INCH-POUND

MIL-PRF-32161
29 June 2004

PERFORMANCE SPECIFICATION
INSULATION, HIGH TEMPERATURE FIRE PROTECTION, THERMAL AND ACOUSTIC

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification establishes the requirements for high temperature materials for use as fire protection, and thermal insulation and acoustic insulation for fire protection areas.

1.2 Classification. High temperature insulation materials should be of the following types and classes, as specified (see 3.4, 6.1.1 and 6.2), and have a fire resistance designation of N-30 (see A.7.3.1.4.2).

Type I - High temperature insulation panel, fire-protective

Type II - High temperature insulation panel, ambient thermal

Type III - High temperature insulation panel, acoustical

Class 1 - Alternate acoustic absorptive treatment for ventilation ducts, bulkheads, and overheads

Class 2 - Alternate acoustic absorptive treatment for machinery Spaces

Class 3 - Alternate high transmission loss treatment for use in other than machinery spaces

Class 4 - Alternate high transmission loss treatment for use in machinery spaces

Comments, suggestions, or questions on this document should be addressed to Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or emailed to commandstandards@navsea.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 www.dodssp.daps.mil

AMSC N/A FSC 2090

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-A-23054	- Acoustical Absorptive Board, Fibrous Glass, Perforated Fibrous Glass Cloth Faced.
MIL-PRF-24596	- Coating Compounds, Nonflaming, Fire-Protective (Metric).
DOD-E-24607	- Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semi gloss (Metric).

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

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.

BUREAU OF MEDICINE AND SURGERY (BUMED)

BUMED INST 6270.8 - Procedures for Obtaining Health Hazard Assessments Pertaining to Operational Use of a Hazardous Material.

(Copies of this document are available online at https://bumed.med.navy.mil or from Bureau of Medicine and Surgery, Department of the Navy, 2300 E Street, NW, Washington, DC 20372-5300.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

S9510-AB-ATM-010 Rev 2 of 30 July 1992 - Nuclear Powered Submarine Atmosphere Control Manual.

(Copies of this document are available from the Naval Sea Systems Command, Code SEA 05Z9, 1333 Isaac Hull Avenue, SE, Stop 5133, Washington Navy Yard DC 20376-5133.)

CODE OF FEDERAL REGULATIONS

40 CFR 261 - Protection of Environment: Identification and Listing of Hazardous Waste

(Copies of these documents are available online at www.access.gpo.gov/nara/cfr or from the Superintendent of Documents, U.S. Government Printing Office, North Capitol & "H" Streets, N.W., Washington, DC 20402-0002.)

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 C 167	-	Thickness and Density of Blanket or Batt Thermal Insulations, Test Methods for. (DoD adopted)
ASTM C 177	-	Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, Standard Test Method for. (DoD adopted)
ASTM C 423	-	Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method, Standard Test Method for. (DoD adopted)
ASTM C 518	-	Steady-State Heat Flux Measurements and Thermal Transmission Properties by means of the Heat Flow Meter Apparatus, Standard Test Method for. (DoD adopted)
ASTM C 592	-	Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type), Standard Specification for. (DoD adopted)
ASTM C 665	-	Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing, Standard Specification for. (DoD adopted)
ASTM C 1139	-	Fibrous Glass Thermal Insulation and Sound Absorbing Blanket and Board for Military Applications, Standard Specification for.
ASTM D 579	-	Greige Woven Glass Fabric, Standard Specification for. (DoD adopted)
ASTM D 5035	-	Breaking Force and Elongation of Textile Fabrics (Strip Method), Standard Test Method for. (DoD adopted)
ASTM E 84	-	Surface Burning Characteristics of Building Materials, Standard Test Method for. (DoD adopted)
ASTM E 90	-	Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions and Elements, Standard Test Method for. (DoD adopted)
ASTM E 795	-	Mounting Test Specimens During Sound Absorption Tests, Standard Practices for. (DoD adopted)
ASTM E 1123	-	Mounting Test Specimens for Sound Transmission Loss Testing of Naval and Marine Ship Bulkhead Treatment Materials, Standard Practices for.

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

UNDERWRITERS LABORATORIES (UL)

UL 1709	-	Rapid Rise Fire Tests of Protection Materials for Structural Steel

(Copies of this document are available www.ul.com or Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.)

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

3. REQUIREMENTS

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

3.2 Material.

3.2.1 Composition.

3.2.1.1 Type I. Type I shall consist of a high temperature fire insulation panel, plus additional materials and requirements as specified in 3.4.1. Asbestos and ceramic fibers and components containing asbestos and ceramic fibers are prohibited.

3.2.1.2 Types II and III. Types II and III shall consist of a high temperature fire insulation panel (type I) plus additional materials and requirements as specified in 3.4.1. The type I material contained in type II and type III configurations shall be the thickness that meets 3.5.3.3 and shall be the outermost layer of the configuration. Asbestos and ceramic fibers and components containing asbestos and ceramic fibers are prohibited.

3.2.2 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.

3.2.3 Toxicity. The high temperature fire insulation shall have no adverse effect on the health of personnel when used for its intended purpose. The high temperature fire insulation shall be assessed by the Navy Environmental Health Center (NAVENVIRHLTHCEN) using the administrative Health Hazard Assessment (HHA). A flowchart for this process can be found as enclosure (1) of BUMEDINST 6270.8. The HHA is a review of the high temperature fire insulation based on information submitted by the manufacturer, to assess health hazards associated with the handling, application, use and removal of the product. The high temperature fire insulation shall not cause any environmental problems during waste disposal (see 4.5 and 6.5).

3.2.4 Off-gassing. The high temperature fire insulation shall meet the requirements in the Nuclear Powered Submarine Atmosphere Control Manual, NAVSEA Technical Manual S9510-AB-ATM-010/(U), for a usage category of Limited (see 4.6 and 6.6).

3.3 High temperature insulation panel.

3.3.1 Dimensions and tolerances. Dimensions and dimensional tolerances are specified in table I (see 6.2).

TABLE I. Dimensional tolerances.

Type	Length (in.)	Width (in.)	Maximum* thickness (in.)	Tolerances (in.)		
				Length	Width	Thickness
Type I, II, and type III classes 1 and 2	36 - 48	24	2.25	±1/4	±1/4	+1/8, -0
Type III, classes 3 and 4	36 - 48	24	4	±1/4	±1/4	+1/4, -0

* Note: A variation of maximum thickness may be requested from NAVSEA to meet the performance requirements of this specification.

3.3.2 Areal density. The density of all types of high temperature insulation panels shall not exceed limits specified in table II.

TABLE II. Material density.

Type	Maximum areal density (lb/ft^2)
Type I	1.4
Type II	1.22
Type III, Class 1	1.31
Type III, Class 2	1.22
Type III, Class 3	3.62
Type III, Class 4	3.52

3.4 Types I, II, and III high temperature insulation panels. Types I, II and III high temperature insulation panels shall have facing materials as described in 3.4.1.

3.4.1 Facing materials.

3.4.1.1 Type I and type II. Type I and type II shall have a facing material which, when separated from the insulation, shall have a breaking strength not less than the values specified in table III. The high temperature fire insulation panel shall be attached to the facing material using an adhesive that meets the fire tests as specified in MIL-A-3316, class 1, grade A adhesive.

TABLE III. Facing requirements.

Breaking strength, minimum, pounds for inch of width			
As received		After heating to 900°F for 2 hours	
Warp	Fill	Warp	Fill
300	255	70	60

3.4.1.2 Type III. Type III, classes 1 through 4, shall have a facing material conforming to the requirements of MIL-A-23054, or to the requirements of ASTM C 1139, type III. The high temperature fire insulation panel shall be attached to the facing material using an adhesive that meets the fire tests as specified in MIL-A-3316, class 1, grade A adhesive.

3.4.2 Facing alignment. In the event that the facing material does not cover the entire surface of the high temperature fire insulation panel, the uncovered portion of the panel shall not extend farther than 1/8 inch from any edge. The facing shall not extend over the edge of the panel more than 1/8 inch.

3.4.3 Facing material adhesion. The facing on types I, II and III shall have a peel strength of not less than 1 lb/in^2.

3.4.3.1 Test notes and observations. Because of the various types of insulation material and attachment methods used, variations in peel strengths may be observed. Some backing materials may not have sufficient structural strength to withstand more than 1 pound of separation force from the cemented facing material. In these instances, it may be observed that the insulation backing material has separated, and a thin layer of matt may be seen attached to the facing. This is not a failure of the adhesive used; it is structural failure of the backing material. Failure of the backing material should be noted in the test report.

3.5 Performance characteristics.

3.5.1 Thermal conductivity of high temperature insulation panel. The thermal conductivity (k) of the type I high temperature fire insulation panel shall not exceed 0.26 Btu-in/ft^2-hr-°F at mean temperature of 75°F (23°C). The thermal conductivity (k) of the type II high temperature thermal insulation panel shall not exceed 0.28 Btu-in/ft^2-hr-°F at mean temperature of 75°F (23°C).

3.5.2 Paintability. Type I, II and III high temperature fire insulation faced panels shall be compatible with specified paint.

3.5.3 Fire performance.

3.5.3.1 Flame spread (types I, II and III). The flame spread index shall not be greater than 25 for type I, type II and type III, classes 1 through 4.

3.5.3.2 Smoke density (types I, II and III). Smoke developed index shall not be greater than 50.

3.5.3.3 Full-scale fire resistance test (type I). The full-scale fire resistance test shall provide a minimum of 30 minutes of protection based on:

a. The fire-containment assembly, bulkhead assemblies with attached insulation, shall have withstood the fire endurance test without passage of flame for a time period equal to that for which the classification is desired, and

b. Transmission of heat through the assembly during the fire endurance test period shall not have raised the average temperature on its unexposed surface more than 250°F (139°C) above its initial temperature, nor the temperature of any one point on the surface, more than 325°F (181°C) above its initial temperature (see 4.4.8.3).

3.5.4 Acoustical performance.

3.5.4.1 Acoustical absorption. Acoustical absorption for type II and type III, classes 1 and 2, shall be equal to or greater than the values in table IV.

TABLE IV. Acoustical absorption properties (type II and type III).

Type	Thickness (in.)	Octave band center frequency (Hz)					
		125	250	500	1000	2000	4000
Type II	2 maximum	0.50	0.60	0.60	0.40	0.20	0.10
Type III, class 1	2 maximum	0.25	0.70	0.85	0.85	0.75	0.75
Type III, class 2	2 maximum	0.40	0.90	0.85	0.70	0.50	0.20

Note: Values indicated under octave band frequency are sound absorption coefficients (Sabin/ft^2).

3.5.4.2 Acoustical transmission loss. Acoustical transmission loss for type II and type III, classes 1 through 4, shall be equal to or greater than the values in table V.

TABLE V. Acoustical transmission loss properties (type II and type III).

Type	Maximum thickness (in)	Octave Band Frequency (Hz)																	
		100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
Type II Class 1	2	-4	-4	-5	-5	-2	1	4	7	10	11	12	14	17	18	18	20	20	20
Type III Class 1	2	1	-1	-4	-5	-2	1	3	5	8	10	12	11	15	17	13	12	11	15
Class 2	2	1	-1	-4	-5	-2	1	3	5	8	10	12	11	15	17	13	12	11	15
Classes 3 and 4	4	-3	-2	2	7	13	16	17	18	18	18	20	22	25	25	25	25	26	23

Note: Values indicated under 1/3 octave band frequency are in decibels (dB), and represent the minimum values to be achieved in order to classify type II and type III insulation materials as acceptable when tested in accordance with ASTM E 90, using the mounting method specified in ASTM E 1123. Values specified in table V represent measured transmission loss of the bulkhead structure with insulation material installed, minus measured transmission loss of the bulkhead structure without any insulation material installed (see ASTM E 1123, section 5.1.1).

3.6 Corrosiveness to steel, copper and aluminum. There shall be no corrosion greater than observed with sterile cotton.

3.7 Resistance to vibration. The insulation blanket shall not, after heating/vibration, lose more than 15.0 percent in mass, nor sag an average of more than 3 inches. There shall be no detrimental effect to the overall physical characteristics of the blanket when comparing to a control specimen. For example, bolts cutting through the insulation material that cause large quantities of fiber or insulation blanket pieces to drop off the test stand holder during or after the test is unacceptable.

3.8 Compression for type I. The unit load required to compress the board to 40 percent of its original thickness shall average not less than 1246 Newton per square meter (N/m^2) (255 pounds per square foot (lb/ft^2)). Upon completion of the test, the board, after a 5-minute interval, shall return to at least 70 percent of its original thickness.

3.9 Disposal. The manufacturer shall certify that the high temperature fire insulation shall not contain any hazardous material or exhibit any hazardous characteristic as defined under 40 CFR 261 (Code of Federal Regulations).

3.10 Workmanship. The finished high temperature insulation units (panels) shall conform to the quality and grade of product established by this document.

4. VERIFICATION

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

a. First article inspection (see 4.2).
b. Conformance inspection (see 4.3).

4.1.1 Inspection conditions. Unless otherwise specified, all inspections shall be performed in accordance with 4.2, 4.3, and 4.4.

4.2 First article inspection. First article inspection shall consist of the examinations of and tests specified in table VI, 4.4, and 4.5. Testing shall be performed on unpainted samples.

TABLE VI. First article inspection.

Inspections	Requirements	Tests
Toxicity	3.2.3	4.5
Off-gassing	3.2.4	4.6
Dimensions and tolerances	3.3.1	4.4.1
Areal density	3.3.2	4.4.2
Facing material adhesion	3.4.3	4.4.5
Thermal conductivity	3.5.1	4.4.6
Flame spread	3.5.3.1	4.4.8.1
Smoke density	3.5.3.2	4.4.8.2
Full-scale fire resistance test	3.5.3.3	4.4.8.3
Acoustical absorption	3.5.4.1	4.4.9.1
Acoustical transmission loss	3.5.4.2	4.4.9.2
Corrosiveness	3.6	4.7
Resistance to vibration	3.7	4.8
Compression	3.8	4.9

4.2.1 First article sample. The first article sample shall consist of one unit (panel) from each type of high temperature insulation acquired at any one time.

4.3 Conformance inspection.

4.3.1 Inspection of end item. Inspections shall be in accordance with table VII, except where otherwise noted. Testing shall be performed on unpainted samples.

