METRIC

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DEPARTMENT OF DEFENSE
STANDARD PRACTICE

FIRE RESISTANCE OF U.S. NAVAL SURFACE SHIPS

AMSC N/A FSC 2090

FOREWORD

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

2. Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Sea Systems Command, ATTN: SEA 05M3, 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 http://assist.daps.dla.mil.

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APPENDICES PAGE

1. SCOPE

1.1 Scope. This standard provides the fire resistance test method and acceptance criteria, following shock testing, for approval of N-Class and AN-Class divisions and their penetrations on U.S. Navy surface ships. The fire resistance test method described herein supersedes fire resistance test method requirements of Appendix A in MIL-PRF-32161, and American Bureau of Shipping (ABS) Naval Vessel Rules Part 1, Chapter 2, Section 1. This standard is applicable to fire resistant divisions constructed from steel, aluminum, and polymer composite structures. This standard does not address ignitability, surface flame spread, heat release rates, smoke density, fire gas toxicity or other material fire performance limits or basic system/component design requirements which may be imposed by other documents and the Naval Technical Authority (NTA).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard 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 standard, 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-S-901	-	Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-PRF-32161	-	Insulation, High Temperature Fire Protection, Thermal and Acoustic

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

DATA ITEM DESCRIPTIONS

DI-ENVR-80708	-	Shock Test Report
DI-ENVR-80709	-	High-Impact Shock Test Procedures

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

NAVSEA DESIGN DATA SHEETS

DDS-078-1	-	Composite Materials, Surface Ships, Topside Structural and Other Topside Applications – Fire Performance Requirements

(Copies of these documents are available from Commander, Naval Sea Systems Command, ATTN: SEA 05M3, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160, or by email at CommandStandards@navy.mil with the subject line “DDS request”.)

NAVSEA DRAWING

803-5184182 - Insulation, Passive Fire Protection Installation Details

(Copies of this document are available from the Commander, Naval Sea Systems Command, ATTN: SEA 05M3, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or by email at CommandStandards@navy.mil.)

NAVSEA INSTRUCTION

NAVSEAINST 9491.1 - LOC of Approved Class HI Shock Testing Facilities

(Copies of this document are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at http://nll.ahf.nmci.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 E2226 - Standard Practice for Application of Hose Stream

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

INTERNATIONAL MARITIME ORGANIZATION (IMO)

Resolution A.754(18) - Recommendation on Fire Resistance Tests for “A,” “B,” and “F” Class Divisions

(Copies of this document can be found in the International Code for Application of Fire Test Procedures, 1998 Edition, ISBN No. IB844E, International Maritime Organization, 4 Albert Embankment, London, SE1 7 SR, United Kingdom. Copies of this document may also be obtained from www.imo.org or New York Nautical Instrument & Service Corp., 140 West Broadway, New York, NY 10013, 212-962-4522, fax 212-406-8420, email info@newyorknautical.com.)

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 ISO, 1, rue de Varembé, CH-1211 Geneva 20, Switzerland or online at www.iso.org.)

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

3. DEFINITIONS

3.1 Division. A physical boundary with fire protection classification. A division may be a transverse bulkhead, a longitudinal bulkhead, a deck, or a combination of all.

3.2 Division, AN-Class. AN-Class divisions are those divisions formed by bulkheads and decks that are designed to protect against structural failure and prevent the passage of flame or hot gases when exposed to a Resolution A.754(18) fire exposure after shock testing in accordance with MIL-S-901. For all AN-Class divisions, including those with penetrations, the test duration is a minimum of 60 minutes. In addition, AN-Class divisions are designed to prevent excessive temperature rise as follows:

3.2.1 Class AN-60. When exposed to fire for 60 minutes after the shock test, (a) there is no passage of flame or hot gases, and (b) the prescribed temperature rise is prevented on unexposed surfaces for 60 minutes.

3.2.2 Class AN-30. When exposed to fire for 60 minutes after the shock test, (a) there is no passage of flame or hot gases, and (b) the prescribed temperature rise is prevented on unexposed surfaces for 30 minutes.

3.2.3 Class AN-0. When exposed to fire for 60 minutes after the shock test, there is no passage of flame or hot gases to the end of 60 minutes. There is no temperature rise requirement.

