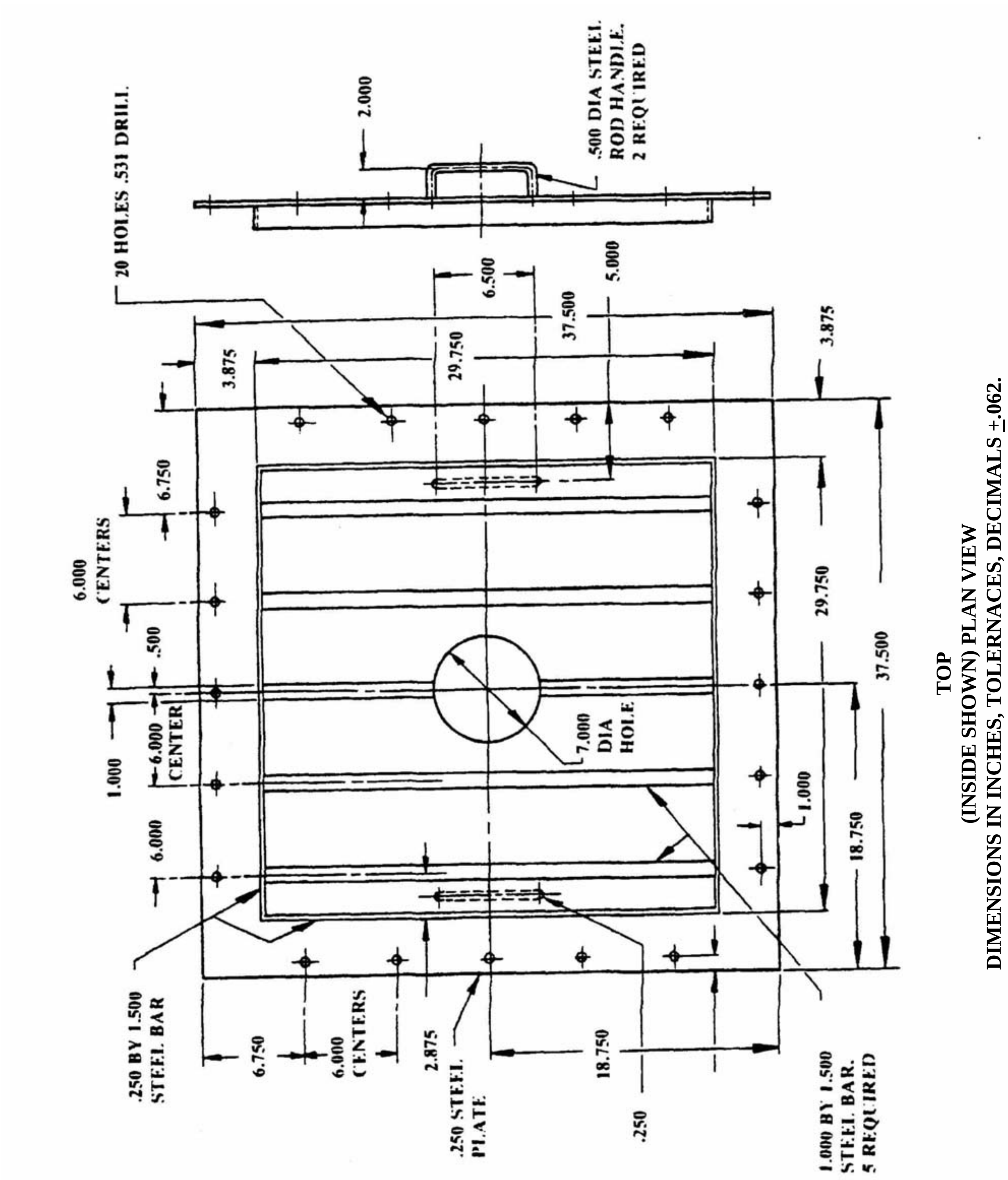