TABLE VII. Inspection of end item.

Inspections	Requirements	Tests
Dimensions and tolerances	3.3.1	4.4.1
Areal density	3.3.2	4.4.2
Facing alignment	3.4.2	4.4.4
Facing material adhesion	3.4.3	4.4.5
Paintability	3.5.2	4.4.7

4.3.1.1 Examination of end item. The lot size shall be the total number of units (panels) (see 4.3.1.1.1).

4.3.1.1.1 Examination of end item for defects in appearance. Inspections shall be in accordance with table VIII and 4.3.2.2.1, except where otherwise noted. Not more than 5 units (panels) shall be selected from a single carton.

TABLE VIII. Examination for visual defects.

Examine	Defect
Appearance (types I, II, and III)	Material is not uniform, void areas noted, facing misaligned, or panel not square.
Classification	Type not as specified (see 1.2).

4.3.2 Testing of the end item.

4.3.2.1 Lot. A lot shall consist of all units (panels) 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.

4.3.2.2 Sampling.

4.3.2.2.1 Sampling for visual examination. At a minimum, the contractor shall randomly select samples from each lot of completed high temperature insulation material as specified in table IX, and inspect them as specified in 4.3.1.1.1 (see 6.2).

TABLE IX. Sampling for visual examination of high temperature insulation material.

Lot size	Sample size
2 to 50	5
51 to 90	7
91 to 150	11
151 to 280	13
281 to 500	16
501 to 1,200	19
1,201 to 3,200	23
3,201 to 10,000	29
10,001 to 35,000	35

4.3.2.2.2 Sampling for tests. At a minimum, the contractor shall randomly select a sample quantity from each lot of completed high temperature insulation material as specified in table X, and test them as specified in 4.4.1 through 4.4.9.2 (see 6.2).

Table X. Sampling for tests.

Lot size	Sample size
2 to 25	3
26 to 50	5
51 to 90	6
91 to 150	7
251 to 280	10
281 to 500	11
501 to 1,200	15
1,201 to 3,200	18
3,201 to 10,000	22
10,001 to 35,000	29

4.3.2.3 Noncompliance. If a sample fails to pass its appropriate inspections, the Contractor shall notify the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected; which were manufactured with essentially the same materials and processes; and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, suitable to the inspection activity, has been taken. After the corrective action has been taken, appropriate inspections shall be repeated on additional sample units. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity.

4.4 Test procedures.

4.4.1 Dimensions. Thickness, length and width shall be determined in accordance with the method specified in ASTM C 167 (see 3.3.1).

4.4.2 Areal density. Density tests shall be performed in accordance with ASTM C 167 (see 3.3.2).

4.4.3 Breaking strength of outer facing (see 3.4.1.1).

4.4.3.1 Method. Unless otherwise specified, breaking strength shall be in accordance with ASTM D 5035. Outer facing specimens shall be cut in both warp and fill directions. Five tests shall be made upon each sample, and the results averaged to give the breaking strength of the sample.

4.4.3.2 Setup. In order to prevent the jaws of the testing machine from cutting the outer facing, the ends of each specimen shall be coated with a polymer solution in accordance with ASTM D 579, or rubber, or painted with a thick shellac for a distance of 1-5/8 inches from each end and allowed to dry in the air before being raveled to the 1-inch width. Small pieces of manila paper or soft cotton twill fabric shall be inserted between the specimen and the face of the jaw.

4.4.3.3 Preparation. For determining the breaking strength after heating, a muffle furnace with accurate, automatic temperature control shall be used. Two specimens 6 inches long and 8 inches wide shall be cut, one with the 6-inch dimension parallel to the warp and the other with the dimension parallel to the fill. The specimens shall be supported on a wire screen or perforated metal plate at least 1/2 inch above the floor of the furnace, and not more than five specimens shall be superimposed upon one another. The furnace thermocouple shall be centrally located not more than 1/2 inch above the topmost specimen.

4.4.3.4 Heating. Specimens shall be placed inside the furnace with the temperature not greater than 200°F and with the furnace door partly open. The temperature shall gradually be raised to 500°F and maintained at this point, until all smoking ceases. The total time consumed in the operation shall not be less than 1 or more than 2 hours. Specimens shall be removed from the furnace and the temperature increased to 900°F. The specimens shall be replaced in the furnace and shall be maintained at 900°F for 2 hours. Then they shall be removed, allowed to cool to room temperature, and the required breaking strength strips cut and tested, as specified in 4.4.3.1.

4.4.4 Facing alignment. Facing alignment shall be determined by direct measurement, using a steel rule with 1-mm graduations (see 3.4.2).

4.4.5 Facing material adhesion.

4.4.5.1 Procedure. Using the test assembly illustrated in figure 1 and a tensile test device, conduct facing material peel tests. The tensile machine shall be configured with a 100-pound load cell utilizing the 50-pound scale for the initial pull. The 10-pound scale may be used to facilitate more accurate readings once the initial separating force is determined. The jaw speed used for this test shall be 6 inches per minute (see 3.4.3).

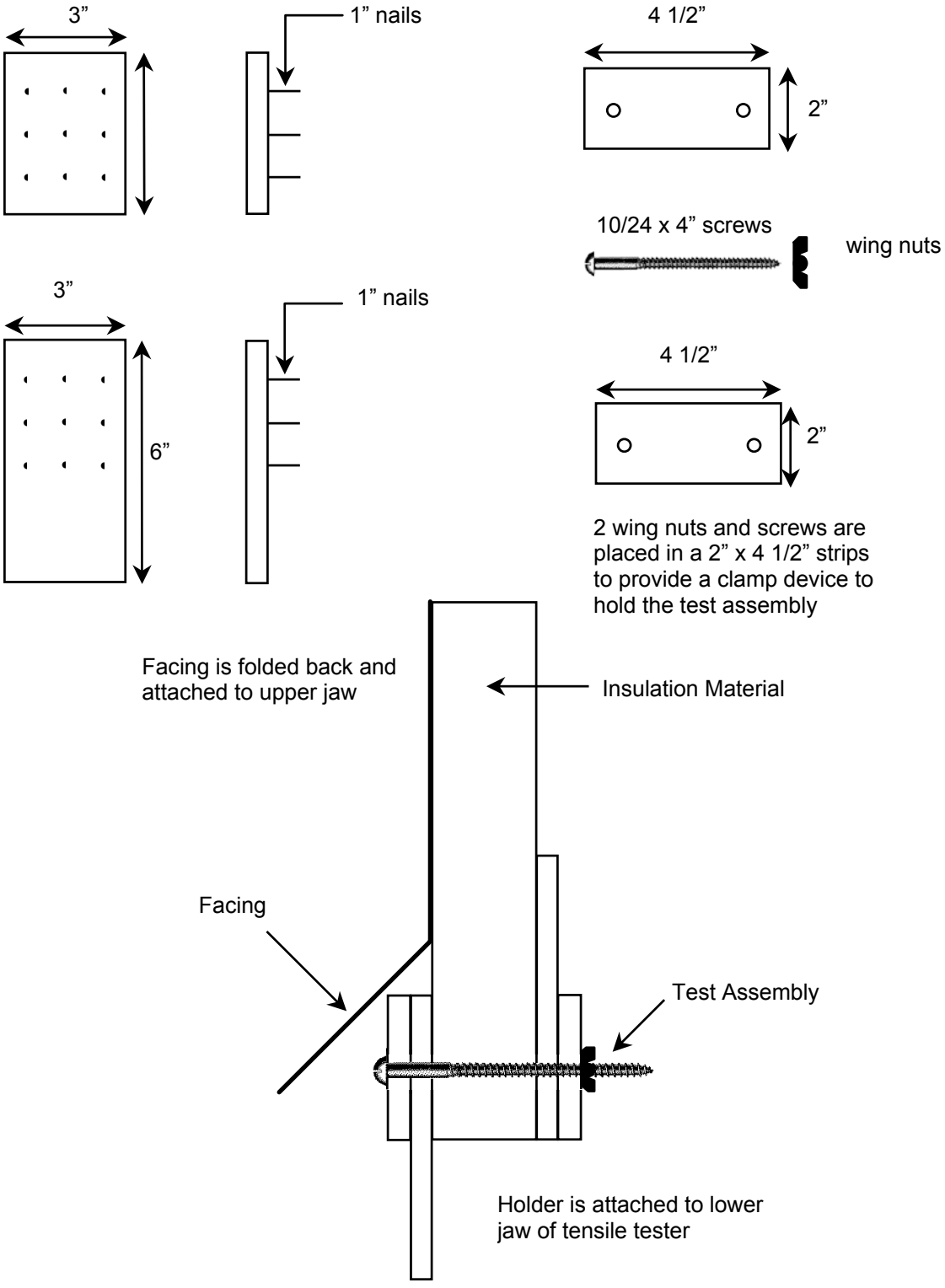


FIGURE 1. Test Assembly.

4.4.5.2 Specimen preparation. Test specimens shall be cut 3 inches wide and 14 inches long. It is preferred that manufacturers provide test specimens with only 6 inches of facing material cemented to the backing material. If this is not possible, cut specimens to size and use a sharp knife to carefully skin the facing material from the backing material for a length of 8 inches. Cut 2 inches off the backing material so that the facing extends 2 inches beyond the backing matt. This will allow space for the facing material to be placed in the tensile tester jaw, without distorting the test specimen.

4.4.5.3 Specimen set-up. Fold the separated facing material back over the cemented piece (a loose-fitting rubber band may be used to keep the facing out of the way during assembly). Place the specimen backing matt on one side of the 4-inch-by-3-inch board with nails (the facing should be up). Align the matt until it is even with both sides and has a length of 4 inches on the board. Press the backing matt on the nails. Carefully align the longer board with nails over the backing matt (also a length of 4 inches on the board) and press firmly in place. The facing material should be on the smooth side of the longer board. Place clamping device over the two boards and tighten with nuts until a slight amount of compression of the backing matt is noted.

4.4.5.4 Set-up of test apparatus in tensile tester. Place the long board of the test assembly in the lower jaw of the tensile tester, with the smooth side of the board and facing material towards the front of the machine. Remove the rubber band (if used) from the facing material and place the 2-inch overlap of facing material in the upper jaw. The material should be aligned as nearly as possible to a 180° pull.

4.4.5.5 Test procedure. Set the jaw drive speed to 6 inches per minute. Start tensile tester and observe force required to peel facing material from the backing matt. Separation forces may vary from 1 pound to 35 pounds.

4.4.6 Thermal conductivity. Thermal conductivity shall be determined in accordance with ASTM C 177 or ASTM C 518 (see 3.5.1). In the case of a dispute, ASTM C 177 shall be the referee test method.

4.4.7 Paintability. Apply one coat of latex flat primer, conforming to MIL-PRF-24596, and one coat of fire-retardant paint, conforming to DoD-E-24607 or MIL-PRF-24596 to the cloth surface of the high temperature insulation facing. The paint shall dry to a uniform smooth coat, which shall have a semi-gloss appearance when viewed under ordinary conditions of illumination. There shall be no shiners or flashers. Tinted colors shall dry to a uniform color (see 3.5.2).

4.4.8 Fire tests. Fire tests shall be performed on unpainted samples.

4.4.8.1 Flame spread. Flame spread tests shall be performed in accordance with ASTM E 84 (see 3.5.3.1).

4.4.8.2 Smoke density. Smoke-developed tests shall be performed in accordance with ASTM E 84 (see 3.5.3.2).

4.4.8.3 Full-scale fire resistance test. The full-scale fire resistance test shall be performed in accordance with Appendix A (see 3.5.3.3).

4.4.9 Acoustical tests. Acoustical tests shall be performed on unpainted samples.

4.4.9.1 Acoustical absorption. Acoustical absorption tests shall be performed in accordance with ASTM C 423, using mounting method A of ASTM E 795 (see 3.5.4.1).

4.4.9.2 Acoustical transmission loss. Acoustical transmission loss tests shall be performed in accordance with ASTM E 90, using the mounting method specified in ASTM E 1123 (see 3.5.4.2).

4.5 Toxicity. To determine conformance with the requirements of 3.2.3, high temperature fire insulation shall be evaluated using the HHA process. Sufficient data to permit a HHA of the product shall be provided by the manufacturer/distributor to the NAVENVIRHLTHCEN. To obtain current technical information requirements specified by the NAVENVIRHLTHCEN, see 6.6.

4.6 Off-gassing. The high temperature fire insulation shall be tested in accordance with the Nuclear Powered Submarine Atmosphere Control Manual, NAVSEA Technical Manual S9510-AB-ATM-010, by a Government approved testing facility. The results shall be submitted to the Government for evaluation and approval for use (see 3.2.4 and 6.6).

4.7 Corrosiveness to steel, copper, and aluminum. The insulation shall be tested in accordance with the corrosiveness method of ASTM C 665 (see 3.6).

4.8 Resistance to vibration. Vibration resistance shall be conducted in accordance with the test method in the Supplementary Requirements Section of ASTM C 592 (see 3.7).

4.9 Compression. The compression test shall be performed in accordance with ASTM C 167 to determine conformance with the requirements of 3.8.

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 command. 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 which may be helpful, but is not mandatory.)

6.1 Intended use. Material covered by this document is intended for use as high temperature fire, thermal and acoustic insulation for ship hulls, bulkheads, overheads, decks, structural panels, stiffeners, and stanchions. It will be used to retard fire spread between compartments.

6.1.1 High temperature fire insulation equivalency rating. Type II and type III materials may be substituted for thermal and acoustic insulation materials (see 6.1.1.1 and 6.1.1.2).

6.1.1.1 Thermal insulation. High temperature thermal insulation may be substituted for thermal insulation in accordance with table XI. Substitutions of thermal insulation (specifically, MIL-I-742, type I) for the equivalent high temperature thermal insulation (type II), as detailed in this specification, are categorically disallowed.

6.1.1.2 Acoustic insulation. High temperature acoustic insulation may be substituted for acoustic insulation in accordance with table XI. Substitutions of acoustic insulation (specifically, MIL-A-23054; MIL-I-22023, type III; any high transmission loss treatment) for the equivalent high temperature acoustic insulation (type III, classes 1 through 4), as listed in this specification, are categorically disallowed.

Table XI. High temperature thermal and acoustic insulation substitutions.