3.3 Division, N-Class. N-Class divisions are fire resistant divisions formed by bulkheads and decks (overheads) that are designed to protect against structural failure and prevent the passage of flame or hot gases when exposed to a rapid rise hydrocarbon fire exposure (Class B), described in Appendix A, after shock testing in accordance with MIL-S-901. The minimum fire test duration is 30 minutes. In addition, N-Class divisions are designed to prevent excessive temperature rise as follows:

3.3.1 Class N-60. When exposed to fire for 60 minutes after the shock test, (a) there is no passage of flame or hot gases, and (b) the prescribed temperature rise is prevented on unexposed surfaces for 60 minutes.

3.3.2 Class N-30. When exposed to fire for 30 minutes after the shock test, (a) there is no passage of flame or hot gases, and (b) the prescribed temperature rise is prevented on unexposed surfaces for 30 minutes.

3.3.3 Class N-0. When exposed to fire for 30 minutes after the shock test, there is no passage of flame or hot gases to the end of 30 minutes. There is no temperature rise requirement.

3.4 Fire resistance. Fire resistance is the ability of a division or boundary (typically a bulkhead or overhead) to withstand fire, give protection from it, prevent fire spread to adjoining compartments, and retain structural integrity under fire. Structural integrity is the ability to continue to carry a structural load. Fire resistance does not address reaction to fire properties such as ignitability, surface flame spread, heat release rates, smoke density, fire gas toxicity, or other material fire performance limits which may be imposed by other documents or the Naval Technical Authority (NTA).

3.4.1 Fire resistance rating. A measure of the elapsed time during which a material, product, or assembly continues to exhibit fire resistance under specified exposure conditions.

3.4.2 Restricted application. When a division is protected against a fire threat from one side only, the division is designated as fire resistant with restricted application.

3.4.3 Un-restricted application. When a division is protected against a fire threat from both sides, the division is designated as fire resistant with unrestricted application. A fire zone bulkhead is always designed for fire resistance with unrestricted application.

3.5 Naval Technical Authority (NTA). The agent authorized to provide approval for products under this standard. For material fire performance on U.S. naval surface ships, the NTA resides with the Technical Warrant Holder for Fire Protection at the Naval Sea Systems Command, Code NAVSEA 05P14, or the designated Engineering Agent. The Naval Technical Authority for shock is NAVSEA 05P13 or their designated approval authority (DAA). For the overall design requirements and approval for use of designs for shipboard divisions and penetrations, the NTA resides with various offices within NAVSEA 05.

3.6 Proposer. A ship design activity, such as a commercial shipbuilder under contract to the government, or a material supplier, who is seeking acceptance of a system design.

4. GENERAL REQUIREMENTS

4.1 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.

4.2 Summary of the test method. Initial testing shall evaluate the fire resistance of a shock tested specimen as outlined in 5.2 and Appendix F. If the test specimen meets the requirements, then a fire resistance test on a full scale test specimen shall be performed as outlined in 5.3 through 5.8 and Appendix A.

4.3 Approval process. The proposer shall obtain approval from the NTA. The approval process shall include subjects listed in 4.3.1 through 4.3.3. The requirements described in this document apply only to fire resistance rating. Other material fire performance limits or basic system/component requirements are contained in MIL-PRF-32161. Additional requirements may be imposed by other documents or the NTA.

4.3.1 Submittal of test procedure. A test procedure shall be submitted to the NTA for approval prior to testing. The test procedure may be prepared by the product vendor, shipbuilder, testing laboratory (government or commercial) or other agent selected by the proposer. The test procedure shall provide all necessary information required for acceptance of the fire resistant system including, but not limited to, penetrations, drawings, materials of construction, material safety data sheets, installation procedures, insulation materials, attachment system, adhesives, barriers, coatings, lagging, etc.

4.3.2 Notification of tests. The proposer shall provide notification to the NTA at least three weeks prior to conducting any tests. The NTA shall have the right to witness all testing.

4.3.3 Submittal of test results. The proposer shall submit test results for acceptance including independent laboratory test reports, digital photos, and video. Refer to 5.9 for product approval and documentation requirements.

4.4 Installation details. Installation details for the fire insulation and attachment method are contained in NAVSEA Drawing 803-5184182 and Appendix A. For naval shipboard installation, the assembly with fire insulation and associated attachment method is to be shock tested (Grade A) in accordance with MIL-S-901 prior to fire resistance testing (see Appendix F).

