TECHNICAL REQUIREMENTS

FOR

COLLAPSIBLE FABRIC STORAGE TANKS

(BLADDERS)

ENVIRONMENT CANADA

December 17, 2009

TABLE OF CONTENTS

TABLE OF CONTENTS

INTRODUCTION

On June 12, 2008, Environment Canada registered the *Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations*. The Regulations came into force on the date that they were registered. The purpose of the Regulations is to reduce the risk of soil and groundwater contamination due to spills and leaks of petroleum products and allied petroleum products from storage tank systems.

The Regulations set forth requirements for the design and construction of storage tank systems installed on or after the day the Regulations came into force. One requirement is that storage tanks must be designed and built to one of the recognized standards identified in the Regulations.

The Regulations cover storage tank systems that are designed to be installed in a fixed location. Although there is no recognized standard available for the design and construction of collapsible fabric storage tanks, Environment Canada recognizes these storage tanks as a legitimate option for storing petroleum products and allied petroleum products. As such, Environment Canada is publishing these Technical Requirements until a recognized standard is developed to replace them.

These Technical Requirements cover minimum requirements for design and construction of a collapsible fabric storage tank that is used for the aboveground storage of petroleum products and allied petroleum products up to and including a capacity of 125,000 L. Installations that have storage tank systems built around collapsible fabric storage tanks will be required to meet all applicable sections of the Regulations.

TECHNICAL REQUIREMENTS FOR COLLAPSIBLE FABRIC STORAGE TANKS (BLADDERS)

1. SCOPE

1.1 These Technical Requirements provide minimum requirements for collapsible fabric storage tanks ("bladders") intended for the above-ground storage of petroleum products and allied petroleum products with a relative density not greater than 1.

1.2 These Technical Requirements cover the fabrication of bladders for use in a fixed location. Bladders fabricated in accordance with these Technical Requirements are not intended for the transportation of product nor are they intended to be transported while containing product.

1.3 These Technical Requirements cover bladders which are fabricated, inspected and tested for leakage before shipment from the factory.

1.4 These Technical Requirements cover bladders that are shop-fabricated from reinforced coated fabrics or polymer films laminated onto textile substrates.

1.5 These Technical Requirements cover the design and performance of bladders having a capacity not greater than 125 000 L.

2. DEFINITIONS

2.1 "**Above-ground tank**" means a tank that operates at atmospheric pressure and that has all of its volume either above-grade or encased within an unfilled secondary containment.

2.2 "**Permeability**" is the rate of liquid transmission through a unit area and unit thickness of flat material, induced by a pressure difference (static head) between two specific surfaces, under specified temperature and humidity conditions. Expressed as $g/h/m^2/mm$.

2.3 "**Permeance**" is the rate of liquid transmission through a unit area of flat material induced by a pressure difference (static head) between two specific surfaces, under specified temperature and humidity conditions. Expressed as $g/h/m^2$.

2.4 “**Radio frequency welding**” is the method of welding thermoplastics using electromagnetic energy to generate the necessary heat and bond two parts together under pressure.

2.5 “**Secondary containment**” means containment that prevents liquids that leak from a storage tank system from reaching outside the containment area.

2.6 “**Substrate (scrim)**” is a woven, open-mesh, reinforced fabric made from continuous filament yarn.

2.7 “**Thermoplastics (thermoplastic materials)**” are polymeric materials that can be repeatedly heated to their softening point. These materials harden when cooled. This action of heating and cooling can be repeated several times without any significant change in the properties of the material.

Table 1 – Reference Documents

Document Number	Edition	Title of Document
ASTM D814	95(2005)	Standard Test Method for Rubber Property – Vapour Transmission of Volatile Liquids
ASTM D471	06	Standard Test Method for Rubber Property – Effect of Liquid
ASTM D751	06	Standard Test Methods for Coated Fabrics
ASTM D2136	02(2007)	Standard Test Method for Coated Fabrics – Low-Temperature Bend Test
ASTM D2565	99(2008)	Standard Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications
ASTM G154	06	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Non-metallic Materials
ANSI/ASME B1.20.1	1983 (R2006)	Pipe Treads – General Purpose (Inch)

3. CONSTRUCTION

3.1 CAPACITY

3.1.1 A bladder shall have a capacity no greater than 125 000 L.

3.1.2 When a nominal capacity of a bladder manufactured in accordance with these requirements is specified, the actual capacity shall be not less than the nominal capacity but not greater than the nominal capacity plus 2.5%.