Specified Thermal/acoustic insulation	Equivalent high temperature insulation from this specification	
	Type and class	Thickness (in.)
Thermal insulation MIL-I-742, type I, 2”	Type II	2.25 maximum
Acoustic insulation MIL-A-23054, 2” MIL-I-22023, type III, 2” For high transmission loss applications for use in other than machinery spaces, 1.0-pound or 1.5-pound septum, 4” For high transmission loss applications for use in machinery spaces, 1.0-pound or 1.5-pound septum, 4”	 Type III, class 1 Type III, class 2 Type III, class 3 Type III, class 4	 2 maximum 2 maximum 4 maximum 4 maximum

6.1.2 Painting instructions. The faced material should be primed with one coat of latex emulsion flat primer, conforming to MIL-PRF-24596, in accordance with manufacturer instructions. The finish coat should be one coat of fire-retardant paint conforming to DoD-E-24607 or MIL-PRF-24596.

6.1.3 Installation details. Installation details for this material are contained in Appendix A. Details for studs and caps are contained in NAVSEA Standard Drawing 803-5184182. For Naval shipboard installation, the assembly with fire insulation and associated attachment method is intended to be shock tested (medium weight, Grade A, in accordance with MIL-S-901) prior to fire resistance testing. This shock test may be incorporated into the fire resistance test method of this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the specification.
b. Type (see 1.2).
c. When a first article sample is required (see 3.1).
d. Dimensions, as required (see 3.3.1).
e. Inspection conditions (see 4.1.1).
f. Lot size, if other than specified (see 4.3.2.1).
g. Sampling for visual examination (see 4.3.2.2.1).
h. Sampling for tests (see 4.3.2.2.2).
j. Packaging requirements (see 5.1).
k. Is Material Safety Data Sheet (MSDS) required? (see 6.4).
l. Toxicity conformance (see 3.2.3 and 6.5).
m. Is off-gassing testing required? (see 3.2.4 and 6.6).

6.3 First article. When a first article inspection is required, the item should be a first article sample. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

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

6.5 Toxicity evaluation. The NAVENVIRHLTHCEN requires sufficient information to permit a HHA of the product. Any questions concerning toxicity and requests for HHA should be addressed to the Commanding Officer, Navy Environmental Health Center, ATTN: Hazardous Materials Department, Industrial Hygiene Directorate, 620 John Paul Jones Circle, Suite 1100, Portsmouth, VA 20378-2103. Upon receipt of the HHA, a copy should be provided to Commander, Naval Sea Systems Command, ATTN: SEA 05Z9, 1333 Isaac Hull Ave., SE, Stop 5133, Washington Navy Yard, DC 20376.

6.6 Off-gassing. Materials to be installed in submarines are to be controlled to prevent off-gassing, which contaminates the atmosphere and results 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, NAVSEA Technical Manual S9510-AB-ATM-010/(U). 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 Commander, Naval Sea Systems Command, ATTN: SEA 05Z9, 1333 Isaac Hull Ave., SE, Stop 5122, Washington Navy Yard DC 20376-5122. The certification request is accompanied by detailed information, including descriptions of the material. 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 Commander, Naval Sea Systems Command, ATTN: SEA 05Z9, 1333 Isaac Hull Ave., SE, Stop 5160, Washington Navy Yard, DC 20376-5160. 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.

Acoustical fire insulation
Fire insulation
Thermal fire insulation

METHOD OF FIRE TESTS FOR FIRE RESISTANCE OF BULKHEADS AND DECKS

A.1 SCOPE

A.1.1 Scope. The test methods described in this document shall be used for determining the fire resistance performance of bulkheads and decks, with or without insulation, utilized on U.S. Navy Ships. This Appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.1.2 Testing requirements. The fire resistance testing specified in this method shall be conducted by an independent testing laboratory that is accredited by a Nationally Recognized Organization such that the laboratory complies with ISO/IEC 17025 or equivalent procedure.

A.1.3 It is the intent that tests conducted in accordance with these test methods will indicate whether bulkheads or deck assemblies will continue to perform their intended function during the period of fire exposure. These tests should not be construed as implying suitability for use after fire exposure.

A.1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

A.1.5 These test methods prescribe a standard fire exposure for comparing the relative performance of different assemblies under controlled laboratory conditions. See A.3.1 for definitions of different assemblies.

A.1.6 Limitations. These test methods do not provide the following:

A.1.6.1 Full information on the performance of assemblies constructed with components or of dimensions other than those tested.

A.1.6.2 An evaluation of the degree to which the assembly contributes to the fire hazard through the generation of smoke, toxic gases, or other products of combustion.

A.1.6.3 Measurement of flame spread over the surface of the test assembly.

A.1.6.4 Test procedures for measuring the performance of other structural shapes (such as vessel skirts), equipment (such as electrical cables, motor-operated valves, etc.), or other items that can be exposed to a rapid high rise, hydrocarbon liquid fire.

A.1.6.5 The erosive effect that the velocities or turbulence, or both, generated in large pool fires has on some fire protection materials.

A.1.6.6 Full information on the performance of assemblies at other exposure conditions or temperatures.

A.1.6.7 Full information concerning structural performance of assemblies under fire conditions.

A.1.7 This test method should be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and should not be used to describe or appraise the fire-hazard or fire-risk of materials, products, or assemblies under actual fire conditions. However, results of the test may be used as elements of a fire-hazard assessment or a fire-risk assessment that takes into account all of the factors that are pertinent to an assessment of the fire-hazard or fire-risk of a particular end use.

A.1.8 This test method does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

A.2 APPLICABLE DOCUMENTS

ASTM INTERNATIONAL

ASTM E 119 - Fire Tests of Building Construction and Materials
ASTM E 176 - Terminology Relating to Fire Standards

(Copies of these documents are available from www.astm.org or ASTM International, 100 Barr Harbor Avenue, PO Box C700, West Conshohocken, PA, USA 19428-2959.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO/IEC 17025 - General Requirements for the Competence of Testing and Calibration Laboratories

(Copies of this document are available from http://www.iso.ch or International Organization for Standardization (ISO) 1, rue de Varembé, Case postale 56 CH-1211 Geneva 20, Switzerland.)

UNDERWRITERS LABORATORIES (UL)

UL 1709 - Rapid Rise Fire Tests of Protection Materials for Structural Steel

(Copies of this document are available from www.ul.com or Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.)

A.3 TERMINOLOGY

A.3.1 Definitions. Refer to ASTM E 176 for definition of terms used in these test methods.

A.3.1.1 Fire Containment Assembly – a structure composed of a bulkhead or deck and attached insulation.

A.4 SUMMARY OF TEST METHODS

A.4.1 A standard fire exposure of controlled extent and severity is specified. The test setup will provide an average total heat flux of 65,000 ± 5,000 Btu per square foot (Btu/ft^2-h) (204 ± 16 kilowatts per square meter (kW/m^2)) and an average temperature of 2,000 ± 200 degrees Fahrenheit (°F) (1,093 ± 111 degrees Celsius (°C)). The required heat flux and temperature shall be attained within the first 5 minutes of the test exposure and maintained for the duration of the test. The fire environment is to be controlled by reproducing the furnace temperatures recorded during the furnace calibration method specified in A.6.1. This temperature shall be maintained throughout the remainder of the fire test as shown in figure A.1. Performance is defined as the time period during which assemblies will continue to perform their intended function when subjected to fire exposure. The results are reported in terms of time increments such as 1/2 hour, 1 hour, 1-1/2 hour, etc.

A.5 SIGNIFICANCE AND USE

A.5.1 These test methods are intended to provide a basis for evaluating the time period during which a bulkhead or deck assembly will continue to perform its intended function when subjected to a controlled, standardized fire exposure.

A.5.1.1 In particular, the selected standard exposure condition simulates the condition of total continuous engulfment of an assembly in the luminous flame (fire plume) of a large, free-burning, hydrocarbon fluid pool fire. The standard fire exposure is basically defined in terms of the total flux incident on the test specimen, together with appropriate temperature conditions.

A.5.1.2 It is recognized that the thermodynamic properties of free-burning, hydrocarbon fluid pool fires have not been completely characterized and are variable depending on the size of the fire, the fuel, environmental factors (such as wind conditions), the physical relationship of the structural member to the exposing fire, and other factors. As a result, the exposure specified in these test methods is not necessarily representative of all the

conditions that exist in large hydrocarbon pool fires. The specified standard exposure is based upon the best available information and testing technology. It provides a basis for comparing the relative performance of different assemblies under controlled conditions.

A.5.1.3 Approval of the material being fire tested will be limited to shipboard use with the assembly on which it was tested including attachment methods. Any variation from the construction or conditions (that is, size, method of assembly, and materials) that are tested may substantially change the performance characteristics of the assembly. Any variations shall be approved by the cognizant NAVSEA authority. Approval documentation should identify major limits for assembly variation for use by shipbuilders and installers.

A.5.1.4 A separate procedure is specified for testing the fire-containment capability of a bulkhead or deck assembly. Acceptance criteria include temperature rise of non-fire-exposed surface, plus the ability of the bulkhead or deck assembly to prohibit passage of flames.

A.6 CONTROL OF FIRE TEST

A.6.1 Fire test exposure conditions.

A.6.1.1 Expose the test specimen to heat flux and temperature conditions representative of total continuous engulfment in the luminous flame region of a large, free-burning, hydrocarbon fluid fueled pool fire. Essential conditions are specified in A.6.1.2 and A.6.1.3. Use calibration assemblies to demonstrate that the required heat flux and temperature levels are generated in the test facility.

A.6.1.2 The test setup will provide an average total heat flux on all exposed surfaces of the test specimen of 65,000 ± 5,000 Btu/ft^2-h (204 ± 16 kW/m^2). This may be controlled by varying the flow of fuel and air, or by varying other parameters within the individual test facility as necessary and allowable. Attain the heat flux of 65,000 ± 5,000 Btu/ft^2-hour (204 ± 16 kW/m^2) within the first 5 minutes of exposure and maintain it for the duration of the test (see sections A.6.2 through A.6.4 for measurement control details). The heat flux exposure is the controlling factor for the test exposure (see UL 1709).

A.6.1.3 The test set-up shall also provide, at all times after the first 5 minutes of the test, an average furnace temperature of 2,000 ± 200°F (1,093 ± 111°C).

A.6.1.4 The fire environment of the actual test shall be controlled by reproducing the furnace temperatures recorded during the furnace calibration method specified in A.6.1.3. This temperature shall be maintained throughout the remainder of the fire test.

A.6.1.5 The furnace environment during an actual test shall also be controlled to maintain the area under the time-temperature curve within 10 percent of the corresponding area under the calibration time-temperature curve for fire tests of 1 hour or less duration; to within 7.5 percent for tests longer than 1 hour but no longer than 2 hours; and to within 5 percent for tests exceeding 2 hours in duration. The area under the time-temperature curve is to be obtained by averaging the results from the furnace control thermocouple readings.

A.6.1.6 Continue the fire-endurance test until the specified conditions of acceptance are exceeded or until the specimen has withstood the fire exposure for a period equal to that for which classification is desired. For the purpose of obtaining additional data, the test may be continued beyond the time at which the specified conditions of acceptance are exceeded.

A.6.2 Heat flux measurements - calibration test.

A.6.2.1 Measure the total heat flux as specified in A.6.1.2, using circular foil heat flux gauges (often called a Gardon gauge, after the developer).

A.6.2.1.1 For fire-containment bulkheads, the heat flux measurements will be made with a calibration assembly and measurements taken at a minimum of 5 points. One total heat flux gauge shall be located at the center

of the test assembly. The other four total heat flux gauges shall be centered one in each of the four quadrants of the test assembly. This location of the total heat flux gauges is as shown in figure A.2.

A.6.2.1.2 For fire containment decks, the heat flux measurements will be made with a calibration assembly and measurements taken at a minimum of 5 points. One total heat flux gauge shall be located at the center of the test assembly. The other four total heat flux gauges shall be centered one in each of the four quadrants of the test assembly. Locations of the total heat flux gauges are as shown in figure A.3.

A.6.2.1.3 Measure the heat flux at least once every minute at each required measurement site.

A.6.2.1.4 All measurements made within 1 minute (that is, recorded time ± 30 seconds) shall be considered as having been made at the same time.

A.6.2.2 At all times after the first 5 minutes of the test, the total heat flux shall be:

A.6.2.2.1 At any one measurement site, 65,000 ± 6,500 Btu/ft^2-h (204 ± 20 kW/m^2).

A.6.2.2.2 For the average of the total number of measurement sites, 65,000 ± 5,000 Btu/ft^2-h (204 ± 16 kW/m^2).

A.6.3 Furnace pressure measurement – calibration and actual tests.

A.6.3.1 When testing the bulkhead or deck assembly, the furnace pressure shall be measured.

A.6.3.2 Measure the furnace pressure at three points located as follows:

A.6.3.2.1 Bulkhead assemblies. At the center and quarter points on the vertical line, 6 inches in front of the exposed face of the sample.

A.6.3.2.2 Deck assemblies. At the center and quarter points on the longitudinal centerline, 12 inches below the sample.

A.6.3.3 The pressure measuring probe tips shall be as shown in figure A.4 and constructed using stainless steel or other suitable materials. The pressure probe shall be constructed with 1/2-inch diameter pipe with 1/16-inch diameter holes, spaced 40 degrees apart around the pipe, drilled 2 inches in from the welded end.

A.6.3.4 Measure the pressure by means of a manometer or equivalent transducer. The manometer or transducer shall be capable of reading 0.01-inch H_2O (2.5 Pa) increments with a measurement precision of 0.005-inch H_2O (1.25 Pa). The differential pressure measurement instrument(s) shall be located to minimize “stack” effects, caused by vertical runs of pressure tubing between the furnace probe(s) and instrument locations.

A.6.3.5 The furnace pressure(s) shall be measured and recorded at intervals not exceeding 1 minute throughout the fire test.

A.6.3.6 Control of the furnace pressure shall be established no later than 5 minutes after the start of the test and shall be maintained throughout the remainder of the test.

A.6.3.6.1 Bulkhead assemblies. The neutral plane (zero pressure differential) shall be maintained at the base of the assembly for the entire test duration. This method places the entire assembly under a positive pressure. The pressure measurements made inside the furnace shall be reported.

A.6.3.6.2 Deck assemblies. The average pressure (use all three pressure probes) within the furnace shall be maintained at a minimum of 0.01-inch H_20 (2.5 Pa) during the test. The pressure measurements made inside the furnace shall be reported.

