INCH-POUND
MIL-DTL-24688A
06 December 2011
SUPERSEDING
DOD-I-24688
18 August 1987

DETAIL SPECIFICATION

INSULATION, THERMAL AND ACOUSTIC ABSORPTIVE, CELLULAR POLYIMIDE FOAM

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

1. SCOPE

1.1 Scope. This specification covers thermal and acoustic absorptive cellular polyimide foam insulation for use on bulkheads, overheads, and ventilation ducting. This specification also covers preformed thermal pipe insulation for use on piping operating at temperatures up to 600 °F in shipboard applications (see 6.1).

1.2 Classification. Flexible and rigid polyimide foam is to be furnished in the following types and classes as specified (see 6.2).

- Type I - Unfaced (thermal and acoustic absorptive) panel
- Type II - Faced panel
  - Class 1 - Fibrous glass cloth faced (thermal)
  - Class 2 - Slotted base board faced with perforated fibrous glass cloth (acoustical)
  - Class 3 - Faced with primer coated aluminized polyester/aluminum foil reinforced with a fibrous glass scrim
  - Class 4 - Faced with primer coated aluminized polyester/aluminum foil reinforced with a fibrous glass scrim laminated to a lightweight fibrous glass cloth
  - Class 5 - Faced with primer coated white polyester film reinforced with a fibrous glass scrim
- Type III - Preformed pipe insulation (thermal)
  - Class 1 - 0.55 pounds per cubic foot (lb/ft³) (maximum) flexible foam unlagged (400 °F upper temperature limit)
  - Class 2 - 0.55 lb/ft³ (maximum) flexible foam prelagged with fibrous glass cloth (400 °F upper temperature limit)
  - Class 3 - 1.5 lb/ft³ (maximum) rigid foam unlagged (600 °F upper temperature limit)
  - Class 4 - 1.5 lb/ft³ (maximum) rigid foam prelagged with fibrous glass cloth (600 °F upper temperature limit)
  - Class 5 - 3 lb/ft³ (maximum) rigid foam unlagged (600 °F upper temperature limit)
  - Class 6 - 3 lb/ft³ (maximum) rigid foam prelagged with fibrous glass cloth (600 °F upper temperature limit)

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil, with the subject line "Document Comment". Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.daps.dla.mil.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 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, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks 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.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-A-3316	-	Adhesives, Fire-Resistant, Thermal Insulation
MIL-C-20079	-	Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
MIL-PRF-24596	-	Coating Compounds, Nonflaming, Fire-Resistant
MIL-DTL-24607	-	Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semigloss

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-1916	-	DoD Preferred Methods for Acceptance of Product

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch/ or https://assist.daps.dla.mil.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications 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.

NAVAL SEA SYSTEMS COMMAND (NAVSEA) PUBLICATIONS

S9510-AB-ATM-010	-	Nuclear Powered Submarine Atmosphere Control Manual

(Copies of the chapter titled “Material Control Program” are available from Commander, Naval Sea Systems Command, ATTN: SEA 05Z4, 1333 Isaac Hull Avenue, SE, Stop 5122, Washington Navy Yard, DC 20376-5122 or online at https://smcl.dt.navy.mil.)

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.

ASTM INTERNATIONAL

ASTM C177	-	Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus
ASTM C302	-	Standard Test Method for Density and Dimensions of Preformed Pipe Covering Type Thermal Insulation
ASTM C335	-	Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation
ASTM C411	-	Standard Test Method for Hot Surface Performance of High Temperature Thermal Insulation

ASTM C421	-	Standard Test Method for Tumbling Friability of Preformed Block Type and Preformed Pipe Covering Type Thermal Insulation
ASTM C423	-	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C447	-	Standard Practice for Estimating the Maximum Use Temperature of Thermal Insulations
ASTM C518	-	Standard Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C585	-	Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing
ASTM C665	-	Standard Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C1304	-	Standard Test Method for Assessing the Odor Emission of Thermal Insulation Materials
ASTM C1338	-	Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
ASTM C1559	-	Standard Test Method for Determining Wicking of Glass Fiber Blanket Insulation (Aircraft Type)
ASTM D1621	-	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D3574	-	Standard Test Methods for Flexible Cellular Materials – Slab, Bonded, and Molded Urethane Foams
ASTM E84	-	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E662	-	Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
ASTM E800	-	Standard Guide for Measurement of Gases Present or Generated During Fires

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 9705	-	Fire Tests – Full Scale Room Test for Surface Products
ISO/IEC 17025	-	General Requirements for the Competence of Testing and Calibration Laboratories

(Copies of this document are available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56 CH-1211 Geneva 20, Switzerland or online at www.iso.org)

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY (TAPPI)

TAPPI T 803 - Puncture Test of Container Board

(Copies of this document are available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092 or online at www.tappi.org.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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 Qualification. The materials furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list (QPL) before contract award (see 4.2 and 6.3).

3.2 Materials. Materials shall be as specified in 3.2.1 through 3.3.2.6.

3.2.1 Type I (unfaced panel). The basic material shall be flexible, cellular, homogeneous polyimide foam.

3.2.2 Type II (faced type I panel). Type II, Classes 1 and 2 materials shall be Type I foam with a fibrous glass cloth facing as specified in 3.2.4. Type II, Class 3 material shall be Type I foam faced with primer coated aluminized polyester/aluminum foil reinforced with a fibrous glass scrim as specified in 3.2.5. Type II, Class 4 material shall be Type I foam faced with primer coated aluminized polyester/aluminum foil reinforced with a fibrous glass scrim laminated to a lightweight fibrous glass cloth as specified in 3.2.5. Type II, Class 5 material shall be Type I foam faced with primer coated white polyester film reinforced with fibrous glass scrim as specified in 3.2.6.

3.2.3 Type III (preformed pipe) (flexible type I and rigid). Type III, Class 1 material shall be Type I flexible foam. Type III, Class 2 material shall be Type I flexible foam prelagged with fibrous glass cloth as specified in 3.2.4. Type III, Class 3 material shall be 1.5 lb/ft³ (maximum) rigid, cellular, homogeneous polyimide foam. Type III, Class 4 material shall be 1.5 lb/ft³ (maximum) rigid, cellular, homogeneous polyimide foam prelagged with fibrous glass cloth as specified in 3.2.4. Type III, Class 5 material shall be 3 lb/ft³ (maximum) rigid, cellular, homogeneous polyimide foam. Type III, Class 6 material shall be 3 lb/ft³ (maximum) rigid, cellular, homogeneous polyimide foam prelagged with fibrous glass cloth as specified in 3.2.4.

3.2.4 Fibrous glass cloth facing. Fibrous glass cloth facing shall conform to the requirements of Type I, Class 2 of MIL-C-20079, and shall be free of wrinkles and other irregularities. Facing for Type II, Class 2 of this specification shall be perforated with nominal 3/16-inch diameter holes on ½-inch centers (see figure 1).

3.2.5 Aluminized polyester/aluminum foil facing with a primer coated surface. Aluminized polyester/aluminum foil facing shall consist of ½-mil thick aluminized polyester film with primer coated surface laminated to a 1-mil thick aluminum foil backing. Type II, Class 3 material shall have a 4 yarns-per-inch by 3 yarns-per-inch (i.e., 4 x 3) fiberglass scrim adhered to the primer coated aluminized polyester/aluminum foil with a fire-retardant thermosetting adhesive meeting the fire requirements of MIL-A-3316. Type II, Class 4 material shall have fibrous glass cloth conforming to the requirements of Type I, Class 2 or Class 3 of MIL-C-20079 adhered with a fire-retardant thermosetting adhesive meeting the fire requirements of MIL-A-3316 to the primer coated aluminized polyester/aluminum foil reinforced with a fibrous glass scrim.

3.2.6 White polyester facing. White polyester facing shall consist of ½-mil thick white polyester film with primer coated surface laminated to a 4 x 3 fiberglass scrim. The fiberglass scrim shall be adhered with a fire-retardant thermosetting adhesive meeting the fire requirements of MIL-A-3316.

3.2.7 Adhesive (type II, all classes and type III, classes 2, 4, and 6). Adhesive for bonding the fibrous glass cloth and the primer coated surface vapor resistant film to Type II, all classes and Type III, Classes 2, 4, and 6 materials shall conform to Class 1, Grade A of MIL-A-3316, or to the fire resistance requirements of MIL-A-3316. Testing shall be as specified in 4.4.1.

3.3 Construction.

3.3.1 Type II. Construction of Type II materials shall be in accordance with 3.3.1.1 through 3.3.1.5.

3.3.1.1 Class 1. The panel shall consist of a backing conforming to Type I unfaced foam, laminated with non-perforated fibrous glass cloth facing.

3.3.1.2 Class 2. The panel shall consist of a backing conforming to Type I unfaced foam. One face of the foam shall be slotted, 3⁄16 inch wide by 3⁄16 inch deep, on ½-inch centers, in one direction only. The perforated glass cloth facing shall be bonded to the slotted side of the foam, installed so that the perforations in the cloth facing are centered over the slots in the foam (see figure 1).

3.3.1.3 Class 3. The panel shall consist of a backing conforming to Type I unfaced foam, laminated with a fire-retardant adhesive meeting the fire requirements of MIL-A-3316, to a primer coated aluminized polyester/aluminum foil reinforced with a fibrous glass scrim.

3.3.1.4 Class 4. The panel shall consist of a backing conforming to Type I unfaced foam, laminated with a fire-retardant adhesive meeting the fire requirements of MIL-A-3316, to a primer coated aluminized polyester/aluminum foil reinforced with a fibrous glass scrim laminated to a lightweight fibrous glass cloth.

3.3.1.5 Class 5. The panel shall consist of a backing conforming to Type I unfaced foam, laminated with a fire-retardant adhesive meeting the fire requirements of MIL-A-3316, to a primer coated white polyester film reinforced with a fibrous glass scrim.

3.3.2 Type III. Construction of Type III (preformed pipe) materials shall be in accordance with 3.3.2.1 through 3.3.2.6.

3.3.2.1 Class 1. Class 1 material shall be Type I, flexible foam formed into pipe insulation. The insulation shall be split or slit lengthwise.

3.3.2.2 Class 2. Class 2 material shall consist of foam conforming to Type I, flexible foam formed into pipe insulation, laminated with adhesive as specified in 3.2.7 and fibrous glass cloth facing conforming to the requirements of MIL-C-20079, Type I.

3.3.2.3 Class 3. Class 3 material shall consist of 1.5 lb/ft³ (maximum) rigid foam formed into pipe insulation. The insulation shall be split or slit lengthwise.

3.3.2.4 Class 4. Class 4 material shall consist of foam conforming to Type III, Class 3, laminated with adhesive as specified in 3.2.7 and fibrous glass cloth facing conforming to the requirements of MIL-C-20079, Type I.

3.3.2.5 Class 5. Class 5 material shall consist of 3 lb/ft³ (maximum) rigid foam formed into pipe insulation. The insulation shall be split or slit lengthwise.

3.3.2.6 Class 6. Class 6 material shall consist of foam conforming to Type III, Class 5, laminated with adhesive as specified in 3.2.7 and fibrous glass cloth facing conforming to the requirements of MIL-C-20079, Type I.

3.4 Dimensions and tolerances.

3.4.1 Type I and type II. Unless otherwise specified (see 6.2), insulation panels shall be furnished in the lengths, width, and tolerances as specified in table I. Dimensions and tolerances shall be determined in accordance with 4.4.2.1.

TABLE I. Panel dimensions and tolerances.

Length (inches)	Width (inches)	Thickness (inches)	Tolerances (inch)		
			Length	Width	Thickness
36	24	½, 1, or 2	±¼	±¼	+⅛ −0
48	24	½, 1, or 2	±¼	±¼	+⅛ −0

3.4.2 Type III. Unless otherwise specified (see 6.2), pipe insulation shall be furnished in the dimensions specified in 3.4.2.1 through 3.4.2.3. Dimensions and tolerances shall be determined in accordance with 4.4.2.2.

3.4.2.1 Length. Pipe insulation shall be furnished in nominal lengths of 48 inches, with a tolerance of ±$\frac{3}{16}$-inch (see 4.4.2.2.1).

3.4.2.2 Size. Pipe insulation shall be furnished to fit Iron Pipe Sizes (IPS) of 1 inch to 5 inches (see 6.2). The longitudinal seam shall close to within ⅛ inch along the entire length of the section. The inside diameter of the insulation shall not exceed the outside diameter of the pipe by ¼ inch for nominal pipe sizes (nps) up to 4½ inches or by 5 percent on 5-inch nps (see 4.4.2.2.2).

3.4.2.3 Thickness. Pipe insulation shall be furnished in nominal thicknesses of ½ inch, ¾ inch, 1 inch, 1½ inches, 2 inches, and 3 inches (see 6.2) with a tolerance of ±$\frac{3}{32}$-inch in thickness (see 4.4.2.2.3).

3.5 Weights and tolerances.

3.5.1 Type I and type II. Panel weight shall not exceed the maximum specified in table II. Weights and tolerances shall be determined in accordance with 4.4.3.1.

TABLE II. Weight (areal density) (maximum).

Type and Class	Weight (lb/ft)		
	½ inch	1 inch	2 inches
Type I	0.02	0.04	0.08
Type II			
Class 1	0.16	0.18	0.22
Class 2	0.14	0.16	0.20
Class 3	0.08	0.10	0.14
Class 4	0.18	0.20	0.24
Class 5	0.08	0.10	0.14

3.5.2 Type III. The base pipe insulation (unlagged) shall not exceed the maximum density specified in table III. Density shall be determined in accordance with 4.4.3.2 and 4.4.3.3.

TABLE III. Density (unlagged) (maximum).

Type and Class	Density (lb/ft)
Type III	
Class 1	0.55
Class 2	0.55
Class 3	1.5
Class 4	1.5
Class 5	3.0
Class 6	3.0

3.6 Facing alignment.

3.6.1 Type II, classes 1, 3, 4, and 5 and type III. If the facing material does not cover the entire surface of the panel or pipe length, the uncovered portion of the panel or pipe length shall not be longer than ⅛ inch from any edge. The facing shall not extend over the edge of the panel or pipe length by more than ⅛ inch. Facing alignment shall be determined in accordance with 4.4.4.

3.6.2 Type II, class 2. Misalignment of the facing material over the slotted panel shall be not greater than 1/16 inch when tested in accordance with 4.4.4.

3.7 Painting. Type I panels shall be furnished unpainted. Unless otherwise specified (see 6.2), Type II shall be furnished unpainted. Painting when required shall conform to MIL-DTL-24607 with color as specified (see 6.2).