5. DETAILED REQUIREMENTS

5.1 Testing and examination. The proposer is responsible for conducting all tests as specified herein. Shock testing shall be performed at Navy approved facilities as listed in NAVSEAINST 9491.1C. 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 the NTA, shall conduct all 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.a2la.org) or International Code Council's International Accreditation Services (www.iasonline.org). The scope of accreditation shall include fire resistance tests required for qualification. The NTA reserves the right to witness the tests, and/or perform any of the tests set forth herein where such testing is deemed necessary to assure compliance to prescribed requirements of the qualification tests.

5.1.1 Test reports. The independent test laboratory shall write a test report for all tests conducted for qualification purposes. This includes tests which fail the qualification requirements. The test report shall be submitted to the NTA. For cases where an unsuccessful test had been conducted prior to the final approval test, the test report shall include an analysis of the failure modes, and description of the modifications made to the test specimen that resulted in the successful test.

5.2 Shock test prior to fire resistance test. Fire resistant divisions and their penetrations, with passive fire protection and associated attachment system, shall be subjected to a Grade A shock test in accordance with MIL-S-901 prior to conducting the fire resistance test. The specific shipboard mounting and location shall be determined and adequately represented in the shock test. The test specimen construction, orientations, fixture and assembly details are provided for guidance in figures F-1 through F-6. Qualification testing shall be performed using both deck (overhead) and bulkhead orientations using minimum and maximum sizes of each type of penetrations. In order to evaluate the performance of proposed fire insulation materials and attachments methods, an intermediate scale 1219 by 3048 millimeters (4 by 10 feet) shock test, followed by intermediate scale fire test, shall be conducted in accordance with Appendix F (see 6.3.6). A detailed shock test procedure shall be submitted to the NTA for approval prior to conducting any tests.

a. The assembly shall not demonstrate loosening or failure of any component or a detectible change of state of materials that may affect fire performance. The penetration integrity after the shock test shall be verified by painting the penetration assembly with soap water and blowing compressed air at 414 kPa (60 psi) through. If there are no bubbles on the other side, the shock-tested assembly shall then be subjected to the applicable fire resistance test method. The verification method for penetration integrity may change from one kind of penetration to another. The test procedure shall include full details of the verification method for approval by the NTA.

b. The NTA may accept previous or related shock test results and analysis to validate fire resistance is not degraded by shock.

c. Upon successful testing of shock test prior to fire resistance test in accordance with Appendix F, a full scale fire resistance test shall be conducted for final qualification purposes.

5.3 Fire resistance test method for N-Class divisions. The fire resistance test method for N-Class divisions shall be as follows:

a. For bulkheads and decks (overheads), the full scale fire resistance test shall be performed in accordance with Appendix A. The hose stream test shall be conducted in accordance with Appendix C.

b. For pipe and duct penetrations, the full scale fire resistance test shall be performed in accordance with Appendix A with the test configuration in accordance with Appendix B. The hose stream test shall be conducted in accordance with Appendix C.

c. For cable transits, the full scale fire resistance test shall be performed in accordance with Appendix A with the test configuration in accordance with Appendix D. The hose stream test shall be conducted in accordance with Appendix C.

d. Qualification testing of penetrations shall be performed using both deck (overhead) and bulkhead orientations using minimum and maximum sizes for each type of penetration.

e. More than one penetration of any type may be tested simultaneously in a division, subject to the review of the test plan and concurrence by the NTA.

f. For bulkhead/door assemblies, the full scale fire resistance test shall be performed in accordance with Appendix A with the test configuration in accordance with Appendix E. The hose stream test shall be conducted in accordance with Appendix C.

g. For polymer composite (fiber reinforced plastic) structures, refer to DDS-078-1 for fire test load during the fire resistance test.

5.4 Fire resistance test method for AN-Class divisions. The fire resistance test method for AN-Class divisions shall be as follows:

a. For bulkheads and decks (overheads), the full scale fire resistance test shall be performed in accordance with Resolution A.754(18).

b. For pipe and duct penetrations, the full scale fire resistance test shall be performed in accordance with Resolution A.754(18) with the test configuration in accordance with Resolution A.754(18), Appendix A.III.

c. For cable transits, the full scale fire resistance test shall be performed in accordance with Resolution A.754(18) with the test configuration in accordance with Resolution A.754(18) Appendix A.IV.

d. Qualification testing of penetrations shall be performed using both deck (overhead) and bulkhead orientations using minimum and maximum sizes for each type of penetration.

e. More than one penetration of any type may be tested simultaneously in a division, subject to the review of the test plan and concurrence by the NTA.

f. For bulkhead/door assemblies, the full scale fire resistance test shall be performed in accordance with Resolution A.754(18).

g. No hose stream test is required for AN-Class divisions.