A.6.4 Furnace gas temperature measurement - calibration and actual tests.

A.6.4.1 Measure the temperature of the furnace environment, exposing either the calibration or test assembly, as specified in A.6.1, using factory manufactured 0.25-inch outside diameter (OD), inconel-sheathed, Type "K" (Chromel-Alumel) thermocouples. The time constant, in air, of the thermocouple assemblies shall be less than 60 seconds. Use standard calibration thermocouples with an accuracy of ±0.75 percent, or better.

A.6.4.2 Obtain the gas temperature from the readings of not less than five thermocouples symmetrically disposed and distributed to show the temperature environment near all parts of the test assembly.

A.6.4.2.1 Bulkhead assemblies. The thermocouples shall be placed 6 inches (152 millimeters) in front of the exposed face of the test assembly at the beginning of the test, and shall not touch the surface of the test assembly during the fire test as a result of specimen growth or deflection.

A.6.4.2.2 Deck assemblies. The thermocouples shall be placed 12 inches (304 millimeters) below the exposed face of the test assembly at the beginning of the test, and shall not touch the surface of the test assembly during the fire test as a result of specimen growth or deflection.

A.6.4.3 Measure the gas temperature at least once every minute at each required measurement site. Consider all measurements made within 1 minute (that is, recorded time ±30 seconds) as having been made at the same time.

A.6.4.4 At all times after the first 5 minutes of the test, each thermocouple shall be 2,000 ± 200°F (1,093 ± 111°C).

A.6.4.5 At all times after the first 5 minutes of the test, the average gas temperature shall be 2,000 ± 200°F (1,093 ± 111°C).

A.6.5 Calibration and control of furnace type test facilities.

A.6.5.1 Calibration runs shall meet the following configuration and procedural criteria:

A.6.5.1.1 During all calibration runs, an instrumented calibration specimen shall be in place during the entire test. The calibration specimen shall be fabricated of noncombustible materials and shall be as follows:

A.6.5.1.1.1 Bulkhead assemblies. The calibration specimen shall consist of a minimum of 1 inch (25 millimeters) of ceramic insulating fiber facing the fire. The fiber shall be suitably supported on a noncombustible wall assembly. The calibration specimen shall have the same dimensions as the actual test specimen with respect to height and width.

A.6.5.1.1.2 Deck assemblies. The calibration assembly shall be identical to the bulkhead assembly calibration specimen, but be positioned in the horizontal orientation. The calibration specimen shall have the same dimensions as the actual test deck assembly with respect to length and width.

A.6.5.1.2 Instrument the calibration specimen to make measurements that are specified as follows:

A.6.5.1.2.1 Total heat flux. See section A.6.2.

A.6.5.1.2.2 Gas temperature. See section A.6.4.

A.6.5.1.2.3 Furnace pressure. See section A.6.3.

A.6.5.1.3 The time duration of the calibration run shall be:

A.6.5.1.3.1 At least as long as the longest subsequent materials test for which it shall apply, or

A.6.5.1.3.2 Until the test facility has reached a steady condition such that the average heat flux and the average gas temperature are within the specified values over a continuous period of 30 minutes.

A.6.5.2 A successful calibration run shall meet the following criteria:

A.6.5.2.1 Total heat flux. See section A.6.1.2 and section A.6.2.

A.6.5.2.2 Gas temperature. See section A.6.1.3 and section A.6.4.

A.6.5.2.3 Test exposure. The test exposure is governed by the heat flux exposure to the test sample. The gas temperature measurements provide a means to replicate the heat flux exposure, as measured in the calibration test, during an actual test.

A.6.5.3 A furnace type facility shall be considered calibrated after an initial test that meets the requirements of A.6.5.1 and A.6.5.2.

A.6.5.4 After the initial calibration, recalibrate the test facility if any repair or modification is made to the heat generation, heat retention, flow or other characteristics of the furnace that could reasonably be expected to affect the initial calibration. Between calibrations, records should be kept of any repairs, modifications, or maintenance made to the facility. At a minimum, the test facility shall provide records of a successful calibration test conducted within the past year prior to testing the bulkhead and/or deck assemblies.

A.6.5.5 Once the test facility has been successfully calibrated, the fire environment is to be simulated during materials testing by reproducing the time-temperature curves recorded during the furnace calibration.

A.6.5.5.1 The accuracy of the furnace control shall be such that the area under the time-temperature measurements of A.6.4.1 through A.6.4.4 is within 10 percent of the corresponding curve developed in the furnace calibration for tests of 1 hour or less in duration, within 7.5 percent for those over 1 hour and not more than 2 hours, and within 5 percent for tests exceeding 2 hours in duration.

A.7 TEST CONFIGURATIONS

A.7.1 Test specimen.

A.7.1.1 The test specimen shall be representative of the construction for which classification is desired with respect to test materials and workmanship.

A.7.2 Conditioning.

A.7.2.1 Protect the test specimen during and after fabrication to ensure the normality of its quality and condition at the time of test. It shall not be tested until its final strength has been attained.

A.7.2.2 If the test specimen contains moisture, solvents, plasticizers, curing compounds, or similar agents, condition the specimen prior to the test, with the objective of providing a condition within the specimen which is representative of that likely to exist in the intended end-use environment of the assembly. When accelerated drying techniques are used to achieve this objective, it is the responsibility of the laboratory conducting the test to avoid procedures that will significantly alter the structural or fire endurance characteristics of the test specimen from those produced as a result of air drying. The temperature and humidity of the test item should be defined at the time of the fire test (see A.7.2.3).

A.7.2.3 If the specimen contains moisture or solvents, measure the actual content of such agents within 24 hours prior to the test. This information may be obtained by weight determinations, moisture meters, or any other appropriate techniques deemed suitable by the testing laboratory.

A.7.3 Test Method A - Bulkhead Assemblies.

A.7.3.1 Tests of fire-containment capability of bulkheads.

A.7.3.1.1 Bulkhead assemblies can have structural, fire containment, or other functions, or combinations thereof. The purpose of this test method is to evaluate the fire containment capability. The test method for bulkhead assemblies assumes there may be fire exposure on either side of the assembly. Therefore, in some cases, both sides of the assembly are required to be tested.

A.7.3.1.2 Size of specimen. The test specimen shall have a fire-exposed surface of not less than 100 square feet (ft^2) (9.3 square meters (m^2)) and a height of not less than 10 feet (3 meters), as shown in figure A.5. Restrain the test specimen on all four edges.

A.7.3.1.3 Temperature measurements during testing.

A.7.3.1.3.1 Temperatures of the unexposed surfaces and between layers, where required, shall be measured using Type K (Chromel-Alumel) thermocouples. The wires for the thermocouples shall not be heavier than No. 18 B&S gauge (0.04 inch (1.02 millimeters)) and shall be electrically insulated with heat resistant and moisture resistant coatings.

A.7.3.1.3.2 The thermocouples on the unexposed face shall be placed under dry felted pads as described in ASTM E 119.

A.7.3.1.3.3 Measure the surface temperatures on the unexposed side of the test specimen throughout the fire test, using thermocouples located as shown in figure A.6.

A.7.3.1.3.3.1 For tests of bulkhead assemblies with insulation only on one side (i.e., fire side or exposed face), nine thermocouples shall be symmetrically located across the unexposed face of the assembly. The thermocouples (denoted as thermocouples 1 - 9 in figure A.6) shall be located on the unexposed face, centered between the frame bays (area between stiffeners).

A.7.3.1.3.3.2 For tests of bulkhead assemblies with insulation on both sides, 18 thermocouples shall be used. Nine thermocouples shall be located on the unexposed face, centered between the frame bays (area between stiffeners). Nine additional thermocouples (denoted as thermocouples 10 - 18 in figure A.6) shall be attached directly to the substrate, under the insulation on the unexposed face. The position of these thermocouples shall be directly under thermocouples 1 - 9, centered in the frame bays.

A.7.3.1.4 Conditions of acceptance. The test shall be regarded as successful if the following conditions are met:

A.7.3.1.4.1 The fire-containment bulkhead assembly shall have withstood the fire endurance test without passage of flame for a time period equal to that for which classification is desired.

A.7.3.1.4.1.1 Flaming on unexposed face. The occurrence and duration of any flaming on the unexposed surface, together with the location of the flaming, should be recorded. In cases where it is difficult to identify whether or not there are flames then the cotton-wool pad should be applied to the area of such disputed flaming to establish whether ignition of the pad can be initiated.

A.7.3.1.4.1.1.1 Cotton-wool pad. Tests with the cotton-wool pad are used to indicate cracks and openings in the test specimen are such that they could lead to the passage of hot gasses sufficient to cause ignition of combustible materials.

A.7.3.1.4.1.1.2 A cotton-wool pad is employed by placing the frame within which it is mounted against the surface of the test specimen, adjacent to the opening or flaming under examination, for a period of 30 seconds, or until ignition (defined as glowing or flaming) of the cotton-wool pad occurs (if this happens before the elapse of the 30 second period). Small adjustments in position may be made so as to achieve the maximum effect from the hot gases. A cotton-wool pad should be used only once.

A.7.3.1.4.2 Transmission of heat through the bulkhead shall not have raised the average temperature on its unexposed surface, as determined by averaging the nine thermocouples specified in A.7.3.1.3.3, more than 250ºF (139ºC) above its initial temperature, nor the temperature of any one point on the surface including any joint, more than 325ºF (181ºC) above its initial temperature for a period of 30 minutes (designated as N-30).

A.7.3.1.5 Bulkheads using applied insulation materials.

A.7.3.1.5.1 Bulkheads using insulation materials applied to a steel structural core.

A.7.3.1.5.1.1 The bulkhead assembly shall have a structural core of stiffened flat steel designed and fabricated in accordance with the specification shown in figure A.5.

A.7.3.1.5.1.2 For fire-containment bulkheads that utilize steel plate as a substrate, the thickness of the steel plate can influence fire endurance as determined by these test methods. In order to directly compare the performance of different fire protection materials when applied to a steel structural core, the steel plate shall be 0.18 ± 0.02 inch (4.5 ± 0.5 millimeters) thick. The joints of the steel plate shall be continuously welded on one side of the bulkhead.

A.7.3.1.5.1.3 Tee Stiffeners shall be constructed on 4-inch (101.6 millimeters) x 4-inch (101.6 millimeters) stiffeners spaced 24 inches (0.61 meters) on center as shown in figure A.5.

A.7.3.1.5.2 Bulkheads using insulation materials applied to a steel structural core – insulated on both faces.

A.7.3.1.5.2.1 The base bulkhead assembly shall be insulated in such a manner as to completely cover the stiffener face (frame bays (area between two parallel stiffeners) and the stiffeners) and the smooth face.

A.7.3.1.5.2.2 The insulation layout for both sides of the bulkhead assembly shall be as shown in figure A.7.

A.7.3.1.5.2.2.1 The details for the insulation layout for the area between stiffeners (stud locations and seams) are shown in figure A.8.

A.7.3.1.5.2.2.2 For the outside edges of the stiffener face (stud locations and seams) the details for the insulation layout shall be as shown in figure A.9.

A.7.3.1.5.2.2.3 The insulation layout and attachment method for covering the stiffeners shall be as shown in figures A.7, A.10 and A.11.

A.7.3.1.5.2.2.4 The insulation layout for the smooth face of the bulkhead assembly (stud locations and seam) shall be as shown in figure A.12.

A.7.3.1.5.2.3 Any deviations from the insulation layouts must be approved in advance by the cognizant NAVSEA authority.

A.7.3.1.5.2.4 The stiffened face shall be exposed to the fire.

A.7.3.1.5.2.5 If the insulation materials used on the stiffened face are different (e.g., materials, density, thickness, etc.) from the materials used on the smooth face, then two tests must be conducted. One test will expose the stiffened face and the second test will expose the smooth face.

A.7.3.1.5.3 Bulkheads using insulation materials applied to a steel structural core – insulated on one face.

A.7.3.1.5.3.1 The base bulkhead assembly shall be insulated in such a manner as to completely cover the stiffener face (frame bays (area between two parallel stiffeners) and the stiffeners).

A.7.3.1.5.3.2 The insulation layout for the stiffened face of the bulkhead assembly shall be as shown in figure A.7.

A.7.3.1.5.3.2.1 The details for the insulation layout for the area between stiffeners (stud locations and seams) are shown in figure A.8.

A.7.3.1.5.3.2.2 The insulation layout and attachment method for covering the stiffeners shall be as shown in figures A.7, A.10 and A.11.

A.7.3.1.5.3.3 Any deviations from the insulation layouts must be approved in advance by the cognizant NAVSEA authority.

A.7.3.1.5.3.4 The stiffened face shall be exposed to the fire.

A.7.3.1.5.4 Bulkheads using insulation materials applied to a non-steel structural core – insulated on one or both faces.

A.7.3.1.5.4.1 Approval of the cognizant NAVSEA authority must be obtained prior to conducting tests. Non-steel structural core tests may involve different application techniques or materials (size, etc). These factors must be evaluated, and these items may require changes to the testing methods.

A.7.3.1.6 Bulkheads using a non-steel structural core – no applied insulation.

A.7.3.1.6.1 Approval of the cognizant NAVSEA authority must be obtained prior to conducting tests. Non-steel structural core tests may involve different application techniques or materials (size, etc). These factors must be evaluated and these items may require changes to the testing methods.

A.7.4 Test Method B - Deck Assemblies.

A.7.4.1 Tests of fire-containment capability of deck assemblies.

A.7.4.1.1 Deck assemblies can have structural, fire containment, or other functions, or combinations thereof. The purpose of this method is to evaluate the fire containment capability. The test method for deck assemblies assumes that there will be fire impingement on only one side of the assembly. Therefore, only the exposed face of the assembly is required to be insulated.

A.7.4.1.2 Size of specimen. The test specimen shall have a fire-exposed surface of not less than 144 ft^2 (13.4 m^2) and a width of not less than 12 feet (3.7 meters), as shown in figure A.13. Restrain the test specimen on all four edges.

A.7.4.1.3 Temperature measurements during testing.

A.7.4.1.3.1 Temperatures of the unexposed surfaces shall be measured using Type K (Chromel-Alumel) thermocouples. The wires for the thermocouples shall not be heavier than No. 18 B&S gauge (0.04 inch (1.02 millimeter)) and shall be electrically insulated with heat resistant and moisture resistant coatings.