3.1.3 As product is withdrawn, a bladder shall collapse so that there is no vapour space.

3.2 MATERIALS

3.2.1 The material property of the bladder shall be designed to provide continued use under the conditions expected to be encountered in the installed environment.

3.2.2 Materials that may be immersed in, or exposed to, petroleum products and allied products, or their vapours, shall have properties that will not be affected by such exposure in a manner that may cause a physical failure of the bladder or a hazardous condition during the life of the bladder.

3.2.3 A bladder shall be manufactured from a polymer fabric that consists of substrate (scrim) and topcoat:

3.2.3.1 The topcoat and substrate must be made of material that is compatible with the petroleum products and allied products being stored.

3.2.3.2 The topcoat and substrate must be able to provide continuous use under the conditions expected to be encountered at the installation site.

3.2.3.3 The topcoat must consist of a double layer of coating applied in two passes on the interior of the bladder.

3.2.4 The polymer fabric shall have a minimum tensile strength of 2000 N (787 N per cm width) when tested in accordance with ASTM D751.

3.3 WELDING

3.3.1 All seams shall be radio-frequency welded by high-frequency dielectric equipment.

3.3.2 All welding shall be done by trained individuals.

3.4 SEAMS

3.4.1 All seams shall provide a permanent bond and shall exhibit characteristics equivalent to the polymer fabric itself.

3.4.2 All seams shall be radio-frequency welded, complete with top and bottom cap strips, and body panels shall be segregated.

3.4.3 Exposed substrate along top and bottom cap strips shall be sealed inside and outside the bladder.

3.5 CORNERS

3.5.1 Corners shall be designed in accordance with good engineering practice to ensure that structural bladder integrity is maintained.

3.5.2 Corners shall be protected from abrasion.

3.6 FITTINGS

3.6.1 All fittings shall be leak-tight stainless steel flanges. If threaded fittings are used, the minimum thread length shall be in accordance with ANSI/ASME B1.20.1, Table 2.

3.6.2 All fittings shall have reinforcement patches, made of the same polymer fabric of the bladder, attached to the tank by high-frequency dielectric welding.

3.6.3 Seaming techniques and methods used to join polymer fabric to the fittings shall be such that bladder integrity is maintained.

3.6.4 All fittings shall have a design pressure of 1035 kPa (gauge) (150 psi).

3.6.5 A minimum of two fittings shall be provided on the top surface of all bladders having a capacity of 2000 L or less:

- 38 mm vent fitting
- 38 mm or 50 mm fill/drain fitting

3.6.6 A minimum of two fittings shall be provided on the top surface of all bladders having a capacity of more than 2000 L:

- 50 mm vent fitting
- 50 mm or 75 mm fill/drain fitting

3.6.7 Only one fitting may be provided below liquid level.

3.6.7.1 If this fitting is provided, it may only be used for draining the bladder when the bladder is being withdrawn from service and removed.

3.6.7.2 This fitting shall be resistant to the product that the bladder is intended to store.

3.6.7.3 This fitting shall be visible for inspection.

3.6.8 All fittings shall be equipped with weather-tight closures at the point of manufacture.

3.6.9 The closures shall be resistant to degradation in the atmosphere.

3.7 FILL OPENING

3.7.1 A wear patch shall be attached to the interior of the bladder directly below the fill opening.

3.8 TEST STRIPS

3.8.1 A minimum of nine 64-mm test strips shall be attached to the exterior top of the bladder.

3.8.2 Each test strip shall contain a 51 mm weld.

3.9 PRODUCTION TESTING

The bladder shall be evaluated for structural integrity in accordance with the following procedure:

3.9.1 Each bladder assembly shall be tested by the manufacturer after all fittings and appurtenances that are appropriate to its use have been fitted.

3.9.2 Each bladder shall be proved tight against leakage at all points including seams, threaded joints and fittings, by applying air pressure of 2 kPa (gauge) measured internally.

3.9.3 While the pressure is maintained, a liquid-soap seam test solution, or equivalent liquid, shall be brushed or poured over all seams, threaded joints and fittings, etc.