5.5 Fire resistance criteria for N-Class divisions, including N-Class doors.

5.5.1 Class N-0. There shall be no passage of flame or hot gases capable of igniting cotton-wool pad on the unexposed face for the period required for the “N-Class” designation. The minimum test duration is 30 minutes. In addition, the specimen is considered to have satisfied the criteria of the hose stream test if no openings develop that allow water to pass to the unexposed face during the application of the hose stream.

5.5.2 Class N-30. In addition to the requirement described above, the average temperature rise on the unexposed surface shall not exceed 139 °C (rise of 250 °F) above the initial temperature for 30 minutes. The temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 30 minutes.

5.5.3 Class N-60. In addition to the requirement described above, the average temperature rise on the unexposed surface shall not exceed 139 °C (rise of 250 °F) above the initial temperature for 60 minutes. The temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 60 minutes.

5.5.4 Load bearing aluminum structures. In addition to requirements listed above in 5.5.1 through 5.5.3, the average temperature of the structural core shall not rise more than 200 °C (rise of 360 °F) above its initial temperature at any time during 30 minutes for N-0 and N-30 Class, and during 60 minutes for N-60 Class.

5.5.5 Composite (fiber reinforced plastic) structures. In addition to requirements listed in 5.5.1 through 5.5.3, the average temperature on the unexposed side of the composite system shall not exceed, at any time, the critical temperature of the composite where structural properties degrade rapidly (refer to DDS-078-1). Location of the deflection gauges shall be provided in the fire test procedure for approval by the NTA prior to testing. During fire testing, deflection measurements shall be recorded and included in the test report. The structure shall not have collapsed, ruptured, or deflected greater than the values acceptable to the NTA for the period specified.

5.6 Fire resistance criteria for N-Class penetrations.

5.6.1 Class N-0. There shall be no passage of flame or hot gases capable of igniting a cotton-wool pad on the unexposed face for the period required for the “N-Class” designation. The minimum test duration shall be 30 minutes. In addition, the specimen is considered to have satisfied the criteria of the hose stream test if no openings develop that allow water to pass to the unexposed face during the application of the hose stream.

5.6.2 Class N-30. In addition to the requirement described above, the temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 30 minutes.

5.6.3 Class N-60. In addition to the requirement described above, the temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 60 minutes.

5.7 Fire resistance criteria for AN-Class divisions, including AN-Class doors.

5.7.1 Class AN-0. There shall be no passage of flame or hot gases capable of igniting a cotton–wool pad on the unexposed face in accordance with Resolution A.754(18) test procedures. The minimum test duration shall be 60 minutes.

5.7.2 Class AN-30. In addition to the requirement described above, the average temperature rise on the unexposed surface shall not exceed 139 °C (rise of 250 °F), and the temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 30 minutes. The minimum test duration shall be 60 minutes.

5.7.3 Class AN-60. In addition to the requirement described above, the average temperature rise on the unexposed surface shall not exceed 139 °C (rise of 250 °F), and the temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 60 minutes. The minimum test duration shall be 60 minutes.

5.8 Fire resistance criteria for AN-Class penetrations.

5.8.1 Class AN-0. There shall be no passage of flame or hot gases capable of igniting a cotton-wool pad on the unexposed face in accordance with Resolution A.754(18) test procedures. The minimum test duration shall be 60 minutes.

5.8.2 Class AN-30. In addition to the requirement described above, the temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 30 minutes. The minimum test duration shall be 60 minutes.

5.8.3 Class AN-60. In addition to the requirement described above, the temperature rise at any point on the unexposed surface shall not exceed 181 °C (rise of 325 °F) above the initial temperature for 60 minutes. The minimum test duration shall be 60 minutes.