A.7.4.1.3.2 The thermocouples on the unexposed face shall be placed under dry felted pads as described in ASTM E 119.

A.7.4.1.3.3 Measure the surface temperatures on the unexposed side of the test specimen throughout the fire test, using thermocouples located as shown in figure A.14.

A.7.4.1.3.4 Nine thermocouples shall be symmetrically located across the unexposed face of the assembly. The thermocouples (denoted as thermocouples 1 - 9 in figure A.14) shall be located on the unexposed face, centered between the frame bays (area between stiffeners).

A.7.4.1.4 Conditions of acceptance. The test method shall be regarded as successful if the following conditions are met:

A.7.4.1.4.1 The fire-containment deck assembly shall have withstood the fire endurance test without passage of flame for a time period equal to that for which classification is desired.

A.7.4.1.4.1.1 Flaming on unexposed face. The occurrence and duration of any flaming on the unexposed surface, together with the location of the flaming, should be recorded. In cases where it is difficult to identify whether or not there are flames then the cotton-wool pad should be applied to the area of such disputed flaming to establish whether ignition of the pad can be initiated.

A.7.4.1.4.1.1.1 Cotton-wool pad. Tests with the cotton-wool pad are used to indicate cracks and openings in the test specimen are such that they could lead to the passage of hot gasses sufficient to cause ignition of combustible materials.

A.7.4.1.4.1.1.2 A cotton-wool pad is employed by placing the frame within which it is mounted against the surface of the test specimen, adjacent to the opening or flaming under examination, for a period of 30 seconds, or until ignition (defined as glowing or flaming) of the cotton-wool pad occurs (if this happens before the elapse of the 30 second period). Small adjustments in position may be made so as to achieve the maximum effect from the hot gases. A cotton-wool pad should be used only once.

A.7.4.1.4.2 Transmission of heat through the deck shall not have raised the average temperature on its unexposed surface, as determined by averaging the nine thermocouples specified in A.7.4.1.3.3, more than 250°F (139°C) above its initial temperature, nor the temperature of any one point on the surface including any joint, more than 325°F (181°C) above its initial temperature, for a period of 30 minutes (designated N-30).

A.7.4.1.5 Decks using applied insulation materials.

A.7.4.1.5.1 Decks using insulation materials applied to a steel structural core.

A.7.4.1.5.1.1 The deck assembly shall have a structural core of stiffened flat steel designed and fabricated in accordance with the specification shown in figure A.13.

A.7.4.1.5.1.2 For fire-containment decks that utilize steel plate as a substrate, the thickness of the steel plate can influence fire endurance as determined by these test methods. In order to directly compare the performance of different fire protection materials when applied to steel structural core, the steel plate shall be 0.18 ± 0.02 inch (4.5 ± 0.5 millimeters) thick. The joints of the steel plate shall be continuously welded on one side of the bulkhead.

A.7.4.1.5.1.3 Stiffeners shall be constructed of 4-inch (101.6-millimeter) x 4-inch (101.6-millimeter) stiffeners spaced 24 inches (0.61 meter) on center as shown in figure A.13.

A.7.4.1.5.1.4 The base deck assembly shall be insulated in such a manner as to completely cover the stiffener face (frame bays (area between two parallel stiffeners) and the stiffeners) (see figure A.15).

A.7.4.1.5.1.5 The details for the insulation layout for the area between stiffeners (stud locations and seams) are shown in figure A.16.

A.7.4.1.5.1.6 The insulation layout and attachment method for covering the stiffeners shall be as shown in figures A.15, A.17 and A.18.

A.7.4.1.5.1.7 Any deviations from the insulation layouts must be approved in advance by the cognizant NAVSEA authority.

A.7.4.1.5.1.8 The stiffened face shall be exposed to the fire.

A.7.4.1.5.2 Decks using insulation materials applied to a non-steel structural core.

A.7.4.1.5.2.1 Approval of the cognizant NAVSEA authority must be obtained prior to conducting tests. Non-steel structural core tests may involve different application techniques or materials (size, etc). These factors must be evaluated, and these items may require changes to the testing methods.

A.7.4.1.6 Decks using a non-steel structural core - no applied insulation.

A.7.4.1.6.1 Approval of the cognizant NAVSEA authority must be obtained prior to conducting tests. Non-steel structural core tests may involve different application techniques or materials (size, etc). These factors must be evaluated, and these items may require changes to the testing methods.

A.7.5 Report.

A.7.5.1 Report the following information:

A.7.5.1.1 General description of the test facility including the method of developing the specified fire environment and the results and date of the current calibration of the test facility. Report the type, location, and orientation of all instrumentation (such as heat flux meters and thermocouple assemblies) used to monitor or control, or both, the fire exposure.

A.7.5.1.2 For a calibration test, report the heat flux incident on the test specimen and the temperature of the fire environment with measurements at intervals of no more than 1 minute. For an actual test, report the temperature of the fire environment with measurements at intervals of no more than 1 minute.

A.7.5.1.3 Indicate whether the fire environment resulted in an exposure that satisfied the criteria set forth herein, in particular the agreement between the time-temperature curves from the calibration test and the actual test. A plot of the time-temperature curve generated by the calibration test and the actual furnace temperatures measured during the actual fire test shall also be provided.

A.7.5.1.4 Indicate the test procedure that was followed and the resulting fire endurance period to the nearest minute.

A.7.5.1.5 Specify the type and location of all thermocouples used to measure the temperature of the test specimen. All temperature measurements shall be given at no more than 1-minute intervals.

A.7.5.1.6 Include a complete description of the test assembly with detailed drawings and photographs. The description shall include dimensions and physical properties of the various materials and components in sufficient detail to adequately define the test assembly.

A.7.5.1.7 The report shall also contain visual observations recorded during the fire test at no less than 5-minute intervals. The visual observations shall include any significant changes in the test specimen, such as the development of cracks, buckling, flaming, smoking, spalling, and similar observable phenomena.

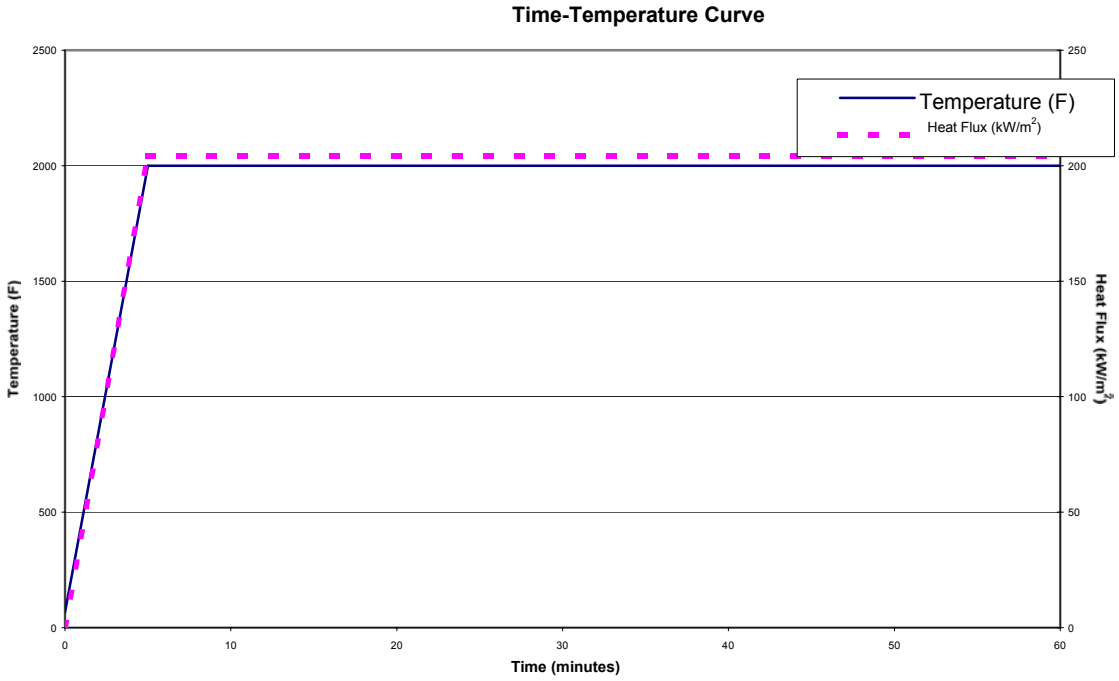


FIGURE A.1. Exposure conditions for high rise hydrocarbon liquid fires.

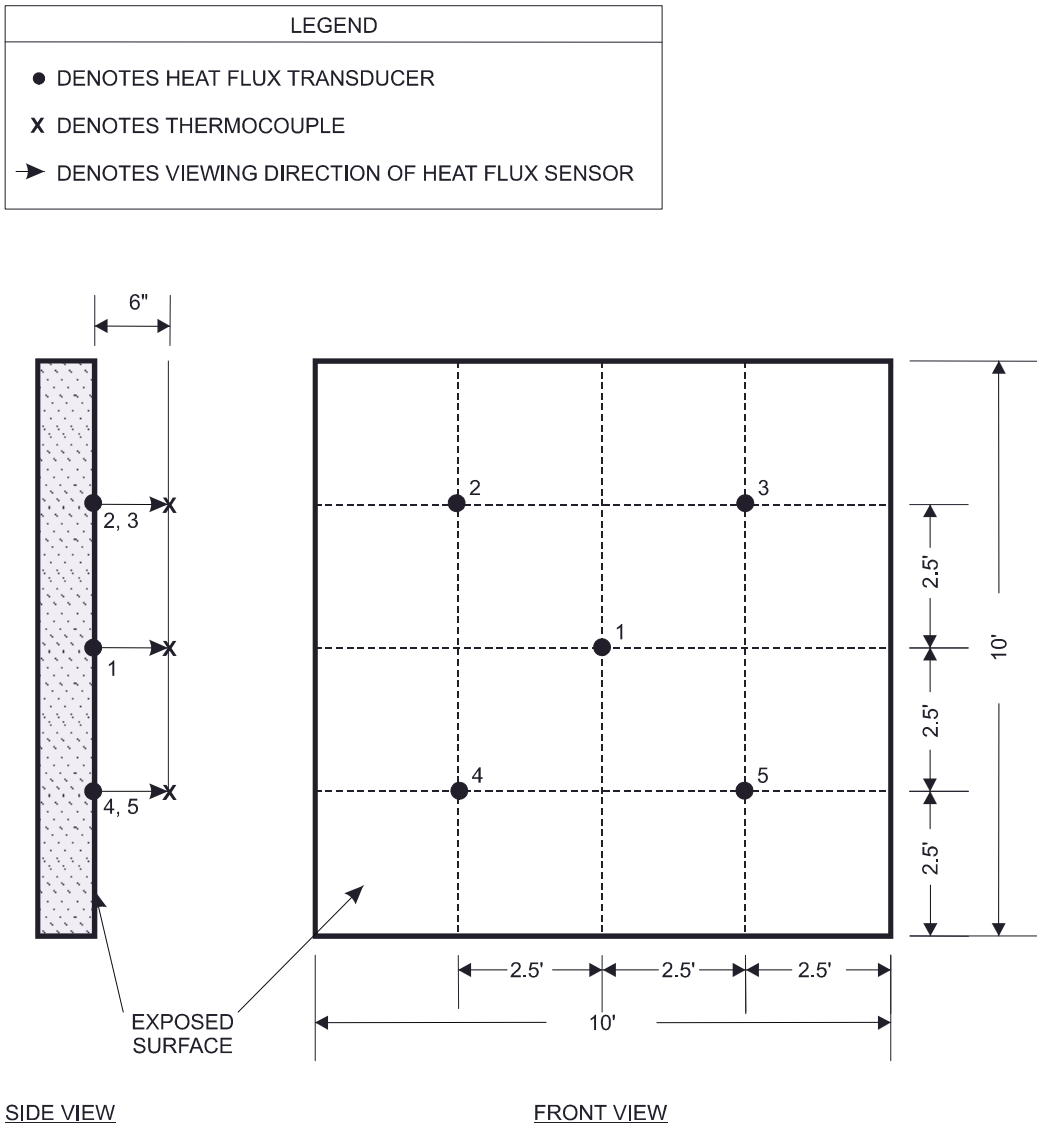
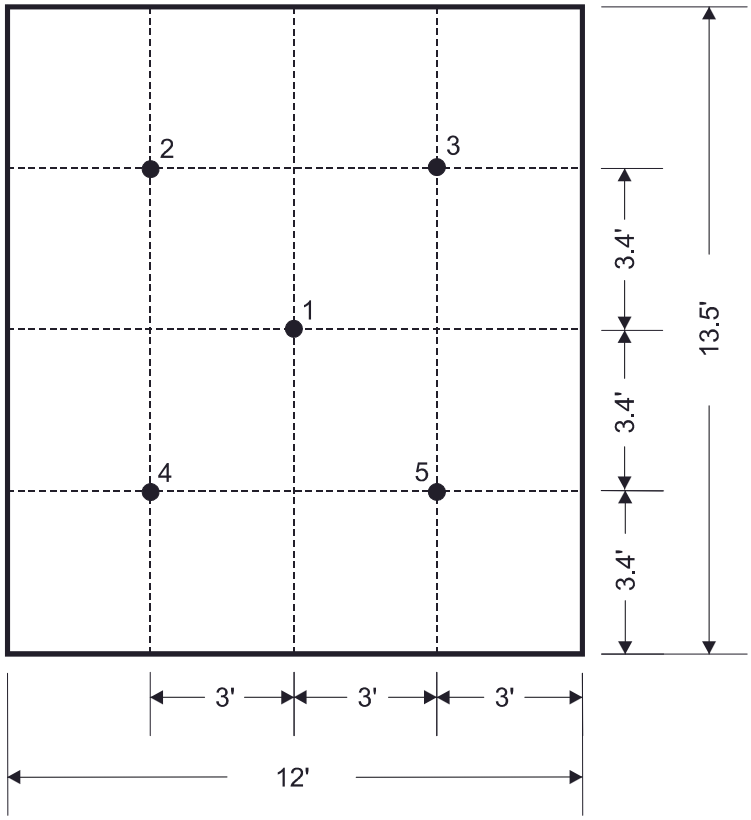


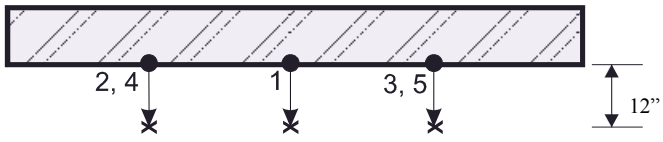
FIGURE A.2. Bulkhead calibration assembly.