3.9.4 A complete inspection of the entire tank surface, including top and bottom, shall be conducted to detect leakage.

3.9.5 Bladders showing evidence of leakage shall be rejected. The pressure shall be removed and the bladder shall be made leak-tight and then retested.

3.9.6 After testing, the plugs in all openings shall be backed off to a hand-tight position.

3.10 SHOP-FABRICATED SECONDARY CONTAINMENT REQUIREMENTS

3.10.1 If a shop-fabricated dyke is provided as a means of secondary containment, the dyke must be capable of supporting the hydrostatic load when full of liquid.

3.10.2 The bladder must be placed entirely within a dyked area

3.11 FIELD REPAIR KIT

3.11.1 Each bladder shall include a field repair kit that contains items necessary to perform on-site repairs of punctures, tears, leaks, etc., and that is readily available in an emergency situation.

3.12 MARKING

3.12.1 Each bladder shall be marked in a permanent manner with the following information, in letters written in a height equal to or greater than that indicated below (all non-bracketed items are to be written exactly as worded; all square-bracketed items indicate the type of information to be marked):

- DANGER, FLAMMABLE OR COMBUSTIBLE LIQUID STORAGE (50 mm)
- SMOKING PROHIBITED WITHIN 6 METRES (50mm)
- KEEP ALL SOURCES OF IGNITION AT LEAST 6 METRES FROM THIS STORAGE TANK (50mm)
- MAXIMUM CAPACITY (50 mm)
- DO NOT OVERFILL – Overfilling may result in permanent damage or failure of the bladder (50 mm)
- Collapsible Fabric Storage Tank (Bladder) (12 mm)
- [Name of manufacturer] (12 mm)
- [Year/month of manufacture] (12 mm)
- Name of certifying agency (12 mm)
- [Fabrication material] (12 mm)

Information must be clearly visible to the owner or operator of the bladder. The markings must be visible when the bladder is empty and resistant to product stored."

4. PERFORMANCE

4.1 GENERAL

4.1.1 Bladder fabric shall meet the performance requirements laid out in this section.

4.1.2 The tank manufacturer shall ensure that performance testing is in conformance with a method certified by a third party testing organization in conformance with this document, using:

4.1.2.1 A document and validated test method; and

4.1.2.2 Technicians that are trained in the maintenance and use of the test equipment

Table 2 – Performance Requirements

Test	Paragraph	Test Reference	Performance
Permeance	4.2	ASTM D814	Less than 10 $g/m^2/h$ over 24 h
Compatibility	4.3	ASTM D471 Rubber Property – Effects of Liquids	Degradation visible under 7X lens
Seam resistance	4.4	Applicable standard test method	Separation = tensile strength
Puncture resistance	4.5.1	ASTM D751 Section 18	No perforation
Bursting strength	4.5.2	ASTM D751 test method with ring clamps	Min 4000 N of bursting strength
Rough handling	4.5.3	ASTM D2136	No visible cracking
Accelerated weathering	4.7.1	ASTM D2565 or ASTM G154	No cracks or deterioration; bladder retains 80% of its tensile strength
Heath aging	4.7.2	Applicable standard test method	90% of tensile strength
Tear strength	4.8	ASTM D751 (tongue tear)	Min. tear strength: as received – 195 N conditioned – 175 N

4.2 PERMEANCE

4.2.1 Bladder fabric shall have a permeance to the liquids listed in Table 3 equal to or less than 10 $g/h/m^2$ over a 24-hour period.

4.2.1.1 At least three representative samples of bladder fabric shall be exposed to the liquids shown in Table 3 for 28 days at an ambient temperature of 23±2°C and a relative humidity of 50±2%.

Table 3: Exposure Liquids

A	Premium unleaded gasoline
B	ASTM reference fuel F
C	Fuel JP-8
D	Distilled water
E	Sodium chloride (saturated)

4.2.1.2 The tests shall be conducted in accordance with ASTM Test Method D814.

4.2.1.3 Calculations shall be made as per Appendix A.

4.2.2 All samples shall pass.

4.3 COMPATIBILITY

4.3.1 Mass and volume change and loss of tensile strength shall be within the limits designated in clauses 4.3.3, 4.3.4 and 4.3.5 when exposed to the liquids specified in Table 3.

4.3.1.1 At least three representative samples of bladder fabric shall be exposed to the appropriate test liquid in Table 3 for 30 days at an ambient temperature of 23±2°C.