3.7.1 Paintability (type II, classes 1, 3, 4, and 5 and type III, classes 2, 4, and 6). The faced panel or prelagged preformed pipe insulation, as furnished, shall be compatible with and shall hold one coat of paint conforming to MIL-DTL-24607 when applied to the facing. The paint shall dry to a uniform smooth coat which shall have a flat to semigloss appearance and exhibit no shiners or flashes when viewed under ordinary conditions of illumination. Paintability determination shall be in accordance with 4.4.5.

3.8 Cutability (type II). When the panel is cut or sawed, the threads of the cloth facing across which the cut is made shall not be separated from the face over a distance of more than ⅛ inch. Determination shall be in accordance with 4.4.6.

3.9 Mass loss by tumbling (type I and type III). The mass loss after tumbling shall be not greater than 3 percent after the first 10 minutes and 5 percent after the second 10 minutes. Determination shall be in accordance with 4.4.7.

3.10 Corrosiveness (type I and type III). The material shall show no corrosion greater than that observed with sterile cotton. Determination shall be in accordance with 4.4.8.

3.11 Wicking (type I and type III). The wicking of the material shall not exceed ½ inch above the water line when tested in accordance with 4.4.9. In addition, precipitates shall not form in the water bearing the wicking specimens.

3.12 Puncture resistance (type II, class 1 only). The puncture resistance of the faced board shall be not less than 800 ounce-inches per inch of tear when tested in accordance with 4.4.10.

3.13 Compressibility.

3.13.1 Type I, type II, and type III, classes 1 and 2. Compressibility of Type I (unfaced) panel and Type III, Class 1 (unlagged preformed pipe) shall be a minimum value of 1.2 pounds per square inch (lb/in²) at 50 percent deflection when tested in accordance with 4.4.11.1. Compressibility of Type II (faced) panel and Type III, Class 2 (prelagged) preformed pipe shall be performed on the unfaced foam backing only with a minimum value of 1.2 lb/in² at 50 percent deflection when tested in accordance with 4.4.11.1.

3.13.2 Type III, classes 3 and 4. Compressibility of Type III, Class 3 (unlagged) preformed pipe shall be a minimum value of 26 lb/in² at 20 percent deflection when tested in accordance with 4.4.11.1. Compressibility of Type III, Class 4 (prelagged) preformed pipe shall be performed on the unfaced foam backing only with a minimum value of 26 lb/in² at 20 percent deflection when tested in accordance with 4.4.11.1.

3.13.3 Type III, classes 5 and 6. Compressibility of Type III, Class 5 (unlagged) preformed pipe shall be a minimum value of 28 lb/in² at 10 percent deflection when tested in accordance with 4.4.11.2. Compressibility of Type III, Class 6 (prelagged) preformed pipe shall be performed on the unfaced foam backing only with a minimum value of 28 lb/in² at 10 percent deflection when tested in accordance with 4.4.11.2.

3.14 Sound absorption (type I and type II, class 2). When tested as specified in 4.4.12, the acoustic absorptive board shall have coefficients of absorption that are equal to or greater than those shown in table IV.

TABLE IV. Minimum sound absorption coefficients.

Type, class	Board thickness (inches)	Frequency, Hz					
		125	250	500	1000	2000	4000
I	½	0.04	0.05	0.15	0.40	0.55	0.55
I	1	0.06	0.20	0.45	0.65	0.65	0.65
I	2	0.15	0.40	0.75	0.75	0.75	0.70
II, 2	½	0.05	0.15	0.35	0.50	0.60	0.60
II, 2	1	0.07	0.25	0.70	0.80	0.75	0.70
II, 2	2	0.25	0.70	0.90	0.85	0.75	0.75

3.15 Thermal conductivity.

3.15.1 Type I and type II, class 1 only. The thermal conductivity of Type I and Type II, Class 1 material shall not exceed 0.32 British thermal units (Btu) inches per hour per square foot at an average mean temperature of 75 °F when tested in accordance with 4.4.13.1.

3.15.2 Type III. The base pipe insulation (unlagged) shall not exceed the maximum thermal conductivity specified in table V when tested in accordance with 4.4.13.2.

TABLE V. Thermal conductivity (unlagged) (maximum).

Mean temp. (°F)	Type III Class 1 (Btu)	Type III Class 2 (Btu)	Type III Class 3 (Btu)	Type III Class 4 (Btu)	Type III Class 5 (Btu)	Type III Class 6 (Btu)
25	0.27	0.27				
50	0.30	0.30				
75	0.32	0.32	0.24	0.24	0.24	0.24
100	0.35	0.35			0.25	0.25
150					0.27	0.27
200	0.48	0.48			0.30	0.30

NOTE:

1. British thermal unit (Btu) measured in inches per hour per square foot at the average mean temperature shown.

3.16 Upper temperature limit (type I, type II, and type III). The upper temperature limit for Type I, Type II, and Type III, Classes 1 and 2 shall be 400 °F and the upper temperature limit for Type III, Classes 3, 4, 5, and 6 shall be 600 °F when tested in accordance with 4.4.14. The material shall not flame, glow, smolder, smoke, soften, collapse, melt, or drip during hot surface exposure.

3.17 Fire resistance. Unless otherwise specified (see 6.2), fire tests shall be performed in accordance with 4.4.15. When specified, a certificate of compliance shall be prepared (see 6.2).

3.17.1 Testing and examination. For fire testing, an independent testing laboratory that is accredited to ISO/IEC 17025 or equivalent procedure, and certified by an American Bureau of Shipping (ABS) surveyor or NAVSEA, shall conduct all fire tests specified in this document. Accreditation to ISO/IEC 17025 shall be obtained from a recognized accreditation body, such as American Association for Laboratory Accreditation (www.a21a.org) or International Code Council's International Accreditation Services (www.iasonline.org). The scope of accreditation shall include fire tests required for qualification. The independent test laboratory shall write a test report for all tests conducted for qualification purposes. NAVSEA reserves the right to witness the tests, and/or perform any of the fire tests set forth herein where such testing is deemed necessary to assure compliance to prescribed requirements of the qualification tests.

3.17.2 Type I and type II.

3.17.2.1 Flame resistance. Type I and Type II, Classes 1, 2, and 5 shall meet the following full scale room test performance requirements when tested in accordance with 4.4.15.1.1:

a. Net peak heat release rate over any 30 second period less than 500 kilowatts (kW).

b. Net average heat release rate for test less than 100 kW.

c. Flame spread must not reach 1.6 feet (0.5 meter) above the floor excluding the area 4 feet (1.2 meters) from the corner with the ignition source.

d. No flaming droplets or flaming material at any location, which fall from the test specimen during the fire test, shall continue flaming after reaching the test platform or floor.

e. Peak smoke production rate less than 89.4 square feet per second (ft^2/s) (8.3 square meters per second [m^2/s]) over any 60 second period of test.

f. Test average smoke production rate less than 15.1 ft^2/s (1.4 m^2/s).

3.17.2.2 Duct insulation room/corner test. Type II, Classes 3 and 4, shall meet the following full scale room test performance requirements when tested in accordance with 4.4.15.1.2:

a. Flame spread shall be not greater than 1 foot of flame spread on horizontal duct runs.

b. No melting or dripping shall be evident.

c. No ignition of the target array on the floor of the test chamber caused by burning insulation shall occur.

Maximum heat release rate for duct insulation shall be 11,384 Btu/min (200 kW) not including the heat release rate of the initiating fuel source (e.g., gas burner).

3.17.2.3 Flame spread and smoke (type I). Flame spread shall be not greater than 10 and smoke developed shall be not greater than 15 when tested in accordance with 4.4.15.2.

3.17.2.4 Flame spread and smoke (type II, all classes). Flame spread shall be not greater than 25 and smoke developed shall be not greater than 50 when tested in accordance with 4.4.15.2.

3.17.3 Type III.

3.17.3.1 Flame spread and smoke (type III, classes 1, 3, and 5). Flame spread shall be not greater than 10 and smoke developed shall be not greater than 15 when tested in accordance with 4.4.15.2.

3.17.3.2 Flame spread and smoke (type III, classes 2, 4, and 6). Flame spread shall be not greater than 25 and smoke developed shall not be greater than 50 when tested in accordance with 4.4.15.2.

3.17.3.3 Pipe insulation room/corner test (type III, all classes). Insulation or insulation system shall be fire tested in the configuration that it is to be installed aboard ship. When tested in accordance with 4.4.15.2.1, the insulation or insulation system shall meet the following performance criteria:

a. Flame spread shall be not greater than 1 foot of flame spread on horizontal pipe runs. Additionally, no melting or dripping shall be evident, and no ignition of the target array on the floor of the test chamber caused by burning insulation shall occur.

b. The maximum heat release rate shall be 11,384 Btu/min (200 kW) not including that of the initiating fuel source.

3.18 Toxic gas generation (type I, type II, and type III). The toxic gas generation shall be not greater than 300 parts per million (ppm) for carbon monoxide (CO), not greater than 5 ppm for hydrogen cyanide (HCN), hydrogen fluoride (HF), hydrogen bromide (HBr), and sulfur dioxide (SO_2), and not greater than 10 ppm for hydrogen chloride (HCL) and mixed nitric oxides (NOX). Determinations shall be made in accordance with 4.4.16.

3.19 Steam aging (hydrolytic stability) (type I and type III, classes 1, 3, and 5). The material shall be exposed in a steam autoclave. Tensile strength shall not change more than 25 percent. Dimensional and weight changes shall not be not greater than 10 percent. Determinations shall be made in accordance with 4.4.17.

3.20 Fungus resistance (type I and type III). Insulation or insulation system for Type I and Type III shall show no signs of fungal growth after 30 days of incubation. Determinations shall be made in accordance with 4.4.18.

3.21 Odor (type I and type III). The material shall produce no offensive odor when tested in accordance with 4.4.19.

3.22 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible, provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.23 Toxicity (type I, type II, and type III). When evaluated in accordance with 4.4.20, the cellular polyimide foam insulation and any of its components shall have no adverse effect on the health of personnel when used for its intended purpose and shall not cause any environmental problems during waste disposal (see 4.4.20 and 6.5).

3.24 Off-gassing (type I, type II, and type III). If the material is required to be used on submarines, the material shall be certified for and assigned a usage category of either “Permitted” or “Limited” in accordance with S9510-AB-ATM-010 chapter titled “Material Control Program” (see 4.4.21 and 6.6). Formulation changes in the material shall require a reevaluation of the material (see 4.4.21).

3.25 Identification markings. Unless otherwise specified (see 6.2), each panel on the backside shall be marked with the information as follows:

a. “Polyimide Foam”

b. “Asbestos Free”

c. Specification number, type, and class

d. Manufacturer’s name

e. Manufacturer’s product identification

Markings shall be legible, permanent, and not less than ⅜ inch in height. A minimum of two complete markings shall be required per panel. Inspection shall be in accordance with 4.4.22.

3.26 Workmanship. Material shall be uniform in quality and condition. Material shall be clean and free from foreign materials, contaminants, and defects that will impair material use and serviceability.

4. VERIFICATION

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

a. Qualification inspection (see 4.2).

b. Conformance inspection (see 4.3).

4.1.1 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be performed in accordance with the test conditions specified herein.

4.2 Qualification inspection. Qualification inspection shall consist of all of the tests listed in table VI.

TABLE VI. Qualification inspection.

Inspection	Requirement	Test
Adhesive		
Type II, all classes and Type III, Classes 2, 4, and 6	3.2.7	4.4.1
Dimensions and tolerances		
Type I and Type II	3.4.1	4.4.2.1
Type III	3.4.2	4.4.2.2
Weights and tolerances	3.5	4.4.3
Type I and Type II	3.5.1	4.4.3.1
Type III	3.5.2	4.4.3.2, 4.4.3.3
Facing alignment		
Type II, Classes 1, 3, 4, and 5 and Type III	3.6.1	4.4.4
Type II, Class 2	3.6.2	4.4.4
Paintability		
Type II, Classes 1, 3, 4, and 5 and Type III, Classes 2, 4, and 6	3.7.1	4.4.5
Cutability		
Type II	3.8	4.4.6
Mass loss by tumbling		
Type I and Type III	3.9	4.4.7
Corrosiveness		
Type I and Type III	3.10	4.4.8
Wicking		
Type I and Type III	3.11	4.4.9
Puncture resistance		
Type II, Class 1	3.12	4.4.10
Compressibility		
Type I, Type II, and Type III, Classes 1 and 2	3.13.1	4.4.11.1
Type III, Classes 3 and 4	3.13.2	4.4.11.1
Type III, Classes 5 and 6	3.13.3	4.4.11.2
Sound absorption		
Type I and Type II, Class 2	3.14	4.4.12

TABLE VI. Qualification inspection - Continued.

Inspection	Requirement	Test
Thermal conductivity		
Type I and Type II	3.15.1	4.4.13.1
Type III	3.15.2	4.4.13.2
Upper temperature limit		
Type I, Type II, and Type III	3.16	4.4.14
Flame resistance		
Type I and Type II, Classes 1, 2, and 5	3.17.2.1	4.4.15.1.1
Duct insulation room/corner test		
Type II, Classes 3 and 4	3.17.2.2	4.4.15.1.2
Flame spread and smoke		
Type I	3.17.2.3	4.4.15.2
Type II, all classes	3.17.2.4	4.4.15.2
Type III, Classes 1, 3, and 5	3.17.3.1	4.4.15.2
Type III, Classes 2, 4, and 6	3.17.3.2	4.4.15.2
Pipe insulation room/corner test		
Type III, all classes	3.17.3.3	4.4.15.2.1
Toxic gas generation		
Type I, Type II, and Type III	3.18	4.4.16
Steam aging		
Type I and Type III, Classes 1, 3, and 5	3.19	4.4.17
Fungus resistance		
Type I and Type III	3.20	4.4.18
Odor		
Type I and Type III	3.21	4.4.19
Toxicity		
Type I, Type II, and Type III	3.23	4.4.20
Off-gassing (submarine use only)		
Type I, Type II, and Type III	3.24	4.4.21
Identification markings	3.25	4.4.22

4.2.1 Qualification sample. The qualification sample shall be taken from a production lot of material and shall consist of enough panels or preformed pipe insulation to perform all tests as required in table VI.

4.3 Conformance inspection. Conformance inspection shall be as specified in table VII, 4.3.1, and 4.3.2.

TABLE VII. Conformance inspection.