(Note: Thermocouples are Type K)

LEGEND
● DENOTES HEAT FLUX TRANSDUCER
X DENOTES THERMOCOUPLE
→ DENOTES VIEWING DIRECTION OF HEAT FLUX TRANSDUCER



REFLECTED CEILING PLAN



SIDE VIEW

FIGURE A.3. Deck calibration assembly.

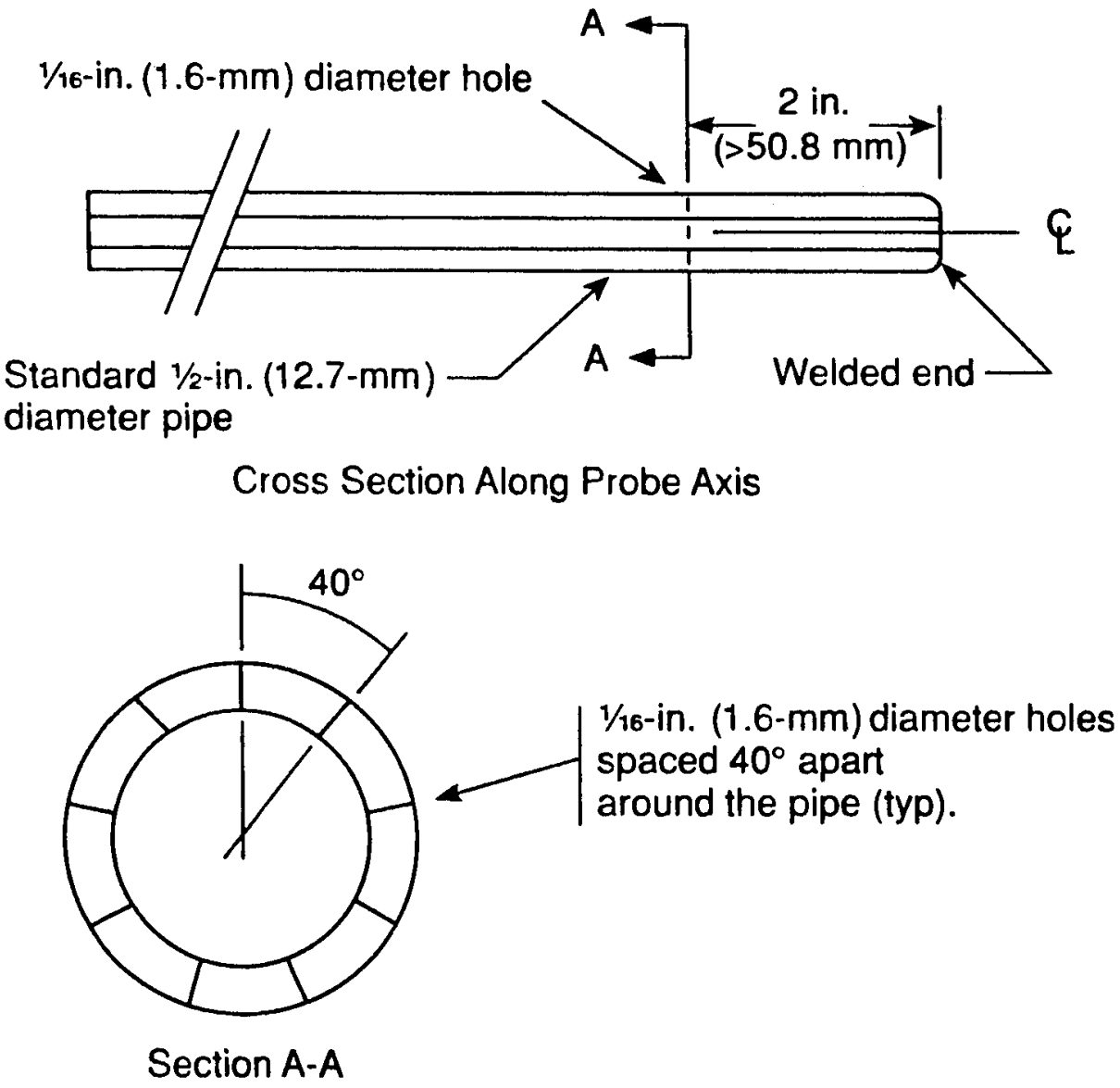
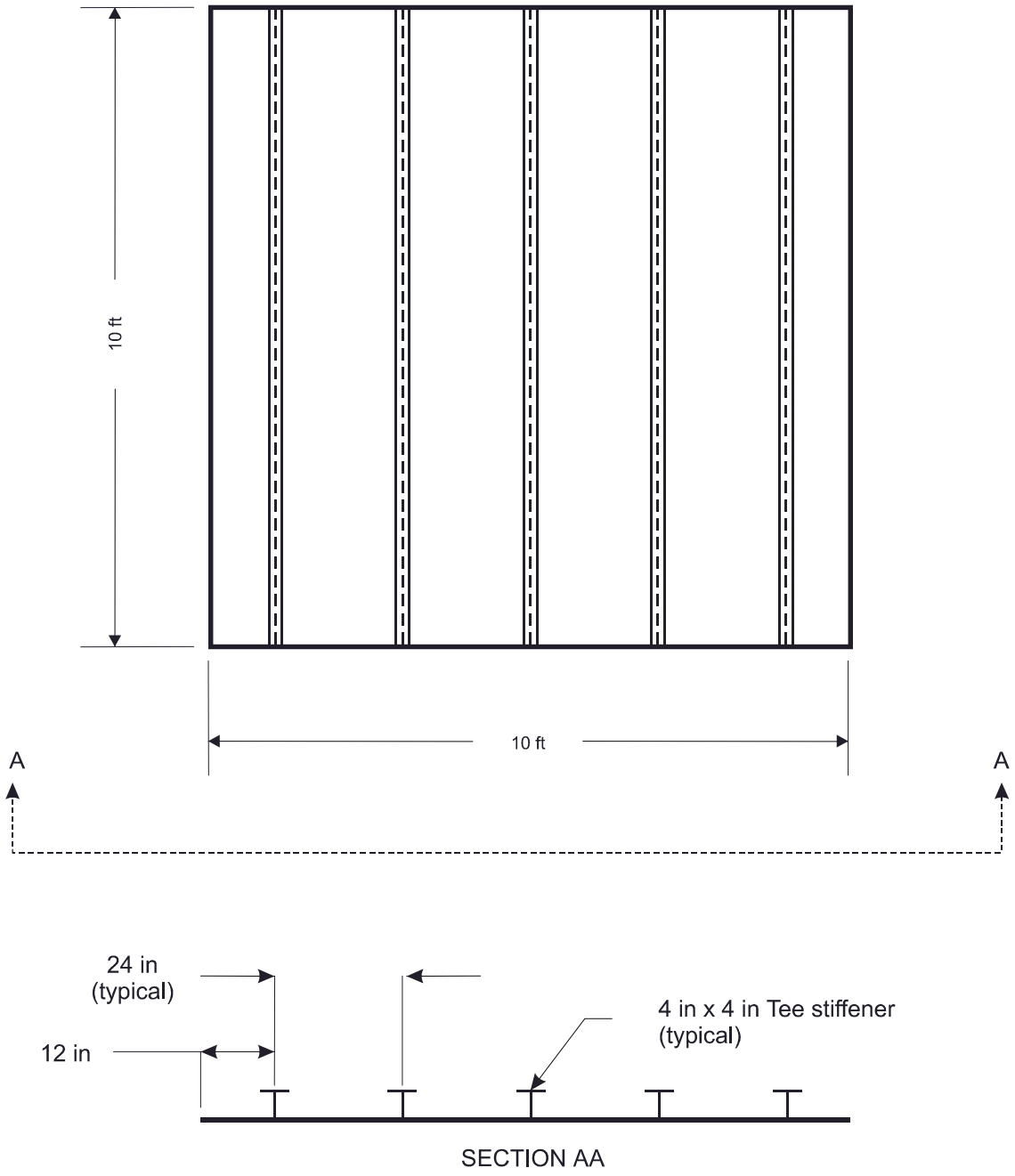
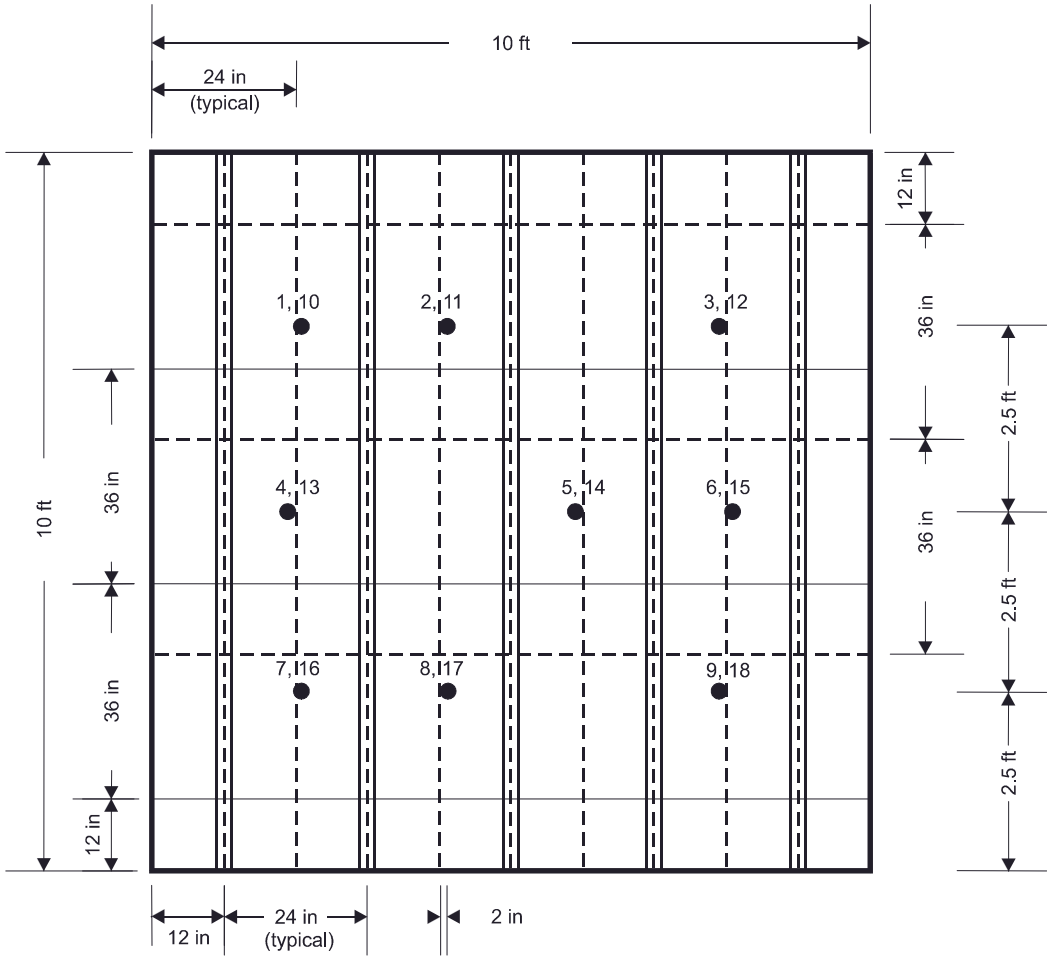


FIGURE A.4. Pressure measuring probe details.



(Note: Tee Stiffeners are 0.263 inch (6 mm) thick)

FIGURE A.5. Bulkhead assembly (stiffener face).



TC#	LOCATION
1 – 9	Unexposed face, centered in frame bay
10 – 18	Unexposed face, centered in frame bay, under insulation

FIGURE A.6. Bulkhead assembly thermocouple locations.

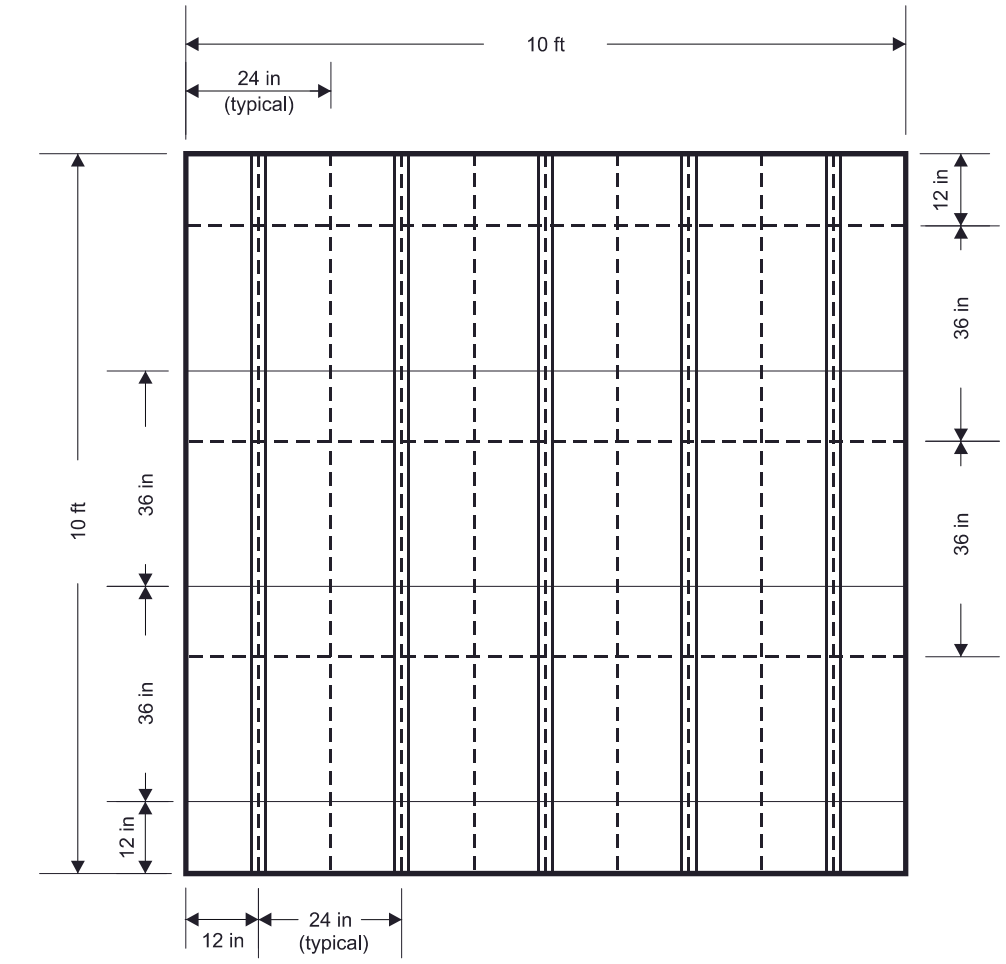


FIGURE A.7. Insulation layout (bulkhead stiffener face).