4.3.1.2 Following exposure, the samples shall be wiped clean and dried for 2 hours at a temperature of 21±2°C.

4.3.1.3 Any presence of delamination or other degradation visible with 7X lens shall be noted.

4.3.2 Samples shall be tested in accordance with sections 10, 11 and 15 of ASTM D471.

4.3.3 The samples shall not exhibit a change in mass in excess of 10%.

4.3.4 The samples shall not exhibit a volume change in excess of 15%.

4.3.5 The samples shall retain not less than 50% of their tensile strength.

4.4 SEAM RESISTANCE

4.4.1 Seam strength shall exceed or be equal to the specified tensile strength of the polymer fabric (clause 3.2.4).

4.4.1.1 At least five specimens that are representative of the bladders shall be bonded in accordance with the manufacturer's instructions. A similar set of specimens shall be prepared from the parent fabric.

4.4.1.2 Each specimen for testing shall be cut to the size of 150 by 100 mm; for the seamed samples, the long dimension shall be perpendicular to the seam and the seam shall be equidistant from the ends of the specimen (Figure 1).

4.4.1.3 The specimens shall be conditioned for a minimum of 24 hours at 23°C ± 2°C.

4.4.1.4 Each specimen shall be secured centrally in the clamps of the testing machine, in such a way that the long dimension is parallel to the direction of application of the load. Care must be taken to ensure that the tension in the specimen is uniform across the clamped width.

4.4.1.5 The load shall be applied by the machine at a velocity of 5±0.1 mm/s until separation occurs.

4.4.2 Maximum load at separation of the seamed samples shall be equal to or exceed the specified tensile strength.

4.5 PHYSICAL RESISTANCE

Bladders shall exhibit puncture resistance, bursting strength and rough handling that meet the requirements of clauses 4.5.1 and 4.5.4.

4.5.1 Puncture Resistance

4.5.1.1 Bladders shall resist the impact of a blunt object without perforation.

4.5.1.2 Polymer fabric shall be subjected to the impact of a 1 kg instrument drop-weight impact apparatus, as illustrated by Figure 2, dropped from a height of 1 m at a temperature of 20°C.

4.5.1.3 Not less than three samples of reinforced polymer fabric, each consisting of 1 m^2 of fabric, shall be spread individually on a bed of drained wet brick-layers' sand 150 mm deep, with the impact made at the centre of the fabric sample. After the impact, the samples shall be examined for perforation.

4.5.1.4 None of the fabric samples shall be perforated.

4.5.2 Bursting Strength

4.5.2.1 Bladders shall exhibit bursting strength that meets the requirements of clause 4.5.2.4.

4.5.2.2 Representative samples shall be subjected to slowly increasing pressure until rupture or failure occurs as described in ASTM D751 Section 18.

4.5.2.3 A minimum of 10 specimens shall be prepared, each measuring at least 12.5 mm greater in diameter than the outside diameter of the testing machine.

4.5.2.4 Samples shall exhibit a bursting strength of not less than 4000 N when tested in accordance with ASTM D751 Test Method with ring clamps.

4.5.3 *Rough Handling*

4.5.3.1 Bladders shall exhibit their ability to withstand rough handling by meeting the requirements of clause 4.5.3.1.1.

4.5.3.1.1 Not less than three samples shall withstand, without failure, rough handling at temperatures of 40°C and −46°C when tested in accordance with modified ASTM D2136 as follows:

4.5.3.1.2 Test samples of fabric, each 10 mm wide occurring along 300 mm length, shall be folded over through 180 degrees.

4.5.3.1.3 A 10 kg roller, 150 mm in diameter, shall be passed over the folded sample ten times.

4.5.3.1.4 The test shall be conducted on all samples at ambient temperatures of 40°C and −46°C.

4.5.3.2 The samples shall not show visible cracking under 5X magnification.

4.6 PROOF OF DESIGN TEST

4.6.1 The representative bladder sample shall be tested to demonstrate the strength of design.

4.6.2 The test sample shall represent the bladder having the largest designed capacity in a series.

4.6.3 The tank shall be filled with water to its design capacity ± 5% and allowed to stand for a minimum of 4 hours.

4.6.4 A complete inspection of the entire tank surface shall be conducted to detect leakage.

4.6.5 Bladders showing evidence of leakage shall not have demonstrated proof of design.

4.6.6 After testing, the plugs in all openings shall be backed off to a hand-tight position.

4.6 RESISTANCE TO ACCELERATED WEATHERING AND AGING

Samples (minimum 3) of the polymer fabric, following a 480-hour exposure to ultraviolet light and water, shall not crack or deteriorate, and when tested for tensile strength, shall retain at least 80% of the values obtained in the "as received" condition.