Inspection	Requirement	Test
Group A		
Dimensions and tolerances		
Type I and Type II	3.4.1	4.4.2.1
Type III	3.4.2	4.4.2.2
Weights and tolerances	3.5	4.4.3
Type I and Type II	3.5.1	4.4.3.1
Type III	3.5.2	4.4.3.2, 4.4.3.3
Identification markings	3.25	4.4.22
Group B		
Adhesive		
Type II, all classes and Type III, Classes 2, 4, and 6	3.2.7	4.4.1
Facing alignment		
Type II, Classes 1, 3, 4, and 5 and Type III	3.6.1	4.4.4
Type II, Class 2	3.6.2	4.4.4
Paintability		
Type II, Classes 1, 3, 4, and 5 and Type III, Classes 2, 4, and 6	3.7.1	4.4.5
Sound absorption		
Type I and Type II, Class 2	3.14	4.4.12
Thermal conductivity		
Type I and Type II	3.15.1	4.4.13.1
Type III	3.15.2	4.4.13.2
Upper temperature limit		
Type I, Type II, and Type III	3.16	4.4.14
Group C		
Cutability		
Type II	3.8	4.4.6
Mass loss by tumbling		
Type I and Type III	3.9	4.4.7
Corrosiveness		
Type I and Type III	3.10	4.4.8
Wicking		
Type I and Type III	3.11	4.4.9
Puncture resistance		
Type II, Class 1	3.12	4.4.10
Compressibility		
Type I, Type II, and Type III, Classes 1 and 2	3.13.1	4.4.11.1
Type III, Classes 3 and 4	3.13.2	4.4.11.1
Type III, Classes 5 and 6	3.13.3	4.4.11.2

TABLE VII. Conformance inspection - Continued.

Inspection	Requirement	Test
Group C - Continued		
Steam aging		
Type I and Type III, Classes 1, 3, and 5	3.19	4.4.17
Fungus resistance		
Type I and Type III	3.20	4.4.18
Odor		
Type I and Type III	3.21	4.4.19
Group D		
Flame resistance		
Type I and Type II, Classes 1, 2, and 5	3.17.2.1	4.4.15.1.1
Duct insulation room/corner test		
Type II, Classes 3 and 4	3.17.2.2	4.4.15.1.2
Flame spread and smoke		
Type I	3.17.2.3	4.4.15.2
Type II, all classes	3.17.2.4	4.4.15.2
Type III, Classes 1, 3, and 5	3.17.3.1	4.4.15.2
Type III, Classes 2, 4, and 6	3.17.3.2	4.4.15.2
Pipe insulation room/corner test		
Type III, all classes	3.17.3.3	4.4.15.2.1
Toxic gas generation		
Type I, Type II, and Type III	3.18	4.4.16

4.3.1 Examination of end item for defects in appearance and dimensions. The sample unit for the examination of table VIII shall be one insulation panel or preformed pipe insulation length, as required. Not more than five panels or preformed pipe insulation lengths shall be selected from a single carton.

TABLE VIII. Examination for visual and dimensional defects.

Examination	Defect
Appearance (Type I)	Surface not sufficiently smooth to permit facing.
Appearance (Type II)	Facing wrinkles or facing not adhered over entire surface of foam. Excessive surface waviness which results in increase of thickness of ¼-inch or greater. Facing not aligned as specified.
Appearance (Type III)	Facing wrinkles or facing not adhered over entire surface of foam.
Paintability (Type II, Classes 1, 3, 4, and 5 and Type III, Classes 2, 4, and 6)	Not as specified in 3.7.1.
Classification	Type not as specified (see 1.2).
Dimensions	Not within limits or tolerances specified in 3.4 or by contract requirements.
Weight	Not as specified in 3.5, table II, and table III.

4.3.2 Testing of the end item. The end item shall be tested in accordance with 4.3.2.1 through 4.3.2.3.

4.3.2.1 Lot. For purposes of sampling and conformance inspection, a lot shall consist of all insulation material of the same type, size, and thickness produced under similar conditions and ready for inspection or shipment at one time. Unless otherwise specified (see 6.2), the lot size shall be expressed in the number of panels or lengths of preformed pipe insulation.

4.3.2.2 Sampling for conformance testing. The sample unit shall be one panel or one length of preformed pipe insulation as applicable. Sampling shall be in accordance with MIL-STD-1916, except where otherwise indicated herein. Conformance tests and examinations are required for all production lots of material.

4.3.2.3 Formulation changes. The addition of any substance that was not present in the qualification sample requires requalification. Any changes in basic ingredients, manufacturing processes, or manufacturing locations which would affect compliance with this specification must be reported to both the contracting activity and NAVSEA. The Government reserves the right to require that all tests specified in this specification be re-performed on a production lot of material produced under the new formulation, new process, or in a new location before any shipment is accepted. Any formulation change not disclosed to NAVSEA will result in immediate disqualification of the product.

4.3.3 Certificate of compliance. When specified (see 6.2), a certificate of compliance shall be prepared.

4.4 Test procedures.

4.4.1 Adhesive. Adhesive testing shall be in accordance with the fire resistance requirements of MIL-A-3316 except that the testing shall be conducted with Type II and Type III insulation materials as applicable (see 3.2.7).

4.4.2 Dimensions and tolerances.

4.4.2.1 Type I and type II. Length, width, thickness, and tolerances shall be determined by ASTM D3574, Test A (see 3.4.1).

4.4.2.2 Type III.

4.4.2.2.1 Length. Length shall be determined in accordance with ASTM C302 (see 3.4.2.1).

4.4.2.2.2 Size. The inner diameter of the pipe insulation shall be determined in accordance with ASTM C585 (see 3.4.2.2).

4.4.2.2.3 Thickness. Thickness shall be determined in accordance with ASTM C302 (see 3.4.2.3).

4.4.3 Weight and tolerances.

4.4.3.1 Type I and type II. Weight and tolerances shall be determined in accordance with ASTM D3574, Test A (see 3.5.1).

4.4.3.2 Type III (classes 1 and 2). Density shall be determined in accordance with ASTM C302 (see 3.5.2).

4.4.3.3 Type III (classes 3, 4, 5, and 6). Density shall be determined in accordance with ASTM D3574, Test A (see 3.5.2).

4.4.4 Facing alignment (type II, classes 1, 2, 3, 4, and 5 and type III). Facing alignment shall be tested by direct measurement using a steel rule with 1/16-inch graduations (see 3.6).

4.4.5 Paintability (type II, classes 1, 3, 4, and 5 and type III, classes 2, 4, and 6). One coat of latex emulsion flat primer conforming to MIL-PRF-24596 and one coat of fire-retardant paint conforming to MIL-DTL-24607 shall be applied to the cloth surface of the Type II panel or the Type III prelagged preformed pipe insulation (see 3.7.1).

4.4.6 Cutability (type II). Panels shall be examined after cutting or sawing to determine conformance to 3.8. Thread separation shall be determined by direct measurement using a rigid rule with 1/16-inch graduations.

4.4.7 Mass loss by tumbling (type I and type III). Mass loss by tumbling shall be determined in accordance with ASTM C421 (see 3.9).

4.4.8 Corrosiveness (type I and type III). Corrosiveness of the material shall be determined in accordance with the corrosiveness method of ASTM C665 (see 3.10).

4.4.9 Wicking (type I and type III). Wicking of the material shall be determined in accordance with ASTM C1559, Procedure A. Only the room temperature water test shall be performed for a period of 48±2 hours (see 3.11).

4.4.10 Puncture resistance (type II, class 1 only). Puncture resistance shall be determined in accordance with the method specified in TAPPI T 803, except as follows: The 24 by 18-inch test specimen shall be placed with the cloth faced down between the clamping plates. The loose sleeve shall be placed against the base of the puncture point and the pointer shall be set about 1 inch above the expected reading. The pendulum shall be raised to the horizontal position. The pendulum shall be released by pushing the latch handle to the left. The reading on the proper scale shall be noted after the pendulum has completed its swing. Two determinations shall be made in the warp direction and two in the filling direction of the cloth on each specimen (see 3.12).

4.4.11 Compressibility.

4.4.11.1 Type I, type II, and type III, classes 1, 2, 3, and 4. Compressibility of the unfaced foam only shall be tested in accordance with ASTM D3574, Test Method C, with exception that the foam shall be tested unflexed (see 3.13.1 and 3.13.2).

4.4.11.2 Type III, classes 5 and 6. Compressibility of the unfaced foam only shall be tested in accordance with ASTM D1621 (see 3.13.3).

4.4.12 Sound absorption (type I and type II, class 2). Sound absorption coefficients shall be determined in accordance with ASTM C423 using Type A mounting (see 3.14).

4.4.13 Thermal conductivity.

4.4.13.1 Type I and type II, class 1 only. Thermal conductivity shall be determined in accordance with ASTM C177 or ASTM C518 (see 3.15.1). In case of a dispute, ASTM C177 shall be the referee test method.

4.4.13.2 Type III. Thermal conductivity shall be tested in accordance with ASTM C335 (see 3.15.2).

4.4.14 Upper temperature limit (type I, type II, and type III). Upper temperature limit shall be determined at the pipe insulation's intended maximum use temperature (400 °F for Type I, Type II, and Type III, Classes 1 and 2 and 600 °F for Type III, Classes 3, 4, 5, and 6). Testing shall be performed in accordance with ASTM C411 and ASTM C447 (see 3.16).

4.4.15 Fire resistance tests.

4.4.15.1 Type I and type II. Fire resistance tests shall be performed in accordance with 4.4.15.1.1 and 4.4.15.1.2.

4.4.15.1.1 Flame resistance (type I and type II, classes 1, 2, and 5). Type I and Type II, Classes 1, 2, and 5 shall be tested in a room fire test in accordance with ISO 9705 (see 3.17.2.1).

4.4.15.1.2 Duct insulation room/corner test (type II, classes 3 and 4). Type II, Classes 3 and 4 shall be tested in accordance with the ventilation duct insulation room/corner fire test (see 3.17.2.2 and Appendix B).

4.4.15.2 Flame spread and smoke (type I, type II, and type III). Flame spread and smoke developed shall be determined in accordance with ASTM E84 (see 3.17.2.3, 3.17.2.4, 3.17.3.1, and 3.17.3.2).

4.4.15.2.1 Pipe insulation room/corner test (type III, all classes). The pipe insulation room/corner test shall be performed in accordance with Appendix A (see 3.17.3.3).

4.4.16 Toxic gas generation (type I, type II, and type III). Toxic gas generation determination shall be conducted in both flaming and non-flaming modes in accordance with ASTM E662. Gas sampling and concentrations shall be measured in accordance with ASTM E800. Fourier Transform Infrared Spectrometer (FTIR), Gas Chromatography/Mass Spectrometer (GC/MS), or similar analytical techniques which can produce traceable results shall be used for the gas analysis (see 3.18).

4.4.17 Steam aging (type I and type III, classes 1, 3, and 5). Steam aging shall be conducted in accordance with ASTM D3574 using Procedure J_1. A random batch sample shall be selected that is large enough to cut into two equal sizes to fit into the autoclave. One sample shall be steam aged and the other shall be used to make visual, dimensional, weight, and tensile strength comparisons after the sample is dry. Tensile strength shall be conducted according to ASTM D3574, Test E (see 3.19).

4.4.18 Fungus resistance (type I and type III). Insulation or insulation system shall show no signs of fungal growth after 30 days of incubation in accordance with ASTM C1338 (see 3.20).

4.4.19 Odor (type I and type III). The material shall produce no offensive odor when tested in accordance with ASTM C1304 (see 3.21).

4.4.20 Toxicity (type I, type II, and type III). The cellular polyimide foam insulation and any of its components shall be evaluated by the Navy and Marine Corps Public Health Center (NMCPHC) using the administrative Health Hazard Assessment (HHA). Sufficient data to permit an HHA of the product shall be provided by the manufacturer/distributor to the NMCPHC as directed by the Qualifying Activity (QA). To obtain current technical information requirements specified by the NMCPHC, see 6.5.

4.4.21 Off-gassing (type I, type II, and type III). The material shall be tested by a Government approved testing facility in accordance with S9510-AB-ATM-010 chapter titled “Material Control Program.” The results shall be submitted to the Government for evaluation and approval for use (see 3.24and 6.6).

4.4.22 Identification markings. Panels shall be visually examined to determine conformance to 3.25.

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 system 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. Insulation as specified herein is intended for the following applications.

6.1.1 Type I. Type I material is a general purpose insulation for thermal and acoustical applications designed to be used as a direct substitute for fibrous glass insulation on an inch for inch thickness basis. Type I material is intended as an alternative for MIL-I-742, Type II and MIL-I-22023, Type I and Type II (all classes).

6.1.2 Type II, class 1. Type II, Class 1 material is intended for use as a thermal insulation substitute for MIL-I-742, Type I. Type II, Class 1 material is not intended for use as an acoustic material.

6.1.3 Type II, class 2. Type II, Class 2 material is designated for use as a lightweight acoustical absorption material for overheads (exclusive of suspended ceiling system panels) and bulkheads in dry, clean shipboard spaces where moisture and water vapor barriers are not required. This material should not be used in areas such as main or auxiliary machinery rooms, galleys, or showers where moisture, petroleum products, or noxious contaminants may be absorbed by the insulation. Type II, Class 2 material is intended for use as an acoustical insulation substitute for MIL-A-23054.

6.1.4 Type II, classes 3 and 4. Type II, Classes 3 and 4 materials are intended for use as lightweight thermal insulation to be applied to round, oval, or rectangular ducts. Type II, Classes 3 and 4 materials are not intended for use on bulkheads and overheads.

6.1.5 Type II, class 5. Type II, Class 5 material is intended for use as a lightweight thermal insulation to be applied in spaces where the insulation may be exposed to moisture and/or oil, such as engine rooms and machinery spaces.

6.1.6 Type III, classes 1 and 2. Type III, Classes 1 and 2 flexible pipe insulation are intended for use on hot piping operating at temperatures from 100 to 400 °F. Type III, Classes 1 and 2 flexible pipe insulation are not intended for use on bulkheads and overheads.