Using 36 in long x 24 in wide blankets

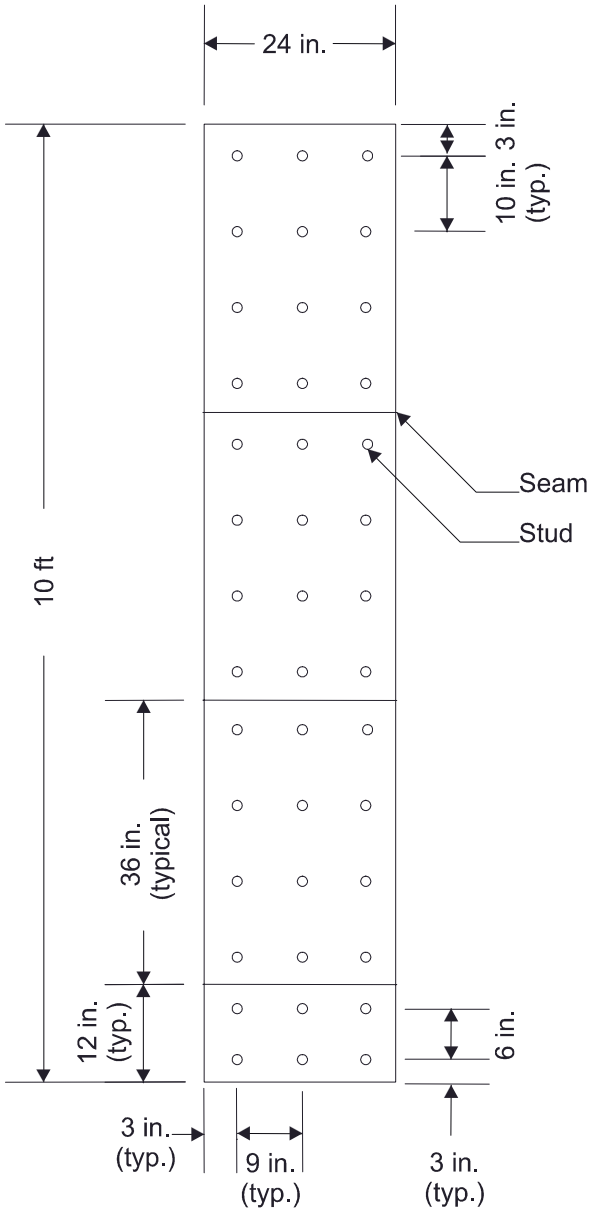


FIGURE A.8. Insulation layout - stud location and seams between stiffeners (typical frame bay panel - plan).

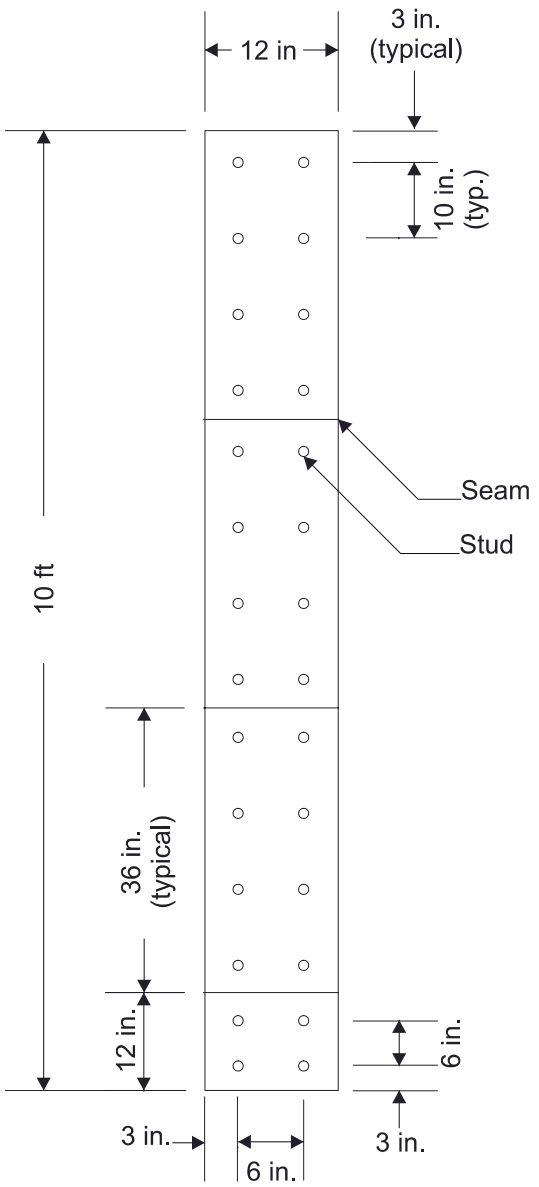


FIGURE A.9. Installation layout - stud location and seams outside edges on stiffener face (typical frame bay panel - plan).

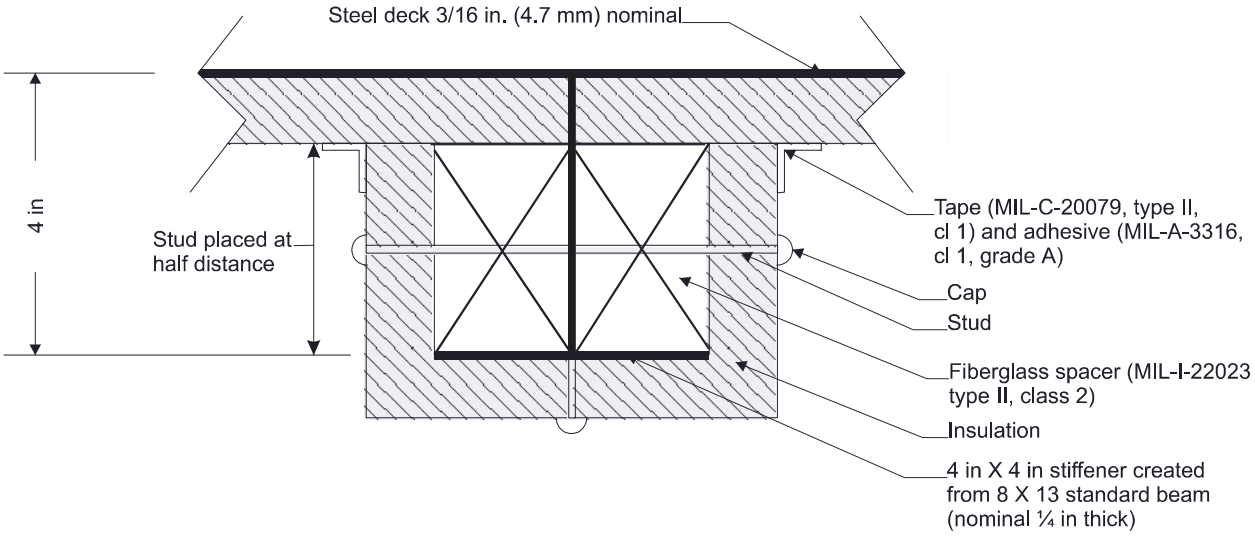


FIGURE A.10. Detail A - insulation attachment on stiffeners (sectional view).

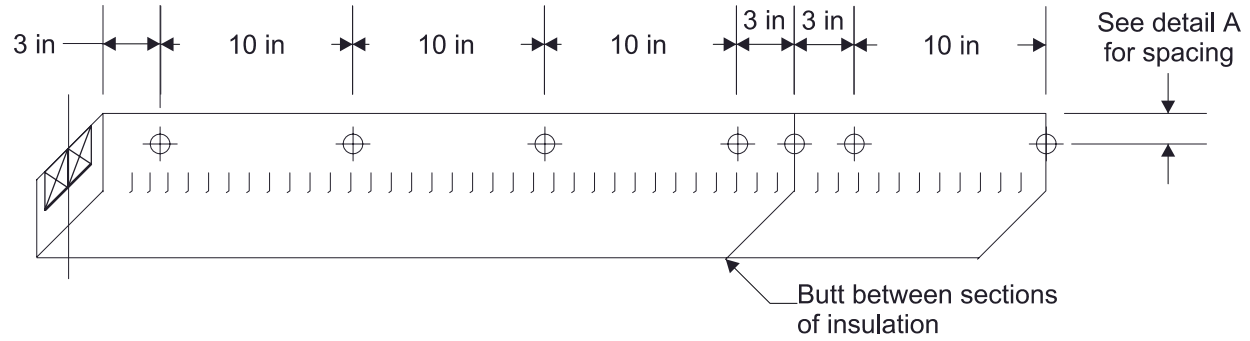


FIGURE A.11. Detail B - stud spacing on 4-in x 4-in stiffener (projection view).

Using 36 in long x 24 in wide blankets

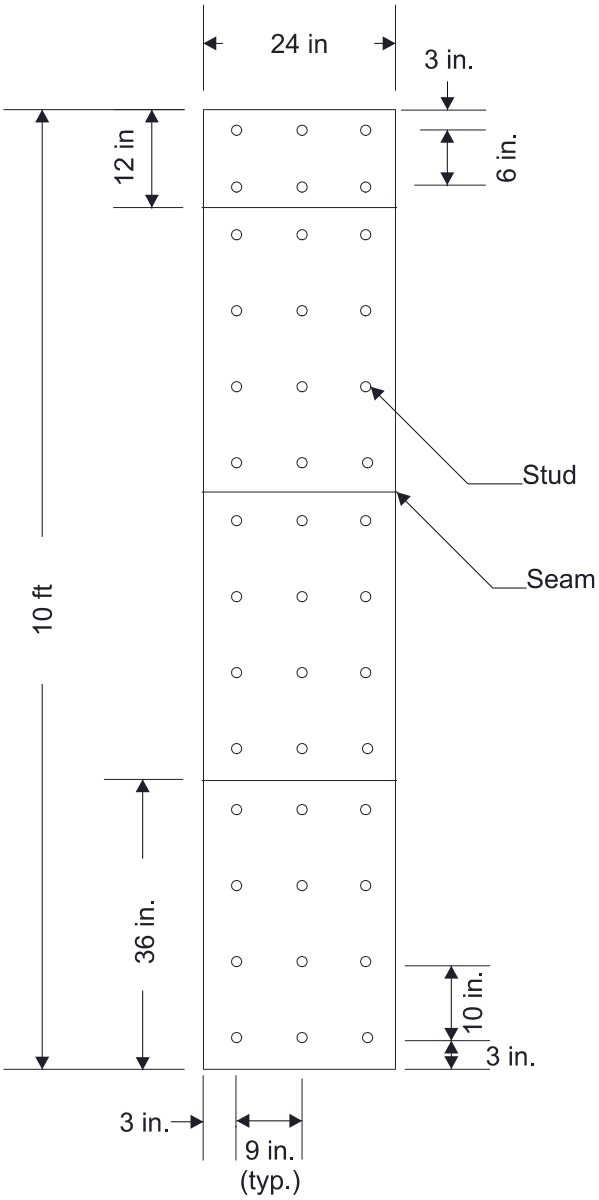


FIGURE A.12. Insulation layout - stud location and seams for smooth side of bulkhead.