4.7.1 *Resistance to Accelerated Weathering*

4.7.1.1 Representative samples (minimum 3) of bladders shall be subjected to accelerated weathering for 480 hours, using either of the following two options:

Option 1

Perform xenon arc exposure in accordance with ASTM D2565, using apparatus Type B, BH or E. Appropriate filters shall be used to simulate the spectral power distribution of natural daylight. For Type B or BH apparatus, use borosilicate glass, inner and outer. For Type E apparatus, use three Suprax filters. The exposure cycle shall be 102 minutes of light and 18 minutes of light and water spray (using deionized water) at a black panel temperature of 63±3°C and a relative humidity of 30±5%. The spectral irradiance shall be 0.35 W/m^2 at 340 mm.

Option 2

Perform fluorescent UV/condensation exposure in accordance with ASTM G154, using UV340 bulbs. The exposure cycle shall be 8 hours of light and 4 hours of condensation, at a black panel temperature of 63±3°C and a condensation temperature of 50±3°C.

4.7.1.2 Subsequent to the weathering, the following test shall be conducted:

4.7.2.2.1 Tensile strength as described in section 4.3

4.7.2 *Resistance to Heat Aging*

Representative samples (minimum 3) of polymer fabric shall be placed in an air-circulating oven for 60 days at 80±1°C. After a 24-hour recovery period at 21°C, the test for tensile strength shall demonstrate 90% retention of its tear strength properties as described in clause 4.8.

4.8 TEAR STRENGTH

4.8.1 Samples (10) of the polymer fabric, when tested in accordance with ASTM D751 (tongue tear), shall have a tear strength of not less than 195 newtons in the “as received” condition (i.e. without exposure to test liquids) and 175 N after exposure to the test liquids as specified in clause 4.3.

4.8.1.1 The tear strengths shall be determined on “as received” samples and on samples immersed in the test liquids.

4.8.1.2 The tear strength shall be determined on 10 samples: 127 mm (5 samples) in the longitudinal direction and 127 mm (5 samples) in the cross-roll direction. Each specimen for testing shall measure 75 mm by 200 mm and shall be cut in the centre of the shorter edge for 75 mm to form tow “tongues,” each of which shall be gripped in the clamps of a recording tensile testing machine and pulled to simulate a tear.

4.8.1.3 After the tearing action is initiated, the pulling action will continue until the moving jaw has travelled for a minimum of 75 mm. The rate of travel shall be approximately 50 mm/min and shall be uniform at all times.

4.8.1.4 The tearing strength of the sample shall be calculated as the average of the tearing strengths obtained for the tested samples. If multiple-ply samples are used, the average obtained shall be divided by the number of plies per specimen.

5. LIFE EXPECTANCY

5.1 SHELF LIFE

5.1.1 Shelf life applies to all bladders. The optimal conditions to store bladders are between 10°C and 43°C with humidity between 50% and 75%. The maximum shelf life of a bladder is 10 years from the date of manufacture.

5.1 SERVICE LIFE

5.2.1 The service life begins when a petroleum product or allied petroleum product is transferred into the bladder.

5.2.2 Service life shall be tested by the manufacturer following section 4.8, using test strips as listed in section 3.8. These tests should be performed as per Table 4, beginning in year 2 and then annually.

5.2.3 The service life cannot be stopped or reversed. Service life is dependent upon climatic conditions and maintenance but shall never exceed 10 years.

Table 4: Frequency of Re-Testing

Frequency	Number of samples per test	Test
Year 2	1 sample	Tensile strength to retain 80%
Year 3 to 7, tested annually	1 sample	Tensile strength to retain 70%
Year 8 to 10, tested annually	1 sample	Tensile to strength retain 50%

6 INSTALLATION, MINIMUM INSTALLATION DISTANCES, AND MAINTENANCE

6.1 Each bladder shall be accompanied by detailed installation and maintenance requirements from the manufacturer.

6.2 Each bladder shall be accompanied by detailed repair instructions.

6.3 MINIMUM REQUIRED DISTANCES FOR INSTALLATION

6.3.1 Bladders shall be installed and maintained to have a minimum distance between the secondary containment and buildings based on the size of the secondary containment and construction or use of the building.