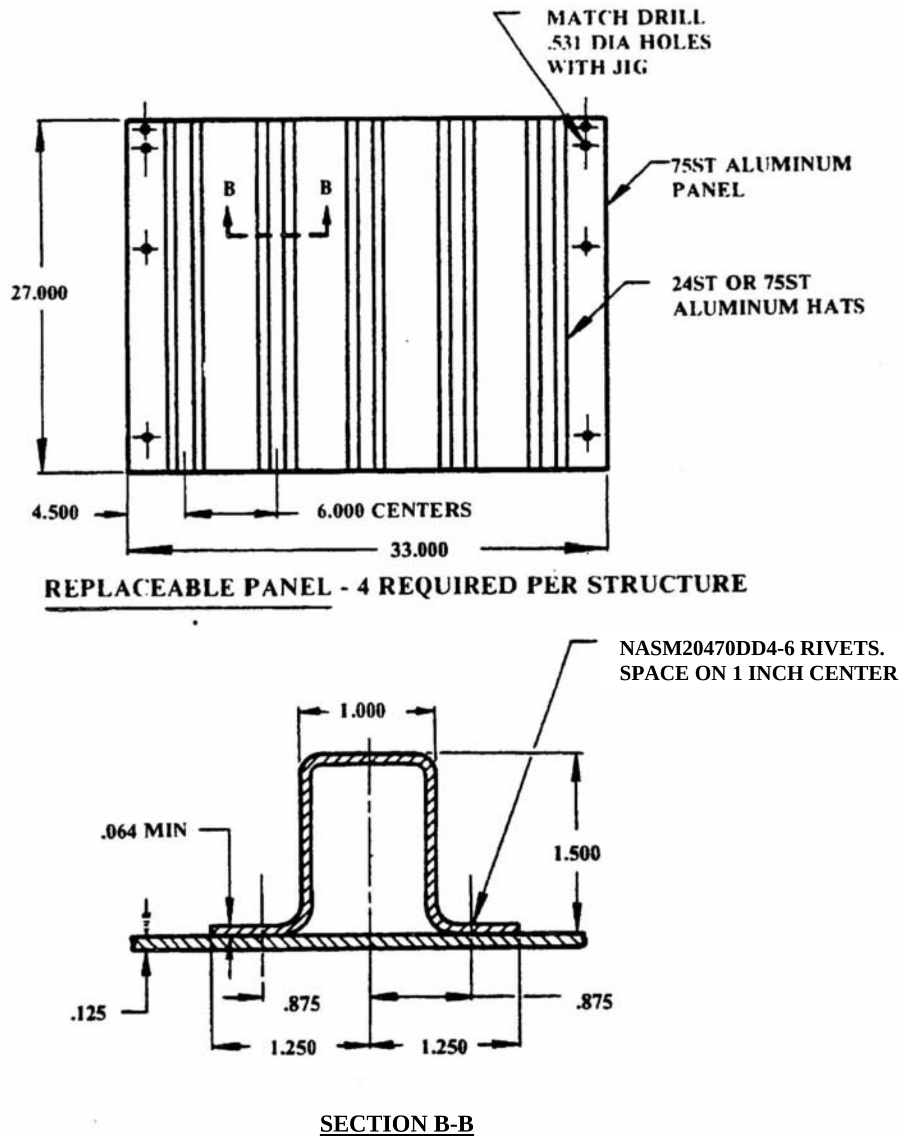