5.9 Approvals and product documentation. For both N-Class and AN-Class divisions and their penetrations, independent test laboratory final reports and video shall be submitted to the NTA. Upon satisfactory review of the test reports, and if the product meets the fire performance criteria in addition to other requirements that may be imposed by the NTA, an approval letter will be issued. This letter will outline restrictions, if any, and instruct the Life Cycle Manager (LCM) to update the appropriate chapter(s) of the Naval Ships' Technical Manual (NSTM) with approved product listing. Any significant alteration to a product shall make the relevant approval to cease to be valid. To obtain a new approval**,** the product shall be resubmitted to the NTA for approval.

6. NOTES

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

6.1 Intended use. This standard provides the fire test procedures and acceptance criteria for qualification of fire resistant divisions and their penetrations on U.S. naval surface ships. It is intended to satisfy the fire resistance requirements for fire resistant divisions and their penetrations in accordance with ABS NVR Part 1, Chapter 2, Section 1. This standard presumes that the detailed division or penetration system development and qualification is accomplished by a ship design activity, such as a commercial shipbuilder, under contract to the government, or material supplier, referred to herein as the "proposer".

6.2 Acquisition requirements. Acquisition documents should specify the following:

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

6.3 Appendices of this standard.

6.3.1 Appendix A. Appendix A is a modified version of Appendix A in MIL-PRF-32161, which requires the use of a rapid rise hydrocarbon pool fire exposure similar to that described in UL 1709 (Rapid Rise Fire Tests of Protection Materials for Structural Steel by Underwriters Laboratories). The fire resistance test method and acceptance criteria for N-Class divisions and penetrations are in accordance with ABS NVR Part 1, Chapter 2, Section 1. The N-Class divisions serve as the principal fire resistance on U.S. naval surface ships. The N-Class fire exposure represents a flammable liquid release from a ship system or unexpended liquid missile fuel.

6.3.2 Appendix B. Appendix B is a modified version of Appendix A.III in Resolution A.754(18), which is applied to the rapid rise fire exposure of Appendix A. Appendix B is only imposed for penetrations in N-Class divisions.

6.3.3 Appendix C. Appendix C is a modified version of Section 5, Appendix A.I in Resolution A.754(18), and ASTM E2226 which is applied to the rapid rise fire exposure of Appendix A. The hose stream test is only imposed for divisions and penetrations in N-Class. The hose stream test is not required for AN-Class divisions and penetrations, consistent with IMO practice for commercial vessels.

6.3.4 Appendix D. Appendix D contains text and drawings from Appendix A.IV in Resolution A.754(18) and MIL-P-24705 and its applicable specification sheets. Appendix D is applied to the rapid rise fire exposure of Appendix A. Appendix D is only imposed for cable penetrations in N-Class divisions.

6.3.5 Appendix E. Appendix E contains text from Resolution A.754(18), Section 2.3. Appendix E is applied to the rapid rise fire exposure of Appendix A. Appendix E is only imposed for bulkhead/door assemblies in N-Class divisions.

6.3.6 Appendix F. Appendix F is applicable to those divisions and penetrations which are required to meet Grade A shock test in accordance with MIL-S-901. This requirement is intended to ensure that fire resistance of divisions, with fire insulation, penetrations, and associated attachment methods, is not degraded in a combat environment. Intermediate scale test specimen size of 1219 by 3048 millimeters (4 by 10 feet) was selected for shock test prior to fire resistance test. The full scale fire resistance test described in Appendix A requires test specimens 3048 by 3048 millimeters (10 by 10 feet) or greater. Laboratories which conduct shock tests are not equipped to perform fire resistance tests. As such, a full scale shock test, followed by full scale fire resistance test, is cost prohibitive due to shipment of large test specimens over long distances to fire test laboratories. A full scale fire resistance test, in accordance with Appendix A, is still required for qualification purposes after successful completion of the shock test prior to fire resistance test.

6.4 Separation distances between penetrations. The separation distances between penetrations in Appendices B and D are applicable to fire resistance tests only. These distances do not reflect any shipboard design criteria.

6.5 AN-Class divisions. The AN-Class is analogous to the commercial International Maritime Organization (IMO) A-Class divisions which are non-combustible, but combined with Navy shock test requirement. The AN-Class provides fire resistance for ordinary combustibles in the limited case where there is no hazard of a flammable liquid fire and unexpended missile fuel is not considered a threat. In this case, the slower rise fire exposure of Resolution A.754(18) is considered adequate if combined with a shock test requirement.