6.3.1.1 The distance between the secondary containment and buildings of ordinary or combustible construction having extensive window areas or associated combustible yard storage shall be two times the secondary containment diameter (if round) or diagonal (if not).

6.3.1.2 The distance between the secondary containment and buildings containing hazardous materials shall be two times the secondary containment diameter or diagonal.

6.3.1.3 The distance between the secondary containment and buildings of unknown construction or varying or unknown storage and yard storage shall be two times the secondary containment diameter or diagonal.

6.3.1.4 The distance between the secondary containment and buildings of ordinary or combustible construction not having extensive window areas, hazardous materials storage or associated combustible yard storage shall be one times the secondary containment diameter or diagonal.

6.3.1.5 The distance between the secondary containment and buildings of fire-resistive or non-combustible construction not having extensive window areas, hazardous materials storage or associated combustible yard storage shall be 0.5 times the secondary containment diameter or diagonal.

Figure 1

SAMPLE – SEAM STRENGTH

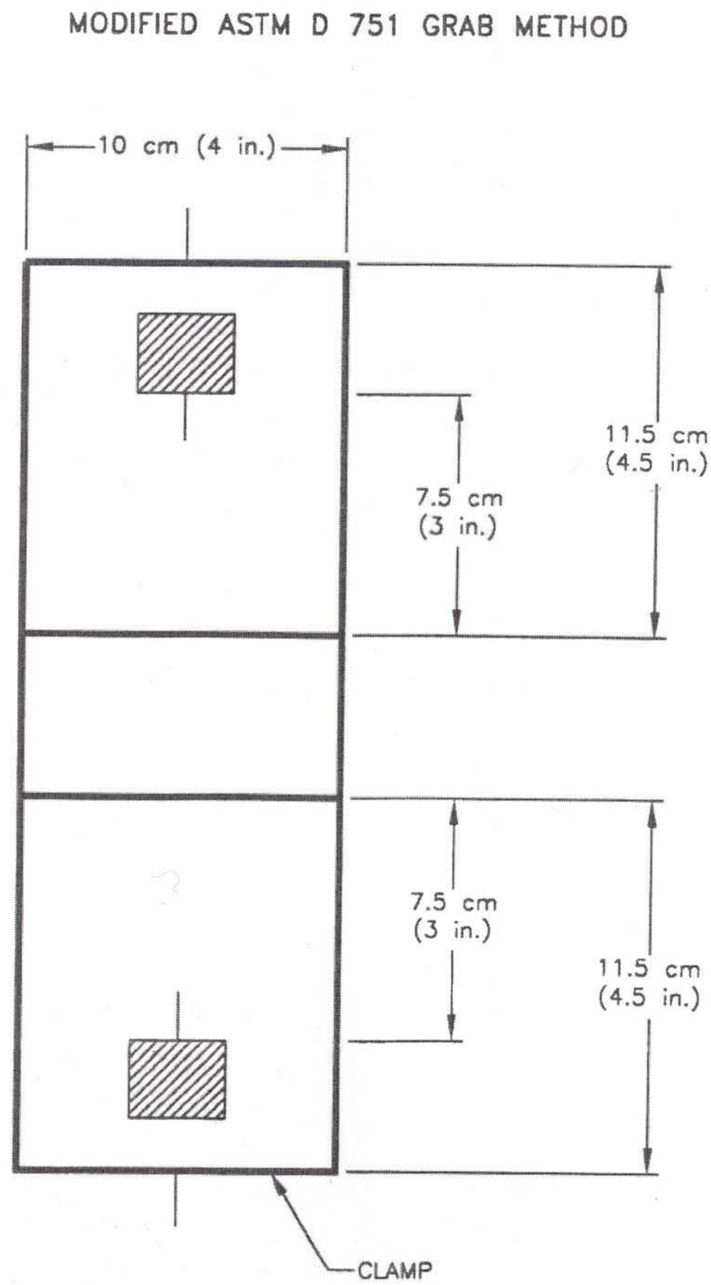
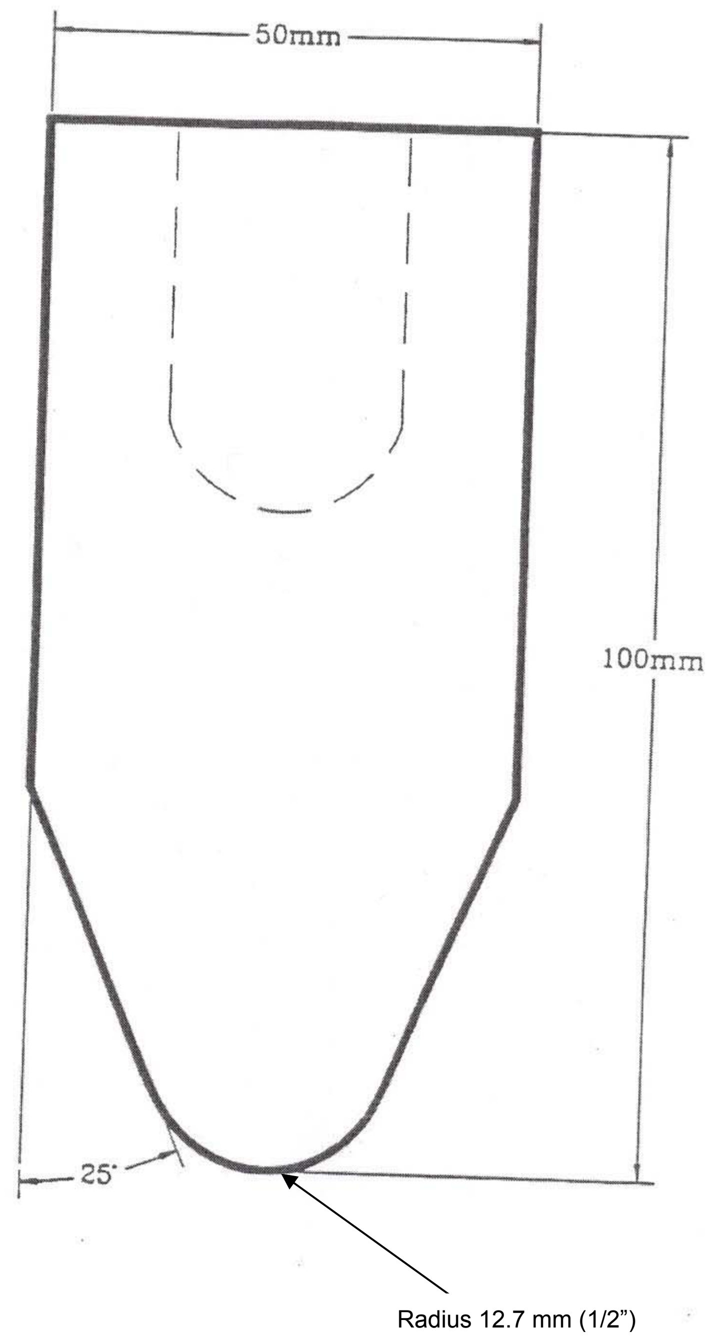


Figure 2

1 kg INSTRUMENT DROP-WEIGHT IMPACT APPARTUS



APPENDIX A

PERMEANCE AND PERMEABILITY CALCULATIONS

Using the method described in subsection 4.2, determine the mass of liquid lost over a 28-day period. From this value, together with the known exposed area of the test specimen, the following calculation can be made:

Mass of liquid lost per hour

$$= \frac{\text{Mass of liquid lost over 28 days}}{28 \times 24}$$

$$= \frac{(W1 - W28)}{672}$$

Permeance (Pc) $$= \frac{\text{Mass of liquid lost per h}}{\text{area of test specimen, cm}} \times 10\ 000$$

$$= \frac{(W1 - W28) \times 10\ 000}{672 \times a}$$

or $$= \frac{(W1 - W28) \times 14.881}{a}$$

$$= .\_\_\_\_\_\_\_\_\ g/h/m^2$$

Where: W1 = original mass of liquid before test (g)

W28 = mass of liquid after 28 days (g)

a = exposed area of test specimen (cm^2)

Permeability (Pb) = permeance x liner thickness in $g/h/m^2/mm$