FIGURE 5. Gunfire test structure (sheet 4 of 5) - Continued.



DIMENSIONS IN INCHES, TOLERANCES, DECIMALS +.062.

FIGURE 5. Gunfire test structure (sheet 5 of 5) - Continued.

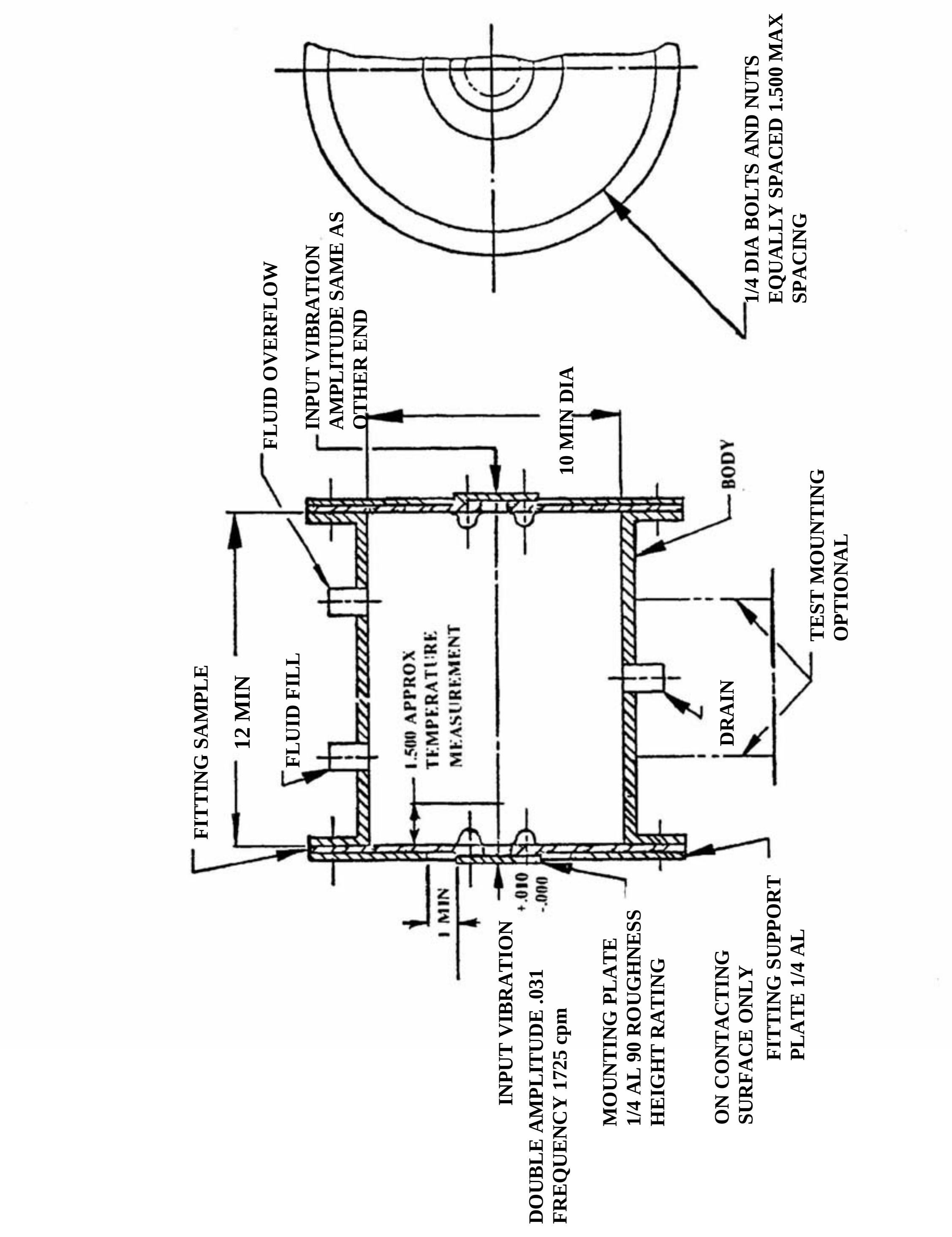


FIGURE 6. Vibration test setup.