6.6 Limits of approval. Approval of the results from this test method is limited to the actual configuration, materials of construction, installation procedures, and orientation of the division and penetration systems tested. The approval of the results from this test method is also limited to the intended ship classes and locations that were identified in the shock test procedure and report. Any significant alteration to a product shall make the relevant approval to cease to be valid. To obtain a new approval**,** the product must be resubmitted to the NTA for approval.

6.7 Applicability to existing penetration systems. The fire resistance test procedures and acceptance criteria are applicable to only those penetrations which require future Navy approvals. Penetrations previously approved by the cognizant NTA are not rescinded by this document and may continue to be used without requalification, i.e., “grandfathered”, as determined by the appropriate NTA.

6.8 Subject term (key word) listing.

AN-Class

Fire insulation

Fire resistance

N-Class

METHOD OF FIRE TESTS FOR FIRE RESISTANCE OF BULKHEADS AND DECKS (OVERHEADS)

A.1 SCOPE

A.1.1 Scope. The test methods described in this appendix are used for determining the fire resistance performance of bulkheads, decks (overheads), and their penetrations, with or without insulation, utilized on U.S. Navy ships. These test methods prescribe a standard fire exposure for comparing the relative performance of different assemblies under controlled laboratory conditions. This appendix is a mandatory part of the standard. 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 Testing for intended function. It is the intent that tests conducted in accordance with these test methods will indicate whether bulkheads or deck (overhead) 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 SI units. The values stated in SI units are to be regarded as the standard. The values given in parentheses are for informational purposes.

A.1.5 Limitations. These test methods do not provide the following:

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

b. 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.

c. Measurement of flame spread over the surface of the test assembly.

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

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

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

g. Full information concerning structural performance of assemblies under fire conditions.

A.1.6 Assessment of the fire hazard or fire risk of a particular end use. 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.1.7 Responsibility of the user. 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

A.2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this appendix. This section does not include documents cited in other sections of this standard 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 appendix, whether or not they are listed.

A.2.2 Government documents.

A.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-I-22023	-	Insulation Felt, Thermal and Sound Absorbing Felt, Fibrous Glass, Flexible

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

A.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 E119	-	Fire Tests of Building Construction and Materials (DoD adopted)
ASTM E176	-	Terminology Relating to Fire Standards
ASTM E2226	-	Standard Practice for Application of Hose Stream

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

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 ISO, 1, rue de Varembé, CH-1211 Geneva 20, Switzerland or online at www.iso.org.)

UNDERWRITERS LABORATORIES (UL)

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

(Copies of this document are available from COMM 2000, 1414 Brook Drive, Downers Grove, IL 60515 or online at www.ul.com.)

A.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.

A.3 DEFINITIONS

A.3.1 Fire containment assembly. A structure composed of a bulkhead or deck (overhead) and attached insulation.

A.3.2 Other terms. Refer to ASTM E176 for definition of terms used in the test methods specified herein.

A.4 SUMMARY OF TEST METHODS

A standard fire exposure of controlled extent and severity is specified. The intent is to provide an average total heat flux of 204±16 kilowatts per square meter (kW/m^2) (65,000±5,000 Btu per square foot/hour (Btu/ft^2-h)) for the duration of the test. The test setup shall provide a minimum average total heat flux of 188 kilowatts per square meter (kW/m^2) (60,000 Btu per square foot/hour (Btu/ft^2-h)) within the first 5 minutes of the test exposure. At all times after 5 min, the average temperature within the furnace shall be maintained at a minimum of 1038 °C (1900 °F) and a maximum of 1149 °C (2100 °F) for the duration of the test as shown in figure A-1. A calibration of the furnace shall be performed to characterize the furnace's heat flux versus temperature profile. Performance is defined as the time period during which assemblies will continue to perform their intended function when subjected to fire exposure. The N-ratings are reported in terms of time increments of 30 minutes.

A.5 SIGNIFICANCE AND USE

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

A.5.1.1 Standardized fire exposure. 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. Conditions produced by the standard exposure can also be achieved from a post-flashover compartment fire involving ordinary combustible materials (Class A) with the appropriate compartment size and ventilation.

A.5.1.2 Conditions of testing. 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 Approvals. 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 NTA. Approval documentation should identify major limits for assembly variation for use by shipbuilders and installers.