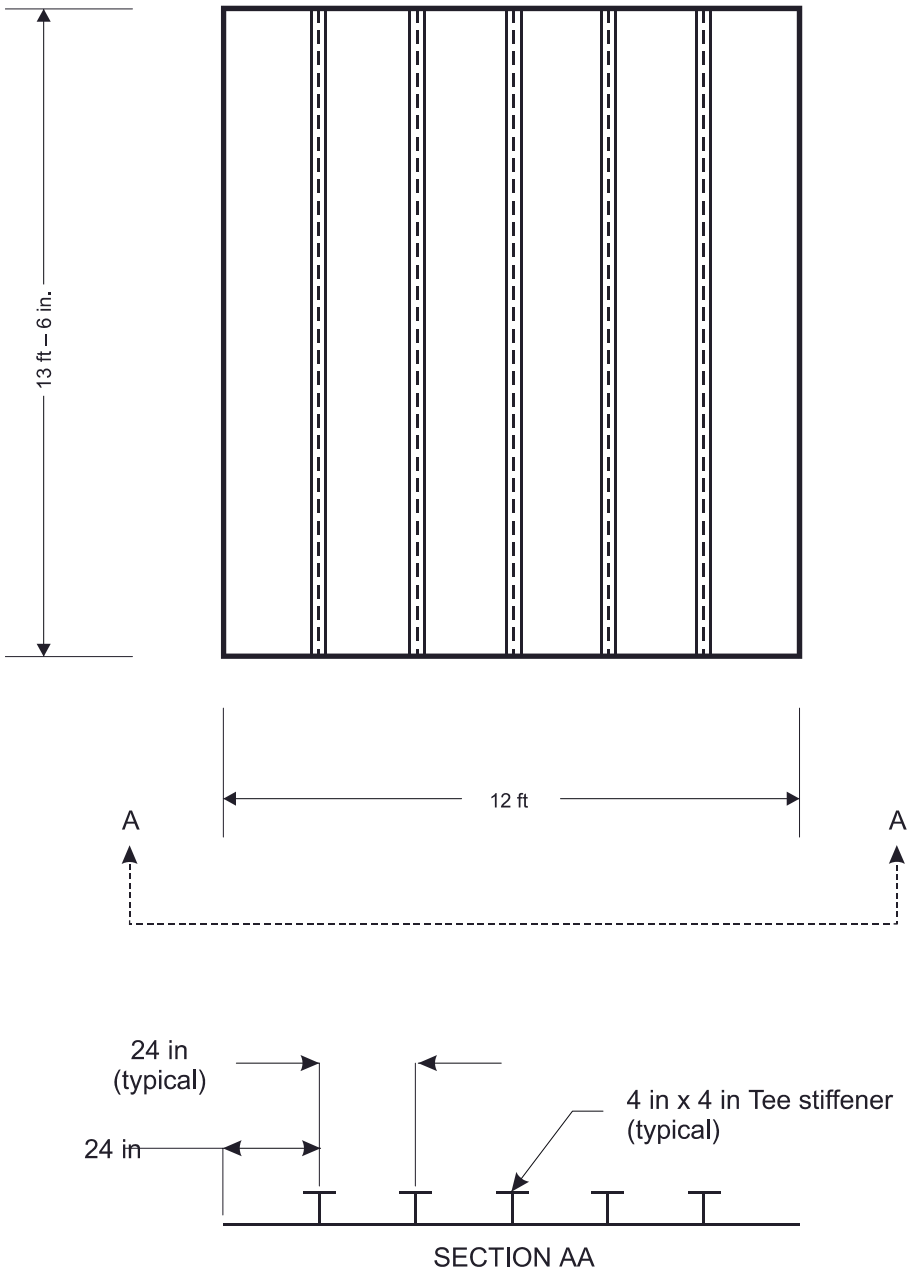
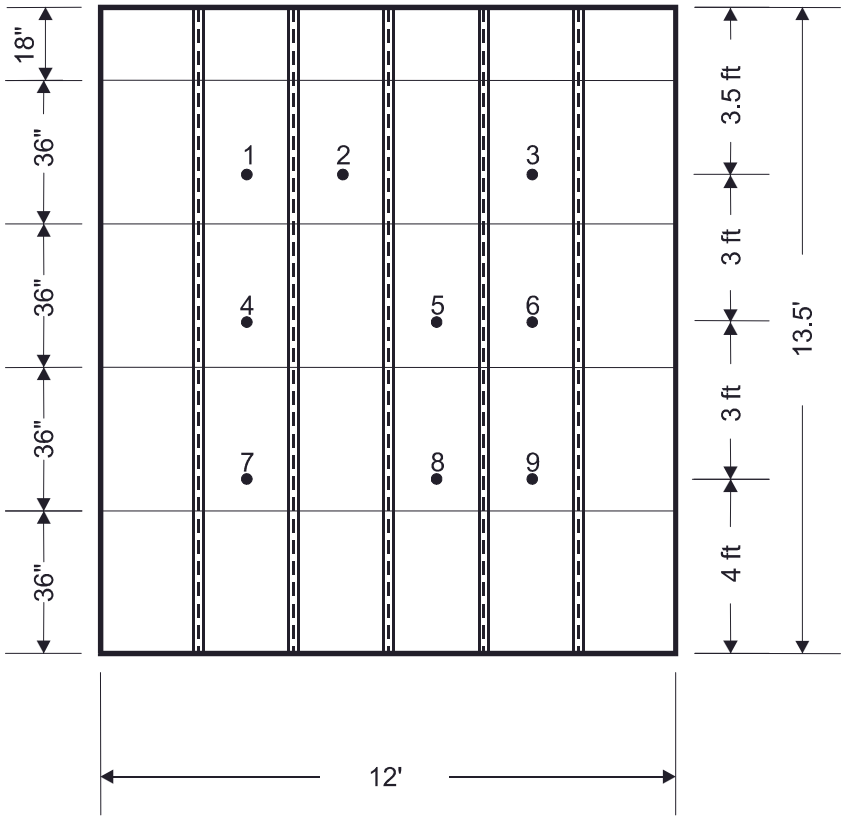


FIGURE A.13. Deck assembly (reflected ceiling plan, stiffener face).



TC#	LOCATION
1 – 9	Unexposed face, centered in frame bay

FIGURE A.14. Deck assembly thermocouple locations.

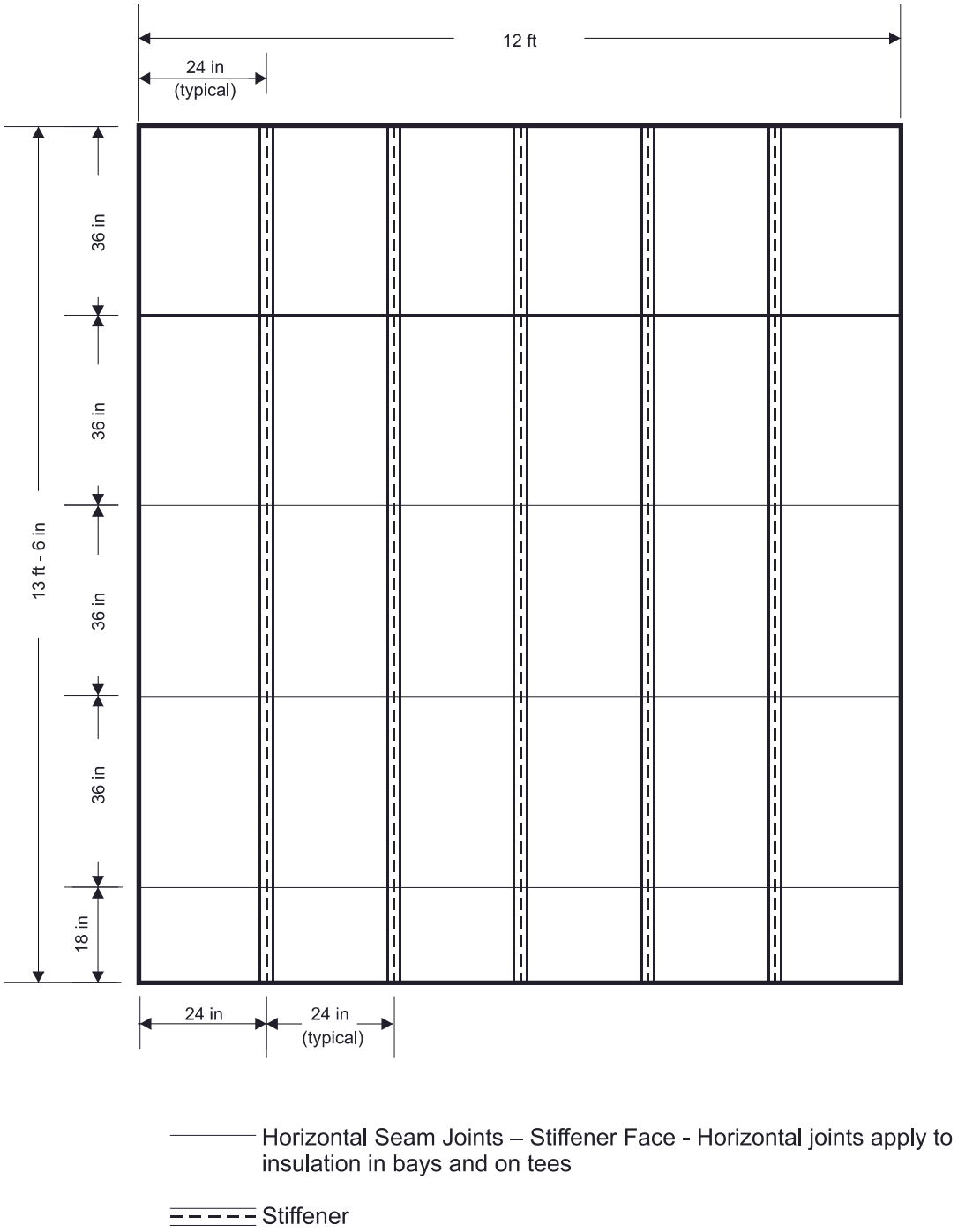


FIGURE A.15. Insulation layout deck assembly (reflected ceiling, stiffener face).

Using 36 in long x 24 in wide blankets

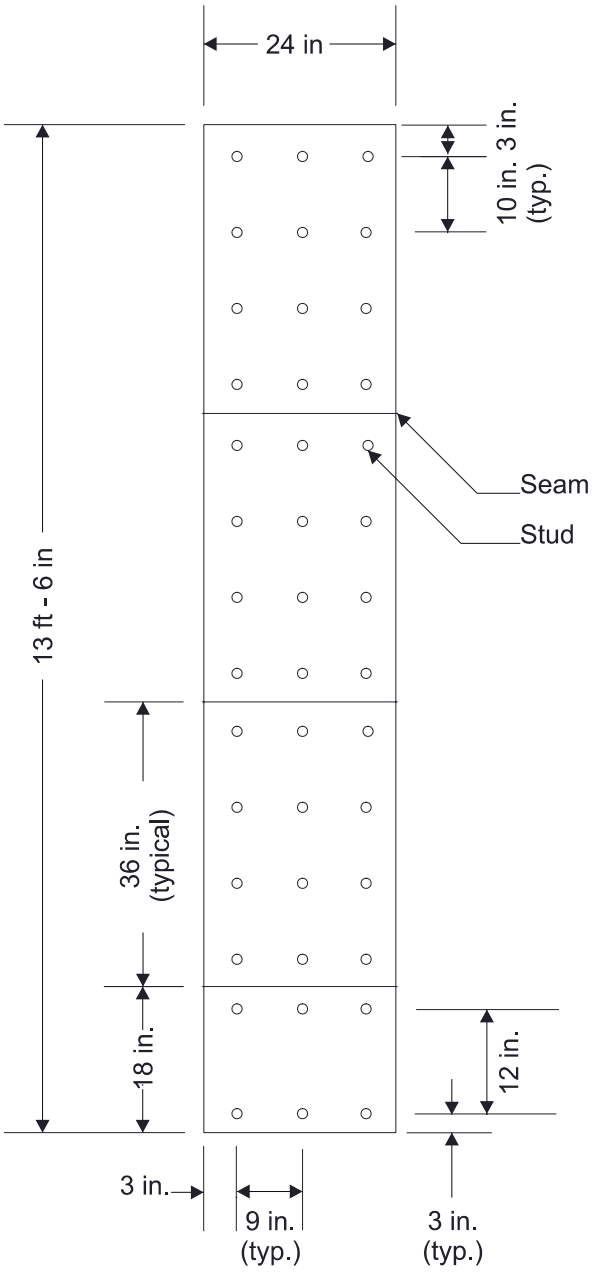


FIGURE A.16. Insulation layout - stud location and seams between stiffeners (typical frame bay panel - plan).

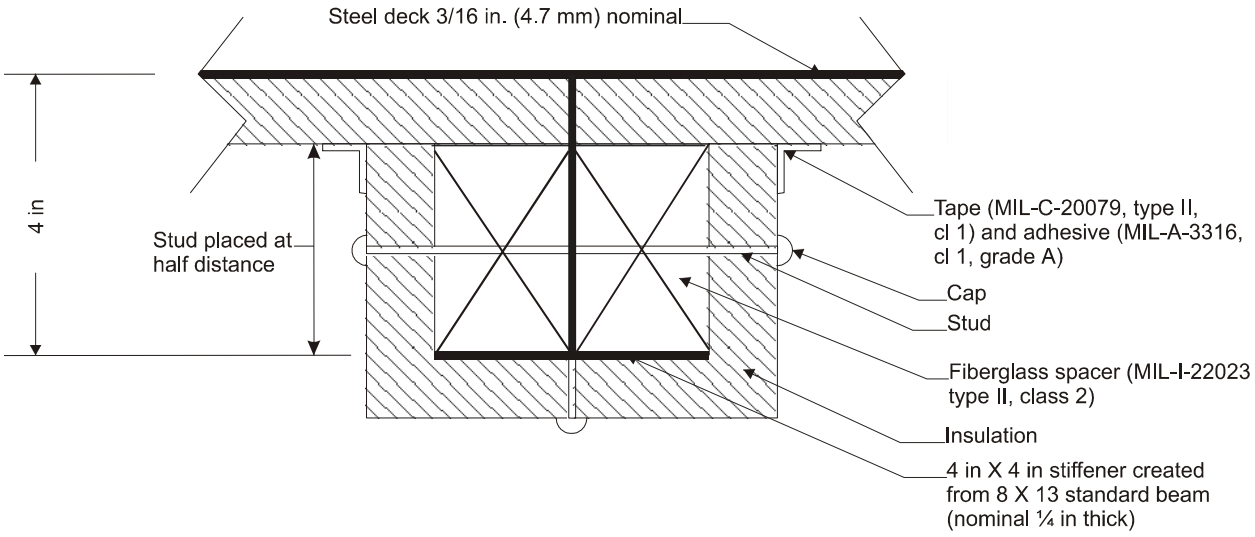


FIGURE A.17. Detail A - insulation attachment on stiffeners (sectional view).

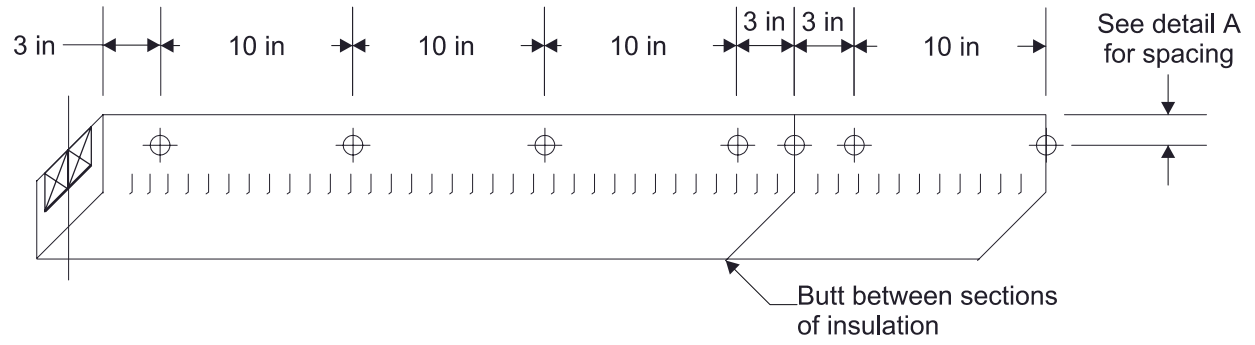


FIGURE A.18. Detail B - stud spacing on 4-in x 4-in stiffener (projection view).

Custodians:
Navy - SH
Air Force - 99
DLA - CC

Preparing Activity:
Navy - SH
(Project 2090-0115)

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 www.dodssp.daps.mil.