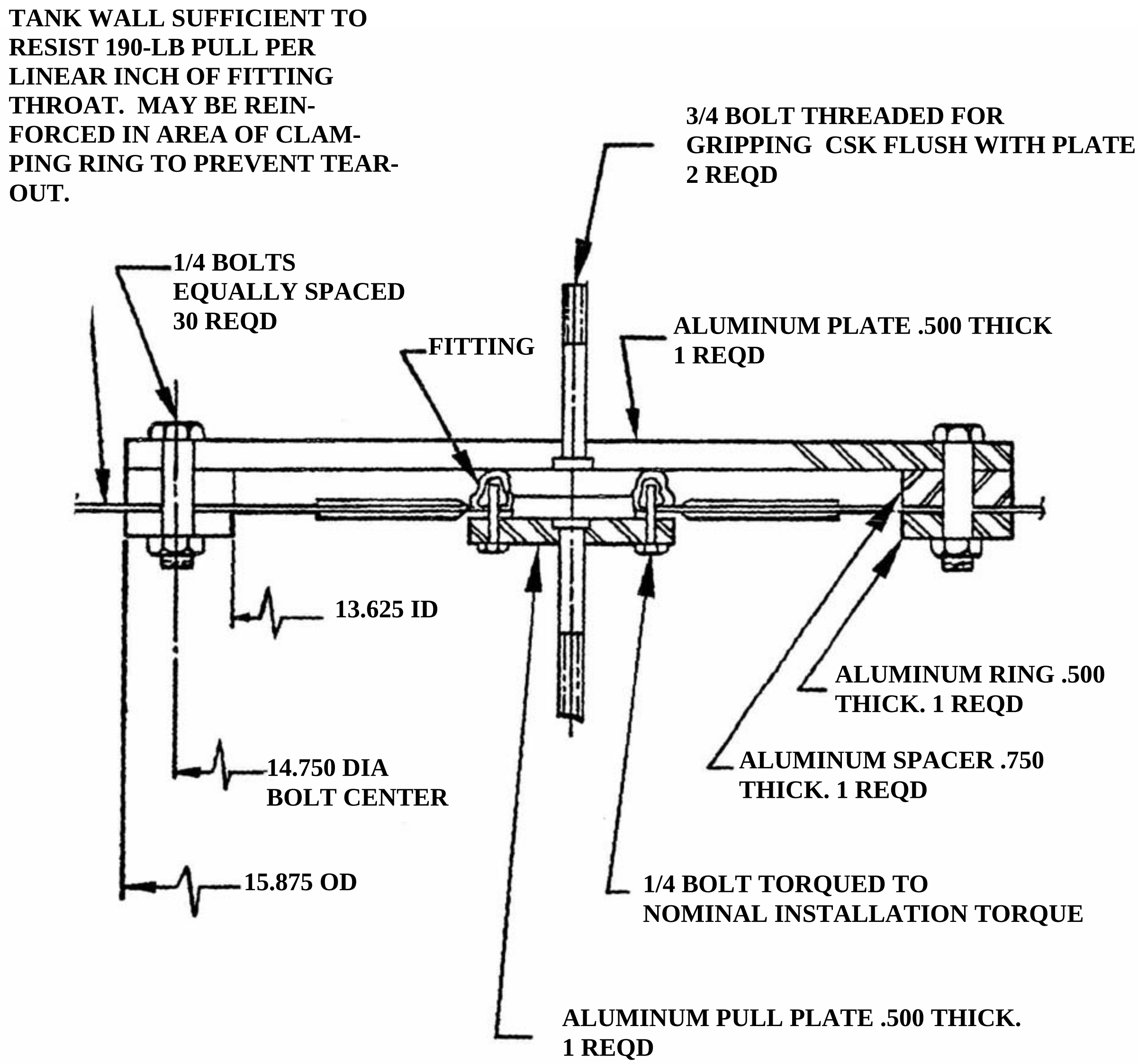


FIGURE 7. Fitting pullout test setup.

CONCLUDING MATERIAL

Custodians:
Army - AV
Navy - AS
Air Force - 99

Preparing activity:
Navy - AS
(Project 1560-0030)

Review activities:
Army - CR4
Air Force - 71
DLA - GS

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil/.