6.1.7 Type III, classes 3, 4, 5, and 6. Type III, Classes 3, 4, 5, and 6 rigid pipe insulation are intended for use on hot piping operating at temperatures from 100 to 600 °F. Type III, Classes 3, 4, 5, and 6 rigid pipe insulation may be used in areas subject to high traffic. Type III, Classes 3, 4, 5, and 6 rigid pipe insulation are not intended for use on bulkheads and overheads.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Type and class required (see 1.2).
c. Length, width, and thickness required, if other than as specified (see 3.4.1 and 3.4.2).
d. Nominal pipe size required (see 3.4.2.2).
e. Thickness of pipe insulation required (see 3.4.2.3).
f. When painting is required and color desired (see 3.7).
g. Fire resistance tests on panels and pipe insulation other than as specified (see 3.17).
h. Toxic gas generation, if other than specified (see 3.18).
i. Toxicity conformance (see 3.23 and 4.4.20).
j. Off-gas testing, when required (see 3.24).
k. Panel identification markings, if other than as specified (see 3.25).
l. Inspection conditions, if other than specified (see 4.1.1).
m. Lot size, if other than specified (see 4.3.2.1).
n. When a certificate of compliance is required (see 4.3.3).
o. Packaging requirements (see 5.1).
p. Activities requiring copies of completed MSDS (see 6.4).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No. 24688 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Commander, Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to CommandStandards@navy.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.daps.dla.mil.

6.4 Material safety data sheets (MSDS). Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. In order to obtain the MSDS, federal acquisition regulation (FAR) clause 52.223-3 must be in the contract.

6.5 Toxicity evaluation. The Navy and Marine Corps Public Health Center (NMCPHC) requires sufficient information to permit an HHA of the product. Any questions concerning toxicity and requests for HHA should be addressed to the Commanding Officer, Navy and Marine Corps Public Health Center (NMCPHC), ATTN: Industrial Hygiene Department, Acquisition Technical Support Division, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 23708-2103. Upon receipt of the HHA, a copy should be provided to the Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil.

6.6 Material certification. Materials to be installed in submarines are to be controlled to prevent off-gassing which contaminates the atmosphere and can result in health hazards to personnel or deleterious effects on machinery. These controls are accomplished through the Submarine Material Control Program, which is described in the Nuclear Powered Submarine Atmosphere Control Manual, S9510-AB-ATM-010 chapter titled "Material Control Program". Under the Submarine Material Control Program, all materials considered for use on submarines require certification and assignment of a usage category. Under the certification process, candidate materials are selected by Navy activities or contractors, and a request for certification is submitted to the Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil. The certification request is accompanied by detailed information, including descriptions of the material, method of application, usage, and storage. A chemical analysis is conducted, which is normally accomplished through off-gas testing. The off-gas test is required to be conducted in a Government approved laboratory designated by the preparing activity. Information pertaining to this test requirement may be obtained from the Naval Sea Systems Command, ATTN: SEA 05S, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard, DC 20376-5160 or emailed to CommandStandards@navy.mil. Based on the chemical analysis results, a usage category is assigned to the material defining whether, and to what extent, the material may be used on submarines.

6.7 Subject term (key word) listing.

Compartment

Duct

Pipe

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

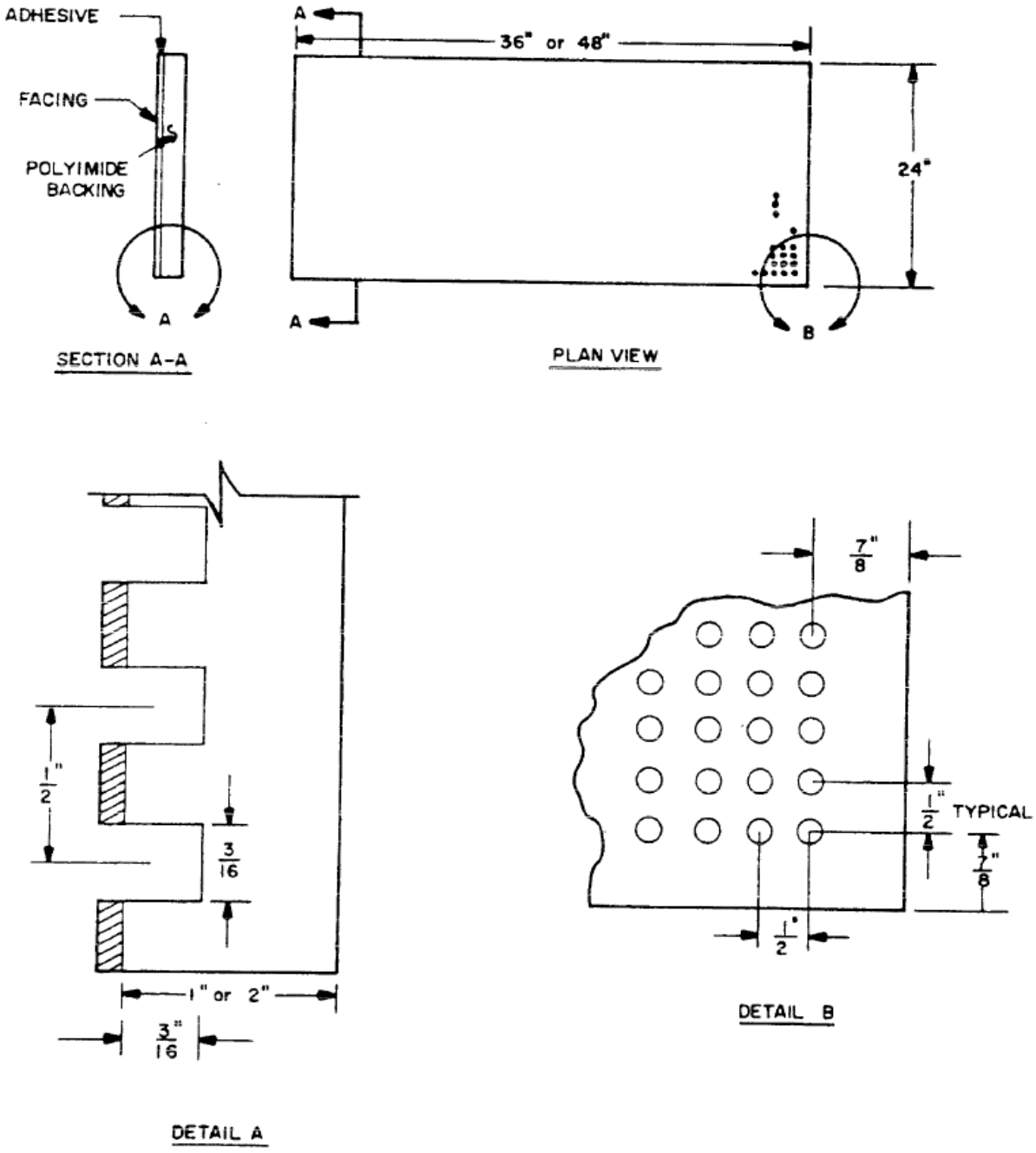


FIGURE 1. Type II, class 2 construction.

PIPE INSULATION ROOM/CORNER TEST

A.1 SCOPE

A.1.1 Scope. This appendix provides the test procedure for a standard room/corner fire test that can be used to evaluate pipe insulation materials. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.1.2 Applicability. The specific performance characteristics to be evaluated are as follows:

a. Flame Spread
b. Heat Release Rate (HRR)
c. Combustion Gas Generation
d. Smoke Optical Density

A.2 TEST COMPARTMENT

A.2.1 Test compartment. The test compartment shall be located inside a larger burn facility to negate the effects of environmental conditions such as wind and rain. The facility shall be capable of providing sufficient combustion air for the test. The fire tests shall be conducted inside a steel compartment that is used to simulate a typical shipboard space. Figures A-1 and A-2 provide an isometric sketch and plan drawing of the compartment. The dimensions of the compartment shall be 10 feet by 10 feet by 8 feet high. Any single dimension of the compartment shall not vary by more than ±1 inch and any single dimension of the vent shall not vary by more than ±½ inch. The compartment shall be constructed of ¼-inch thick steel plate. Reinforcing stiffeners may be used, however they should not interfere with the installation of the test pipes.

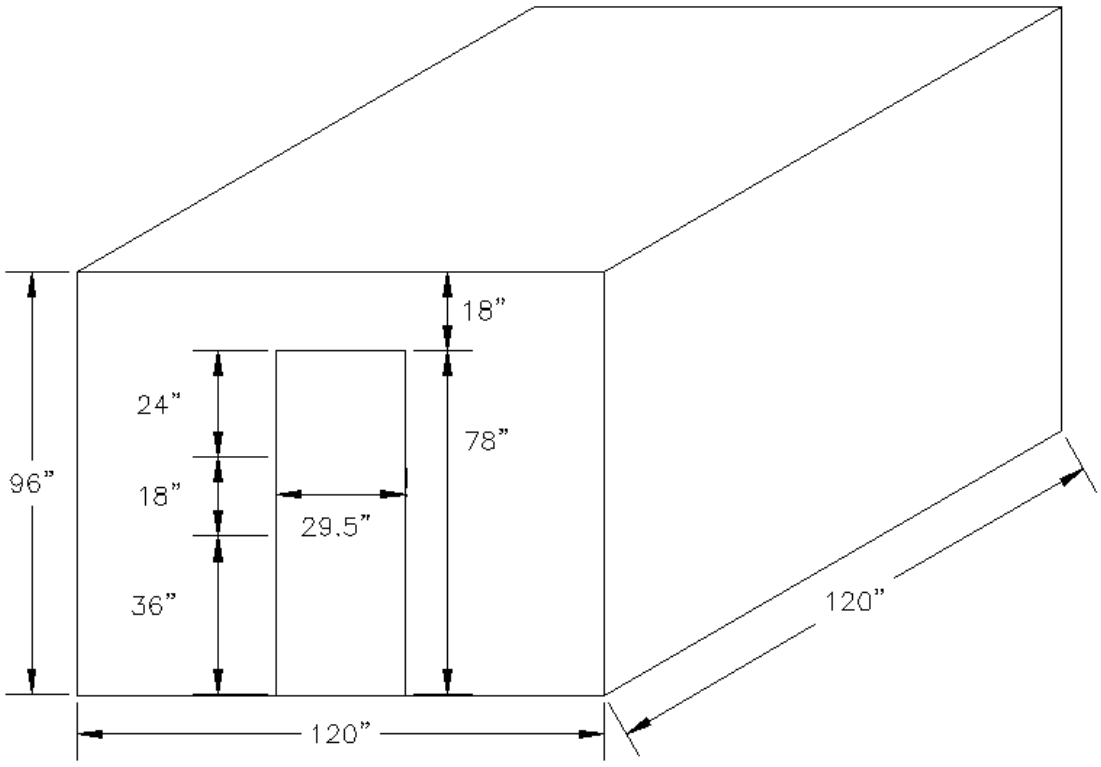


FIGURE A-1. CBD steel compartment for use in pipe insulation tests.

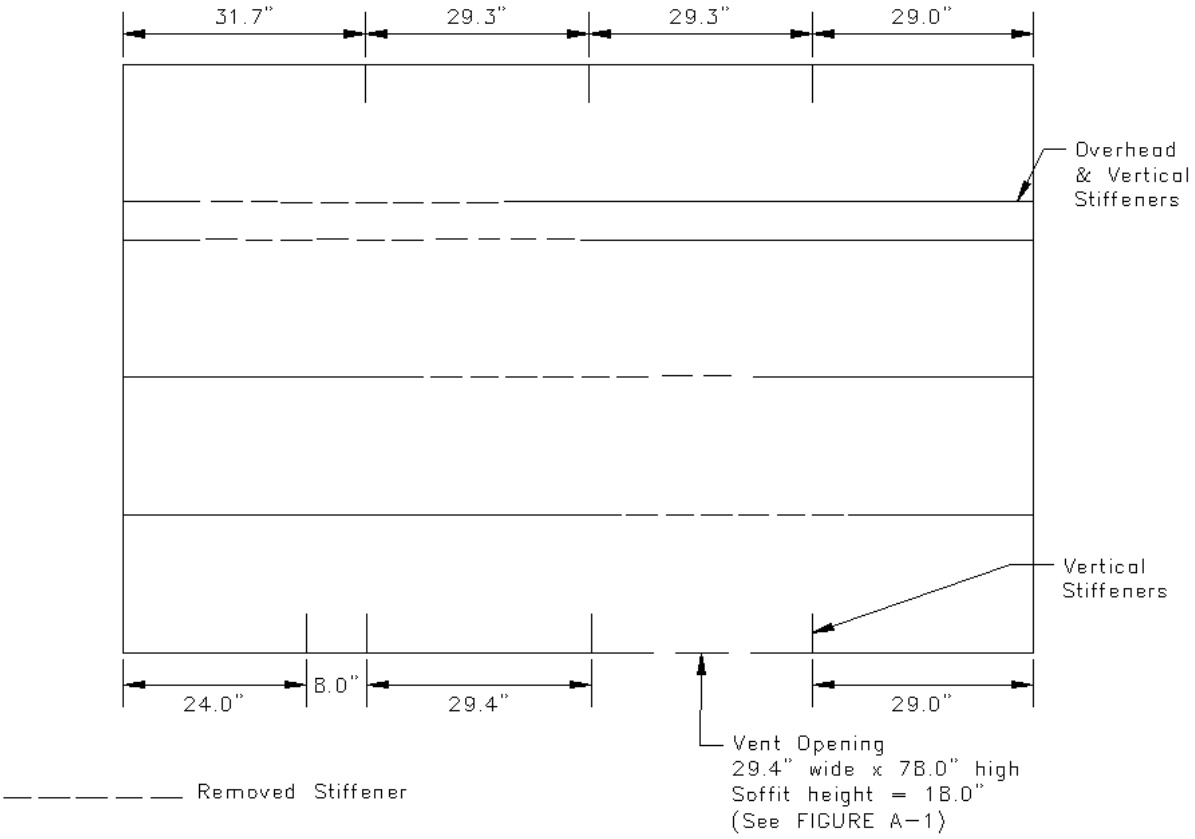


FIGURE A-2. Reflected overhead view of stiffener arrangement.

A.3 TEST PIPE CONFIGURATION

A.3.1 Test pipe configuration. The insulated pipe configurations shall be installed inside the test compartment in a manner that provides a vertical run of piping in the corner area above the ignition source, and as this vertical run meets the overhead, the run changes into a horizontal pipe run across the overhead of the compartment. Figure A-3 provides a sketch of this arrangement. The pipe configuration shall consist of five ½-inch inner diameter pipes installed as a closely spaced pipe bundle. The test configuration is shown on figure A-4. Each pipe run shall be 5 feet in length for the vertical portion and 10 feet in length for the horizontal portion. Figure A-5 provides a sketch of the construction of the pipes. The pipe runs shall be supported using ½-inch steel angle welded vertically to the ceiling of the compartment. Horizontal supports for the piping shall be attached to the vertical segments using ¼-inch bolts. The pipe runs shall be secured in place at each support using wire tied to the cross supports. The support locations and details are provided on figures A-4 and A-6. The geometric center of the vertical run shall be centered over the wood crib.