A.5.1.4 Fire containment capability. A separate procedure is specified for testing the fire-containment capability of a bulkhead or deck (overhead) assembly. Acceptance criteria include temperature rise of the unexposed face, plus the ability of the bulkhead or deck (overhead) assembly to prohibit passage of flames.

A.6 CONTROL OF FIRE TEST

A.6.1 Fire test exposure conditions.

a. The test specimen shall be exposed to heat flux and temperature conditions as specified in b and c below. Calibration assemblies shall be used to demonstrate that the required heat flux and temperature levels are generated in the test furnace.

b. The test setup shall provide an average total heat flux, on all exposed surfaces of the test specimen, of 204±16 kW/m^2 (65,000±5,000 Btu/ft^2-h) by adjusting the temperature inside the test furnace. The test setup shall provide a minimum average total heat flux of 188 kW/m^2 (60,000 Btu/ft^2-h) within the first 5 minutes of the test exposure. At all times after 5 min, the average temperature within the furnace shall be maintained at a minimum of 1038 °C (1900 °F) and a maximum of 1149 °C (2100 °F) for the duration of the test as shown in figure A-1. 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.

c. The fire resistance test shall continue 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. The total heat flux shall be measured as specified in A.6.1, using circular foil heat flux gauges (often called a Gardon gauge, after the developer).

(1) For fire-containment bulkheads, the heat flux measurements shall 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-2.

(2) For fire containment decks (overheads), the heat flux measurements shall 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.

(3) The heat flux shall be measured at intervals of 15 sec or less at each required measurement site.

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

a. When testing the bulkhead or deck (overhead) assembly, the furnace pressure shall be measured at points located as follows:

(1) Bulkhead assemblies. Furnace pressure measurements shall be provided at two locations with pressure probes. One location will be on the vertical centerline directly beneath the bulkhead installed through the unexposed face of the test restraint frame and will protrude into the furnace at a distance of 152 millimeters (6 inches) away from the exposed face of the test specimen. The second location shall be on the vertical centerline directly above the bulkhead installed through the unexposed face of the test restraint frame and will protrude into the furnace at a distance of 152 millimeters (6 inches) away from the exposed face of the test specimen. The neutral plane (zero pressure differential) for the bulkhead assembly 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.

(2) Deck (overhead) assemblies. Furnace pressure measurements shall be provided at the center and quarter points along the longest edge, 304 millimeters (12 inches) below the exposed face of the test specimen. This measurement shall be made through the side of the furnace or through the top of the restraint frame.

b. 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 a 12.7-millimeter (0.5-inch) diameter pipe with 1.6-millimeter (0.0625-inch) diameter holes, spaced 40 degrees apart around the pipe, drilled 50.8 millimeters (2 inches) from the welded end.

c. The pressure shall be measured by means of a manometer or equivalent transducer. The manometer or transducer shall be capable of reading 2.5 Pa (0.01-inch H_2O) increments with a measurement precision of 1.25 Pa (0.005-inch H_2O). 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.

d. The furnace pressure(s) shall be measured and recorded at intervals of 15 sec or less throughout the fire test.

e. 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.

(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.

(2) Deck (overhead) assemblies. The average pressure (use all three pressure probes) within the furnace shall be maintained at a minimum of 2.5 Pa (0.01-inch H_20) 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. The temperature of the furnace environment shall be measured, exposing either the calibration or test assembly, as specified in A.6.1, using factory manufactured 6.35 millimeters (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. Standard calibration thermocouples with an accuracy of ±0.75 percent, or better, shall be used.

b. The gas temperature shall be obtained 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.

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

(2) Deck (overhead) assemblies. The thermocouples shall be placed 304.8 millimeters (12 inches) below the exposed face of the test assembly at the beginning of the test, and should not touch the surface of the test assembly during the fire test as a result of specimen growth or deflection.

c. The furnace temperature shall be measured at intervals of 15 sec or less at each required measurement site.

d. At all times after the first 5 minutes of the test, each thermocouple shall be 1,093±56 °C (2,000±100 °F).

e. At all times after the first 5 minutes of the test, the average gas temperature shall be 1,093±56 °C (2,000±100 °F).

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

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

(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) Bulkhead assemblies. The calibration specimen shall consist of a minimum of 25.4 millimeters (1 inch) 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.