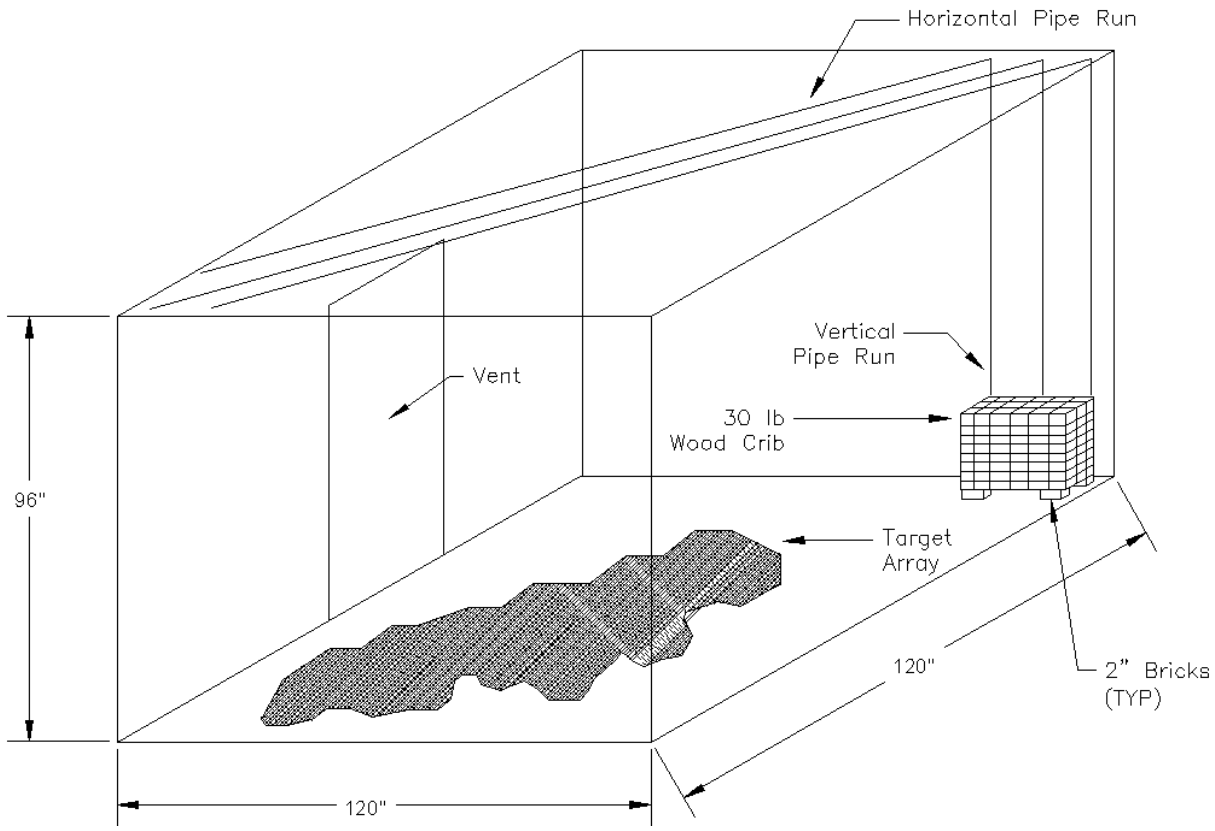


FIGURE A-3. Conceptual drawing of pipe insulation test set-up.

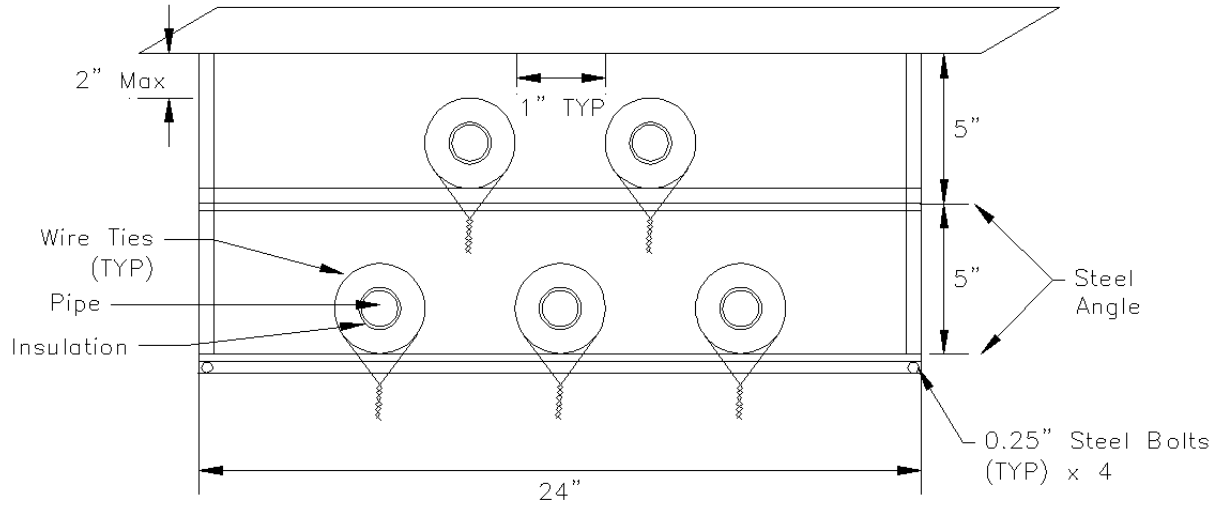


FIGURE A-4. Section view of pipe arrangement.

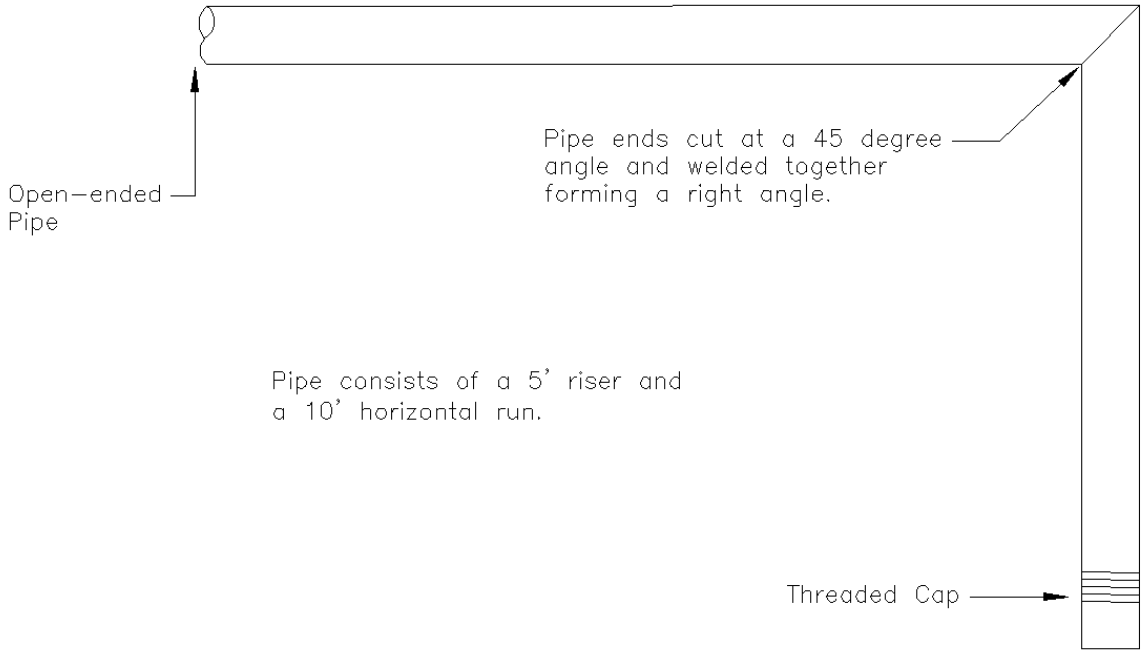


FIGURE A-5. Typical elevation of pipe set-up.

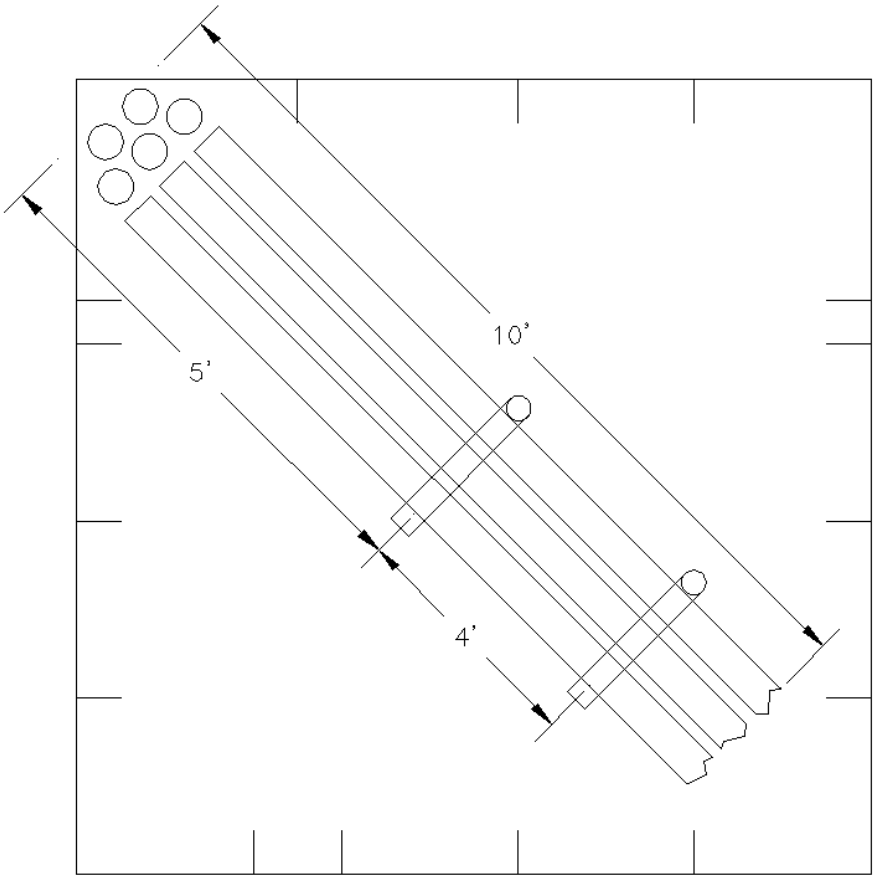


FIGURE A-6. Location of horizontal pipe supports.

A.4 IGNITION SOURCE

A.4.1 Ignition source. The ignition source used for these experiments shall be the standard 30 lb (13.6 kg) wood crib as outlined in the Uniform Building Code Standard 26 – 3 room/corner test procedure. The crib consists of 1½-inch square fir sticks, cut to 15-inch lengths, and assembled into a 15-inch square plan with five evenly spaced sticks per tier aligned perpendicular to the tier below. The construction shall use 8d common nails and should consist of between 45-50 sticks such that the per-test weight of the wood crib should be 30±½ lbs. The final crib assembly shall be conditioned to a moisture content of not greater than 8 percent. Inside the test compartment, the crib shall be supported above the deck by 2 inches high by 4 inches wide metal supports or bricks. The crib shall be placed in the test corner area such that it is 1 inch from the adjacent wall surfaces. The crib shall be ignited using a 6-inch square pan containing 6.76 oz (200 milliliters [mL]) of heptane and placed under the center of the crib.

A.5 INSTRUMENTATION

A.5.1 Layout. A general layout of the instrumentation is shown on figure A-7.

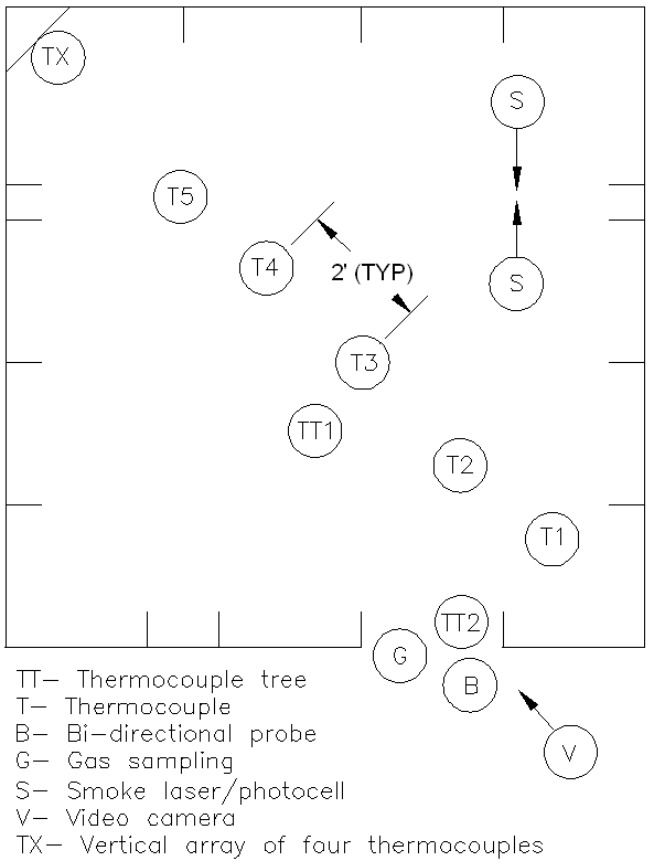


FIGURE A-7. Plan view of instrumentation layout.

A.5.2 Temperatures. A vertical thermocouple tree shall be located in the center of the compartment. The tree shall consist of 16 thermocouples located every 6 inches below the ceiling. A second thermocouple tree shall be located in the vertical centerline of the vent. This tree consists of 13 thermocouples located 1, 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, and 72 inches below the top of the vent opening. All of the thermocouples shall be a maximum of 24 gauge, Type K, thermocouples. Each thermocouple shall have a bare bead.

A.5.3 Flame spread. Along with visual observations, flame spread may be assessed using thermocouples along the entire simulated pipe array. Spaced 2 feet on center, the thermocouples shall be installed along both the vertical and horizontal portions of the piping assembly. All of the thermocouples shall be a maximum of 24 gauge, Type K, thermocouples. Each thermocouple shall have a bare bead.

A.5.4 Air flow. Air movement both in and out of the compartment shall be measured in the vent opening by two bi-directional probes. One probe shall be located 8 inches from the top of the doorway and a second probe shall be located 18 inches above the deck. Both probes shall be located along the centerline of the vent. (These may be eliminated if HRR measurements are performed in a hood/exhaust system.)

A.5.5 Gas concentrations. Gas analyzers provide a continuous monitoring of oxygen (O_2), carbon monoxide (CO), and carbon dioxide (CO_2) concentrations of gases exiting the test compartment. The oxygen concentration shall be measured via a paramagnetic oxygen analyzer while the CO and CO_2 concentrations shall be measured via infrared process analyzers. The sampling probe shall be located along the vertical centerline of the vent and 8 inches (0.20 meter) below the top of the vent opening.

A.5.6 Smoke. Three laser/photocells or equivalent instruments shall be used to assess the smoke production within the compartment. The path length shall be 3.3 feet, and they shall be placed horizontally at 3.84, 5.35, and 6.56 feet above the deck and near the center of the compartment.

A.5.7 Target array. In order to assess the potential for the pipe insulation materials to cause secondary ignitions due to melting, dripping, or falling pieces, a target array of wood excelsior shall be placed on the deck of the compartment beginning 1 foot away from the corner of the wood crib, under the horizontal pipe run, and extend the full length of the horizontal pipe run.

A.5.8 Weight loss. In order to assess the amount of insulation consumed during the test, each pipe shall be weighed prior to insulation being applied, weighed in its final insulated test configuration, and weighed at the conclusion of the test.

A.5.9 Heat release rate. The heat release rate of the fire inside the compartment shall be measured. The technique to be used is at the discretion of the testing laboratory, but it should be based on oxygen depletion calorimetry. Use of hood/exhaust system for the performance of the procedure is allowed.

A.5.10 Data collection. Data obtained during the test shall be recorded at intervals not to exceed 5 seconds.

A.6 DOCUMENTATION

A.6.1 Video. A video record shall be made of each test and shall cover the full duration of the tests. The camera shall be located outside of the compartment vent providing a full view of the test array. When necessary, the camera may be relocated to document unusual test developments.

A.6.2 Photographs. A series of photographs shall, as a minimum, be taken before and after each test showing the arrangement of the test pipes.

A.6.3 Damage sketches. In order to more effectively show the extent of pipe insulation damage, post-test sketches shall be made of each tested configuration. This may involve the removal of the exterior lagging (when required) and exposing and measuring the damaged insulation.

A.7 INSTALLATION OF TEST MATERIALS

A.7.1 Installation of test materials. The pipe installation shall be installed on the ½-inch pipes. The insulation on the vertical riser section shall extend past the threaded end cap, and a plug or cap of the same insulation shall be adhered in place over the pipe cap. All butt joints and seams shall be sealed using the appropriate adhesives. Figure A-8 shows an elevation view of a typical installed insulation. If lagging/adhesives are used, then the cure time as specified by the manufacturer shall be allowed prior to testing.

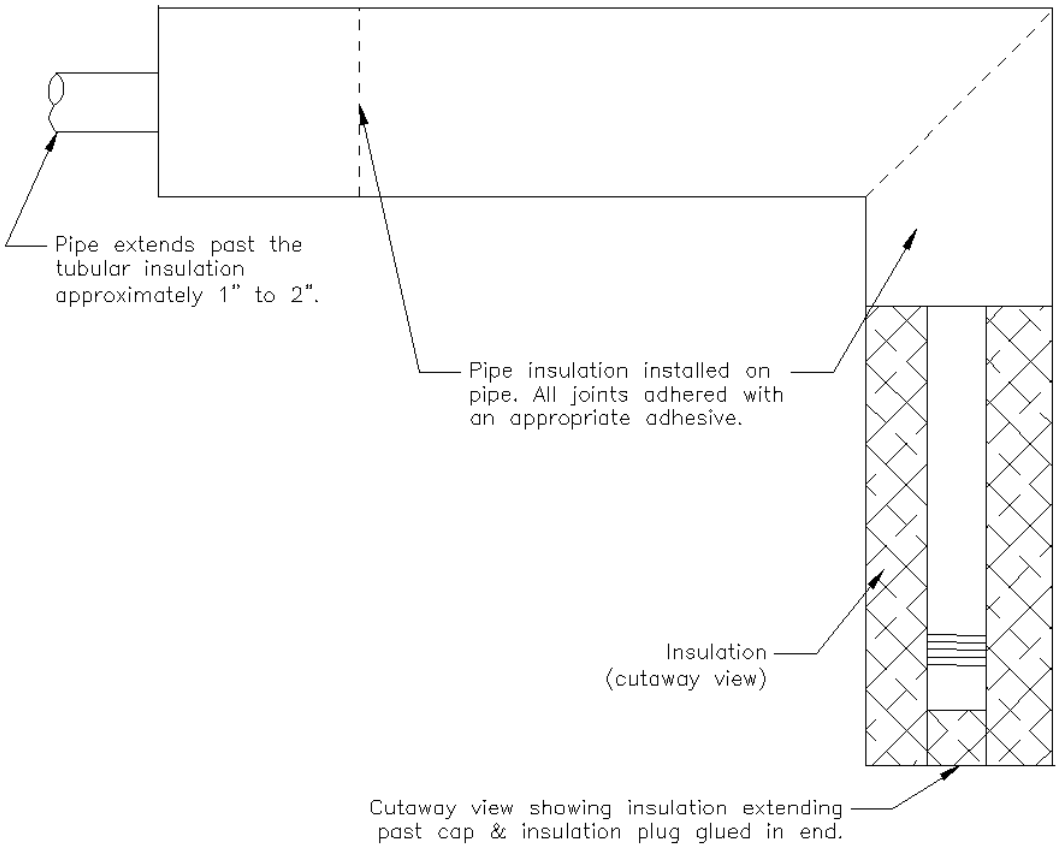


FIGURE A-8. Typical elevation of pipe with insulation installed.

A.8 TEST PROCEDURES

A.8.1 Environmental. The environmental conditions inside the test compartment just prior to test shall be 50 to 90 °F.

A.8.2 Procedures. The following test procedures shall be followed:

a. Install test pipe insulations.

b. Verify the placement and operation of instrumentation, video, and position of target array.

c. Verify environmental conditions.

d. Position wood crib in test corner.

e. Pour heptane fuel into pan and position under the wood crib.

f. Begin 2-minute baseline data collection.

g. At 2-minute mark, ignite heptane.

h. Continue the test until either 15 minutes of burn time has elapsed (17 minutes total), or the test must be ended due to safety considerations.

DUCT INSULATION ROOM/CORNER TEST

B.1 SCOPE

B.1.1 Scope. This appendix provides the test procedure for a standard room/corner fire test that can be used to evaluate ventilation duct insulation materials that are applied to the exterior surfaces of ventilation ducts. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

B.1.2 Applicability. The specific performance characteristics to be evaluated are as follows:

a. Flame Spread
b. HRR
c. Combustion Gas Generation
d. Smoke Optical Density

B.2 TEST COMPARTMENT

B.2.1 Test compartment. The test compartment shall be located inside a larger burn facility to negate the effects of environmental conditions such as wind and rain. The facility shall be capable of providing sufficient combustion air for the test. The fire tests shall be conducted inside a steel compartment that is used to simulate a typical shipboard space. Figure B-1 provides an isometric sketch of the compartment. The dimensions of the compartment shall be 10 feet by 10 feet by 8 feet high with a single vent 2.45 feet by 6.5 feet. Any single dimension of the compartment shall not vary by more than ±1 inch and any single dimension of the vent shall not vary by more than ±½ inch. The compartment shall be constructed of ¼-inch thick steel plate. Reinforcing stiffeners may be used, however they should not interfere with the installation of the test ducts.

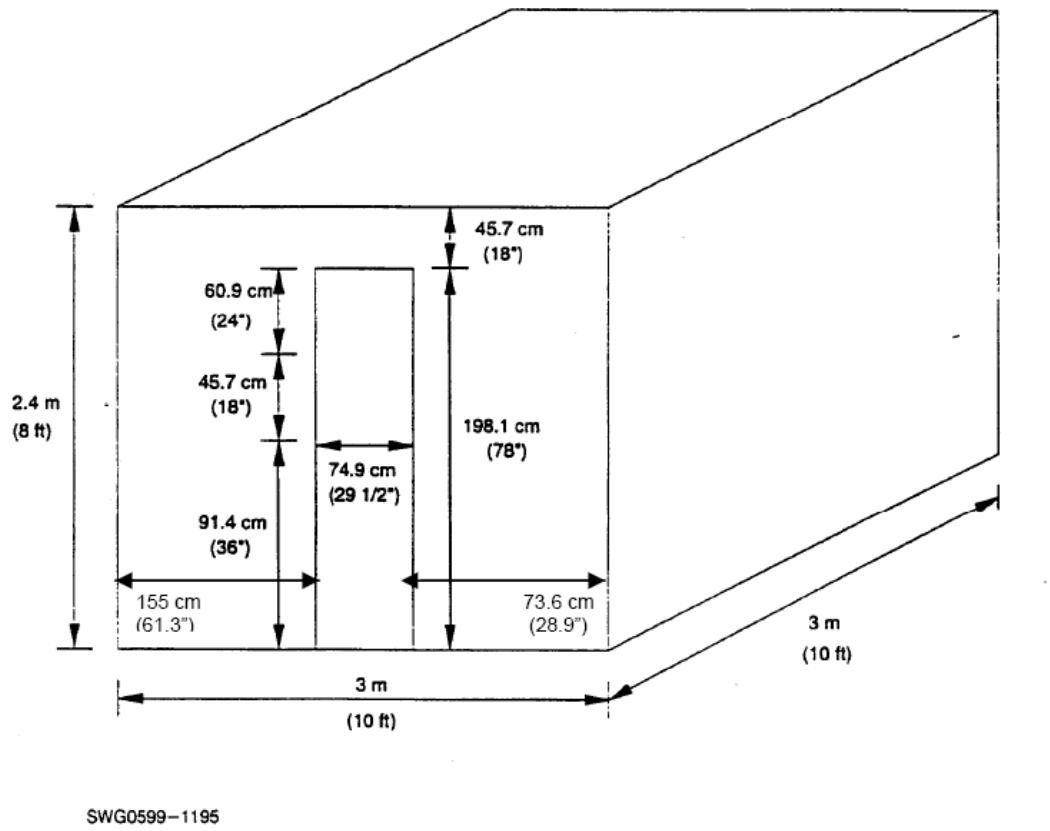


FIGURE B-1. Steel compartment for use in duct insulation tests.

B.3 TEST DUCT CONFIGURATION

B.3.1 Test duct configuration. The base ventilation ducts to be tested shall be pre-fabricated and should be of non-watertight construction using galvanized sheet steel with a thickness of 0.0635 inch. The duct configuration, as shown on figure B-2, shall consist of two base ducts, one with a 6-inch by 15-inch cross section and one with an 18-inch by 15-inch cross section. Each duct shall be 55 inches in length for the vertical portion and 85 inches in length for the horizontal portion. The bottom of the vertical portion of the ducts shall be welded closed using the same metal as the ducts. The ends of the horizontal portion of the ducts that are the most remote from the fire source shall remain open. Ducting that provides transition from the vertical to horizontal shall be welded.

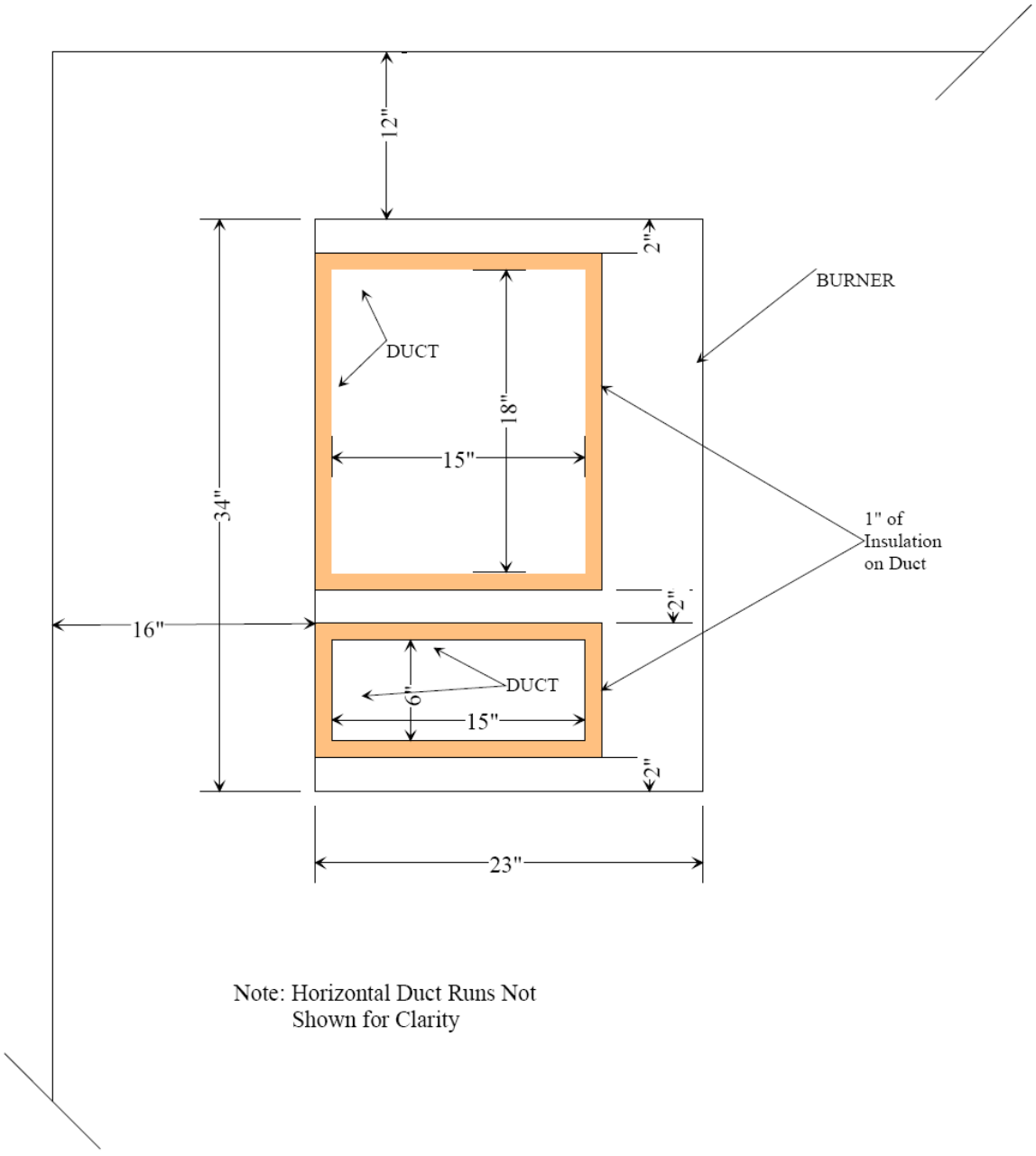


FIGURE B-2. Plan view of duct and burner arrangement.

B.3.2 Insulation thickness. Vent duct insulation material shall be applied at a thickness of 1 inch.

B.3.3 Installation configuration. The insulated duct configurations shall be installed inside the test compartment in a manner that provides a vertical run of ducting in the area above the ignition source, and as this vertical run meets the overhead, the run changes into a horizontal duct run across the underside of the compartment overhead. Figure B-3 provides a sketch of this arrangement. The finished sides of the insulated duct configuration shall be 16 inches from the left wall, 14 inches from the back wall, and 4 inches from the overhead. There shall be a 2-inch separation between the finished sides of the two insulated ducts. The finished bottom of the vertical ducts shall be 8 inches above the top surface of the burner.

B.3.4 Test duct supports. The duct runs shall be supported using ½-inch steel angle welded vertically to the ceiling of the compartment or equivalent supports. Horizontal supports for the ducts shall be ½-inch steel angle attached to the vertical segments using bolts.

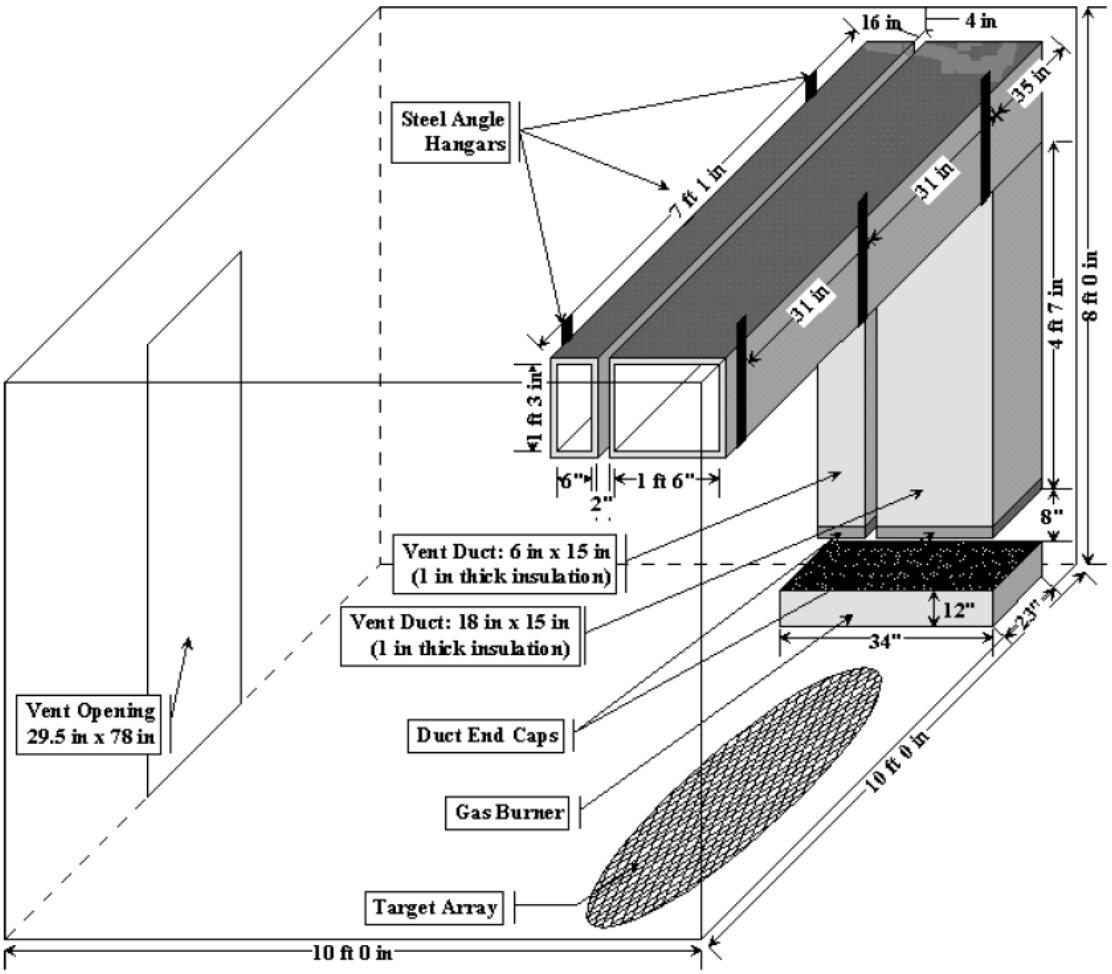


FIGURE B-3. Drawing of duct insulation test set-up.

B.4 IGNITION SOURCE

B.4.1 Ignition source. The ignition source shall be a gas fired burner, as shown on figure B-4, with fuel bed surface dimensions of 23 inches by 34 inches by 12 inches high. The burner shall use C.P. Grade propane as the fuel. The gas piping will be installed inside the burner box and the box then filled with materials to allow for the diffusion of the gas. The burner shall be positioned on the floor of the test compartment such that the 23-inch dimension is 12 inches from the back wall and the 34-inch dimension is 16 inches from the left wall as shown on figure B-5. The spacings shall be measured from the interior surface of the wall to the edge of the fuel bed of the burner. The heat release rates for the burner shall be as shown below:

Test Time (Minutes)	Heat Release Rate (kW)
0 – 5	100
5 – 10	150
10 – 20	200

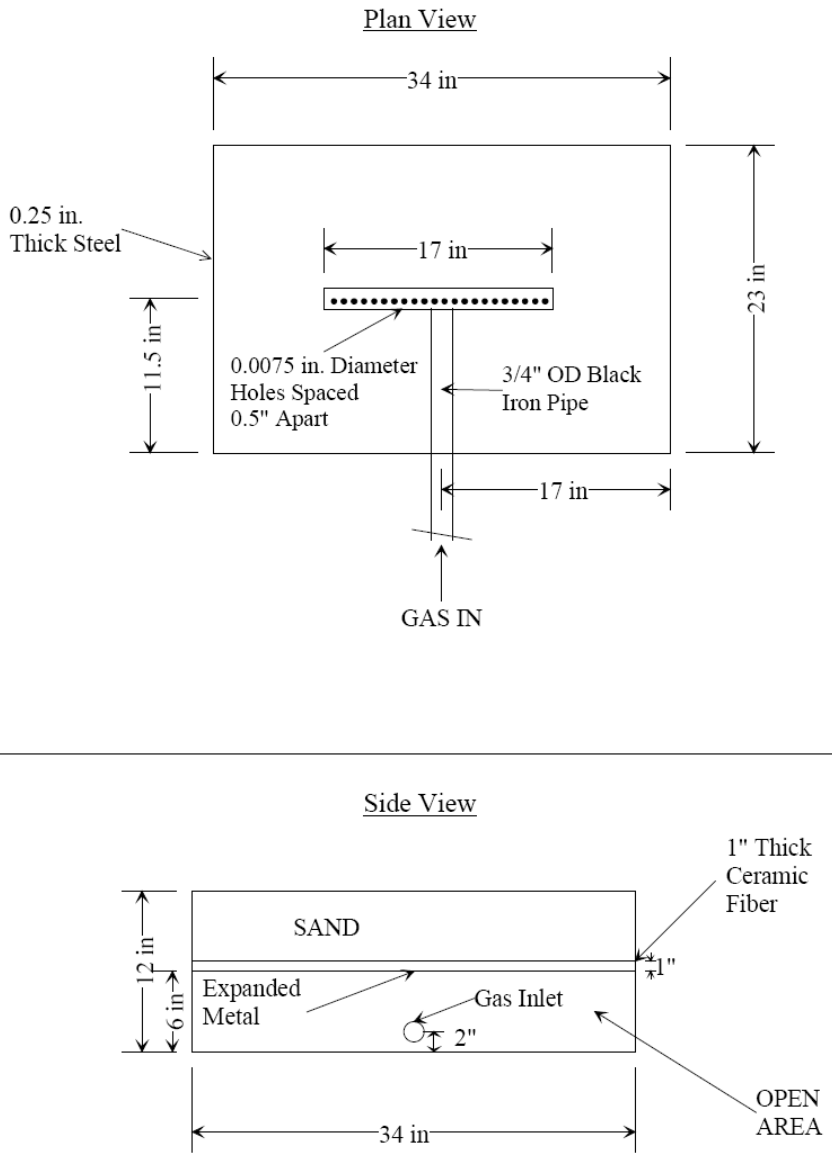


FIGURE B-4. Ignition burner.

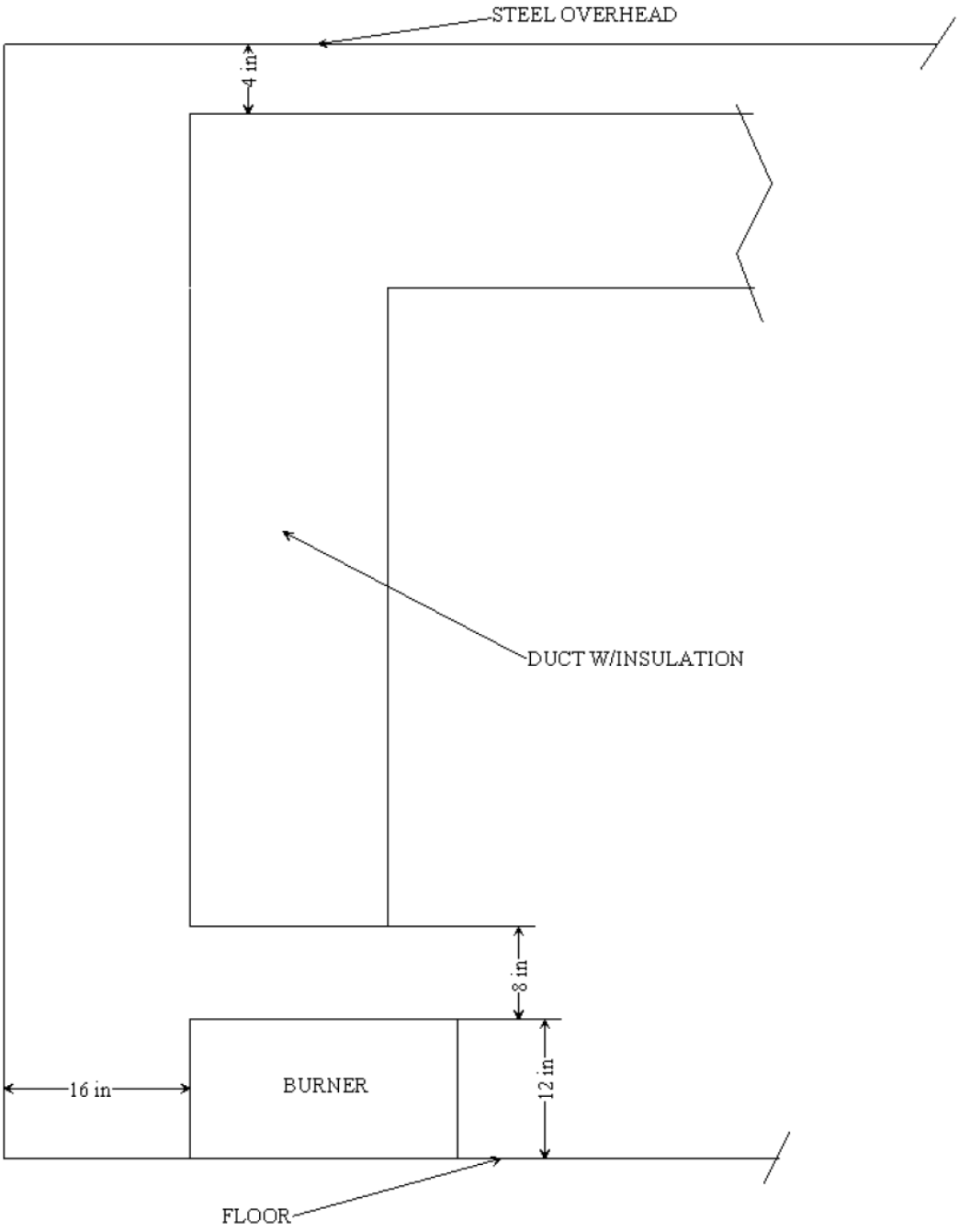
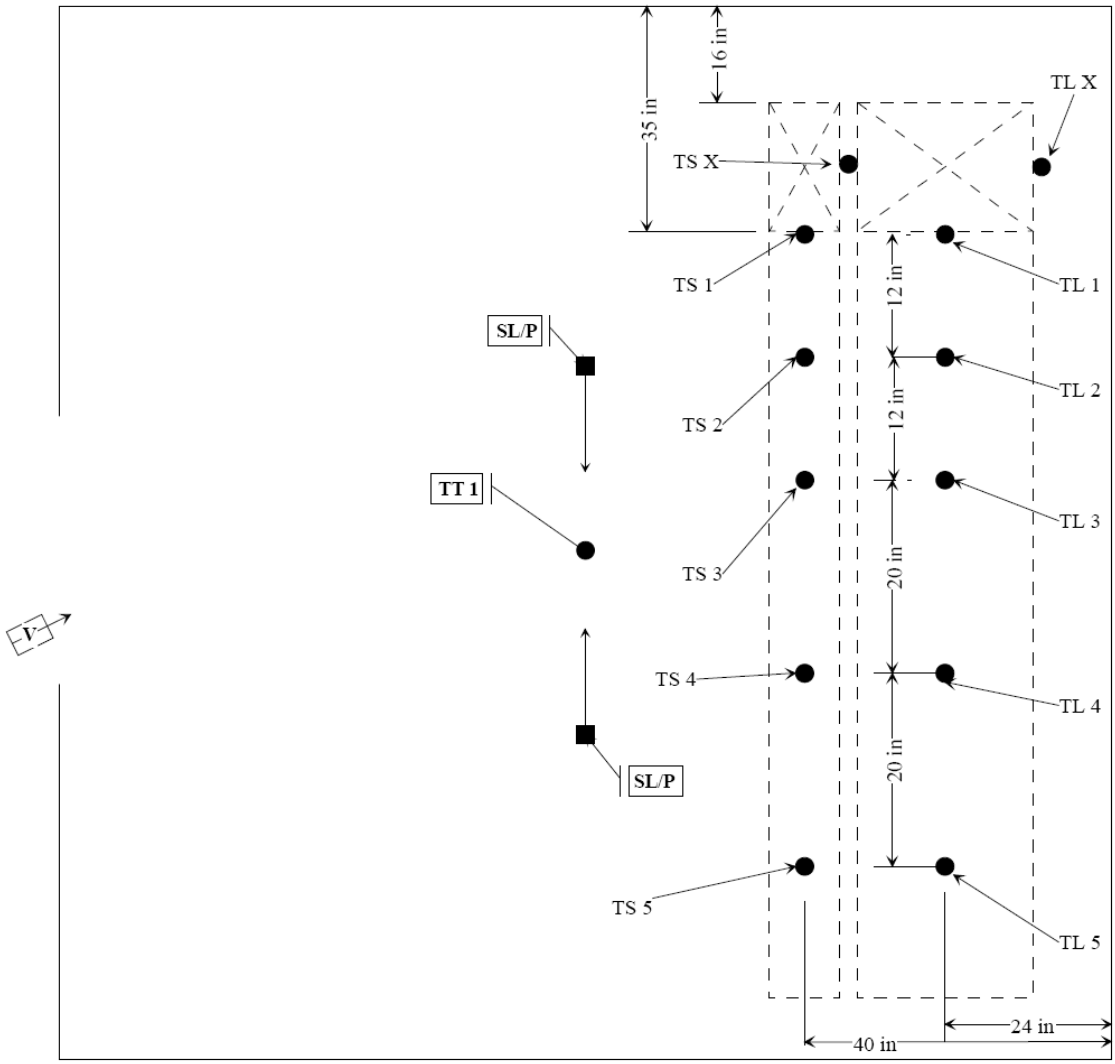


FIGURE B-5. Side view of duct and burner arrangement.

B.5 INSTRUMENTATION

B.5.1 Instrumentation. A general layout of the instrumentation is shown on figure B-6.

B.5.1.1 Temperatures. A vertical thermocouple tree shall be located in the center of the compartment. The tree shall consist of 16 thermocouples located every 6 inches below the ceiling. Temperatures shall also be measured along the vertical and the horizontal runs of the ducts (see B.5.1.2). All of the thermocouples shall be a maximum of 24 gauge, Type K, thermocouples. Each thermocouple shall have a bare bead.



TS 1 - 5: Thermocouples along the horizontal section of the small duct (2" below overhead)
TS X: Array of 4 thermocouples between the vertical sections of the ducts
TL 1 - 5: Thermocouples along the horizontal section of the large duct (2"below overhead)
TL X: Array of 4 thermocouples along the vertical section of the large duct (1" from surface of insulation)
TT 1: Thermocouple tree in the center of the room
SL/P: Smoke laser/photocell located at the center of the room (3 each)
V: Video camera directed into the room through the vent door

FIGURE B-6. Plan view of instrumentation layout.

B.5.1.1 Temperatures. A vertical thermocouple tree shall be located in the center of the compartment. The tree shall consist of 16 thermocouples located every 6 inches below the ceiling. Temperatures shall also be measured along the vertical and the horizontal runs of the ducts (see B.5.1.2). All of the thermocouples shall be a maximum of 24 gauge, Type K, thermocouples. Each thermocouple shall have a bare bead.

B.5.1.2 Flame spread. Along with visual observations, flame spread may be assessed using thermocouples along the entire simulated duct array. The thermocouples shall be installed along both the vertical and horizontal portions of the duct assembly as shown on figures B-6 and B-7. All of the thermocouples shall be a maximum of 24 gauge, Type K, thermocouples. Each thermocouple shall have a bare bead.

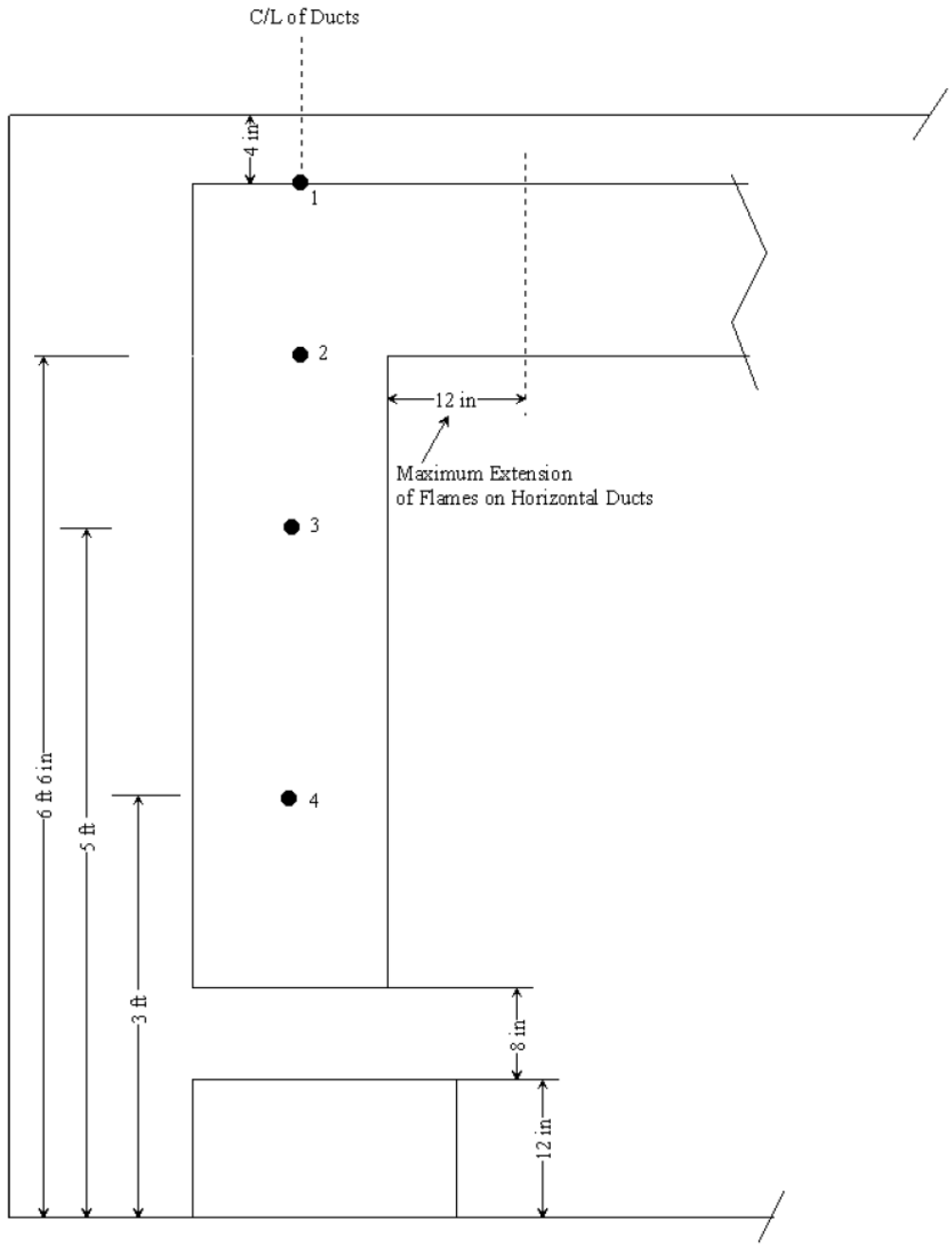


FIGURE B-7. Vertical trees – TS X and TL X.

B.5.1.3 Gas concentrations. Gas analyzers shall provide a continuous monitoring of O_2, CO, and CO_2 concentrations of gases in the exhaust hood. The oxygen concentration shall be measured via a paramagnetic oxygen analyzer while the CO and CO_2 concentrations shall be measured via infrared process analyzers.

B.5.1.4 Smoke. Three light/photocells or equivalent instruments shall be used to assess the smoke production within the compartment. The path length shall be 3.3 feet, and they shall be placed horizontally at 3.84, 5.35, and 6.56 feet above the deck and near the center of the compartment. One light/photocell assembly or equivalent instruments shall also be used to assess the smoke production within the exhaust duct.

B.5.1.5 Target array. In order to assess the potential for the duct insulation materials to cause secondary ignitions due to melting, dripping, or falling pieces, a target array of wood excelsior shall be placed on the deck of the compartment beginning 1 foot away from the edge of the gas burner, under the horizontal duct run, and extend the full length and width of the horizontal portion of the duct configuration.

B.5.1.6 Weight loss. In order to assess the amount of insulation consumed during the test, each duct shall be weighed prior to insulation being applied, weighed in its final insulated test configuration, and weighed at the conclusion of the test.

B.5.1.7 Heat release rate. The heat release rate of the fire inside the compartment shall be measured. A hood/exhaust system shall be used to capture all of the exhaust gases exiting from the room doorway. The exhaust system shall be instrumented so as to measure the heat release rate based on oxygen depletion calorimetry.

B.5.1.8 Data collection. Data obtained during the test shall be recorded at intervals not to exceed 5 seconds.

B.6 DOCUMENTATION

B.6.1 Video. Full test video shall be taken during each test. The camera shall be located outside of the compartment vent providing a full view of the test array. When necessary, the camera may be relocated to document unusual test developments.

B.6.2 Photographs. A series of photographs shall, as a minimum, be taken before and after each test showing the arrangement of the test configuration.

B.6.3 Damage sketches. In order to more effectively show the extent of duct insulation damage, post-test sketches shall be made of each tested configuration. This may involve the removal of the exterior lagging (when required) and exposing and measuring the damaged insulation.

B.7 INSTALLATION OF TEST MATERIALS

B.7.1 Installation of test materials. The duct insulation shall be installed on both ducts. The insulation shall also be installed on the bottom of the vertical riser section. All butt joints and seams shall be sealed using the appropriate adhesives. Figure B-8 shows an elevation view of a typical installed insulation. If laggings/adhesives are used, then the cure time as specified by the manufacturer shall be allowed prior to testing.

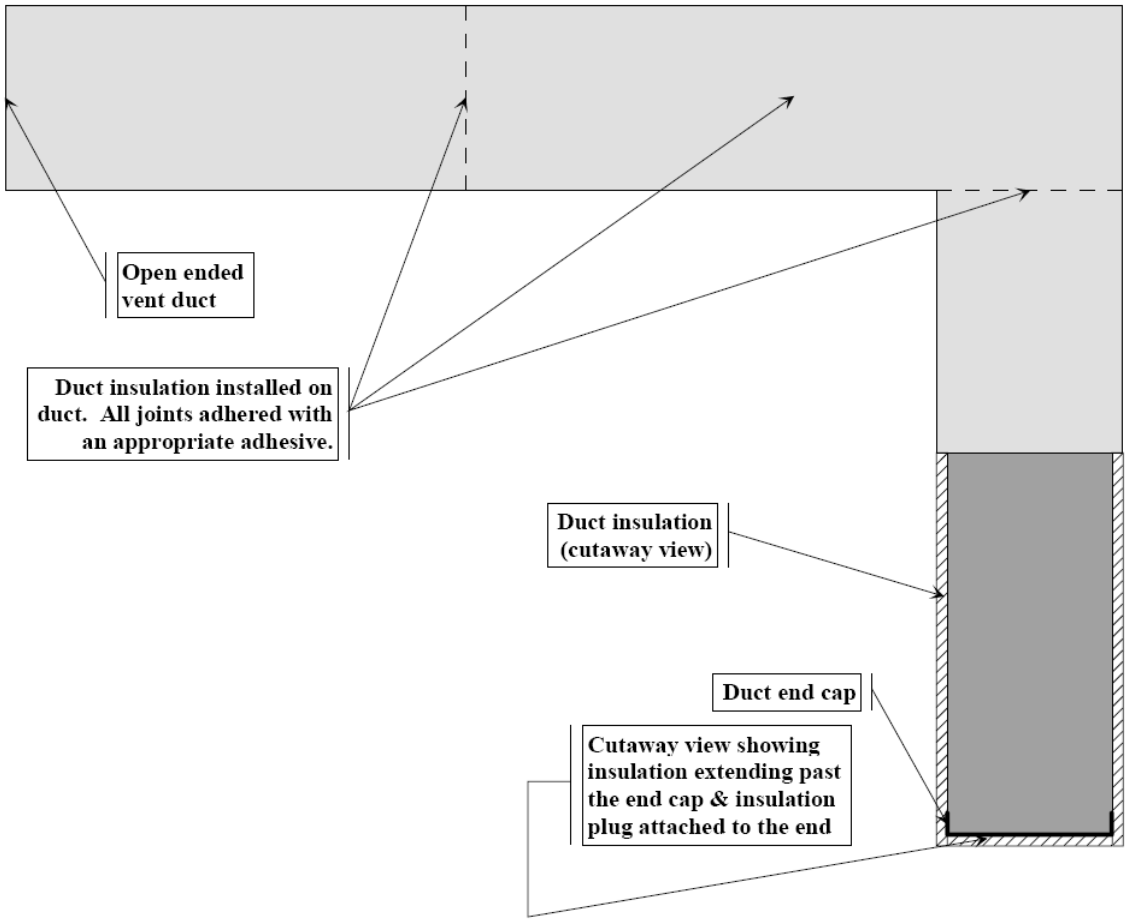


FIGURE B-8. Typical elevation of duct with insulation installed.

B.8 TEST PROCEDURES

B.8.1 Environmental. The environmental conditions inside the test compartment just prior to test shall be 50 to 90 °F.

B.8.2 Procedures. The following test procedures shall be followed:

a. Clean the sand burner.

b. Verify placement of gas burner.

c. Install test ducts.

d. Verify placement and operation of instrumentation, video, and position of target array.

e. Verify environmental conditions.

f. Begin 2-minute baseline data collection.

g. At 2-minute mark, ignite gas burner.

h. At 20 minutes of burn time (22 minutes total) shutoff the gas burner.

i. If flaming is noted on the test ducts after the burner is secured, continue video and data collection until all flaming has ceased or 10 minutes have elapsed, whichever occurs first.

j. The test may be ended at an earlier time due to safety considerations.

Custodians:
Army – CR4
Navy – SH
Air Force – 99

Review Activities:
Army – CE
Navy – YD
Air Force – 84
DLA – IS

Preparing Activity:
Navy – SH
(Project 5640-2010-002)

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 https://assist.daps.dla.mil.