(b) Deck (overhead) assemblies. The calibration assembly shall consist of a minimum of 25.4 millimeters (1 inch) of ceramic insulating fiber facing the fire. The fiber shall be suitably supported on a noncombustible deck assembly. The calibration specimen shall have the same dimensions as the actual test deck assembly with respect to length and width.

(2) Instrument the calibration specimen and furnace to make measurements that are specified as follows:

(a) Total heat flux – see A.6.2.

(b) Furnace pressure – see A.6.3.

(c) Furnace temperature – see A.6.4.

(3) The time duration of the calibration run shall be:

(a) At least as long as the longest subsequent materials test for which it shall apply, or

(b) 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.

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

(1) Total heat flux – see A.6.1 and A.6.2.

(2) Furnace temperature – see A.6.1, A.6.2, and A.6.4.

(3) The test exposure is governed by the heat flux exposure to the test sample. The furnace temperature measurements provide a means to replicate the heat flux exposure, as measured in the calibration test, during an actual test.

c. The furnace shall be characterized by the calibration specimen for the average heat flux associated with an average temperature. This shall be performed by initially reaching a target average temperature of 982 °C (1800 °F) and maintaining that temperature so as to collect sufficient data on the average heat flux associated with that temperature. The gas shall then be increased and this procedure repeated to collect sufficient data on the average heat flux associated with average temperatures of 1038 °C (1900 °F), 1093 °C (2000 °F), 1149 °C (2100 °F), and 1204 °C (2200 °F), respectively.

d. A furnace facility shall be considered calibrated after an initial calibration test that meets the requirements of A.6.5.a, A.6.5.b, and A.6.5.c.

e. After the initial calibration, the test facility shall be recalibrated 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 shall 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 (overhead) assemblies.

A.7 TEST CONFIGURATIONS

A.7.1 Test specimen. 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. The test specimen shall be protected 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.

b. If the test specimen contains moisture, solvents, plasticizers, curing compounds, or similar agents, the specimen shall be conditioned 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 c below).

c. If the specimen contains moisture or solvents, the actual content of such agents shall be measured 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.

d. If the specimen contains passive fire protection materials used to protect bulkheads or decks (overheads), the laboratory conducting the test shall make measurements of thickness, area weight, density, and other pertinent properties of these materials used in the test specimen.

A.7.3 Test method A - bulkhead assemblies.

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

A.7.3.1.1 Conditions of test. 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 9.3 square meters (m^2) (100 square feet (ft^2)) and a height of not less than 3048 millimeters (10 feet), as shown in figure A-5. Restrain the test specimen on all four edges as approved by the NTA.

A.7.3.1.3 Temperature measurements during testing.

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

b. The thermocouples on the outermost unexposed face shall be placed under dry felted pads as described in ASTM E119.

c. The surface temperatures on the unexposed side of the test specimen shall be measured throughout the fire test, using locations as shown in figure A-6. Locations as indicated shall be moved if they are located over stiffeners, impaling pins, or insulation seams. Movement of thermocouples shall be approved by the NTA.

(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 through 9 in figure A-6) shall be located on the unexposed face, centered between the frame bays (area between stiffeners). If thermocouples are located over insulation seams, they shall be moved such that the measuring junction is 50.8 millimeters (2 inches) away from the seams. If more than one layer of insulation is used, additional thermocouples can be placed between layers in planar positions directly under thermocouples 1 through 9.

(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 the stiffeners). If thermocouples are located over insulation seams, they shall be moved such that the measuring junction is 50.8 millimeters (2 inches) away from the seams. Nine additional thermocouples (denoted as thermocouples 10 through 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. If more than one layer of insulation is used, additional thermocouples can be placed between layers in planar positions directly under thermocouples 1 through 9.

(3) For tests of bulkhead assemblies with a structural core other than steel, thermocouples shall be fixed to the core material by means of peening or other approved means to get representative temperature data for the structural core. These thermocouples shall be placed on the fire side of this structural core and in planar positions as thermocouples 1 through 9 in figure A-6.

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

a. The fire-containment bulkhead assembly shall have withstood the fire resistance test without passage of flame or hot gases for a time period equal to that for which classification is desired.

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

(a) 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.

(b) A cotton-wool pad is employed by placing the frame (as constructed in ASTM E119) 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 shall be used only once.

b. 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.c, more than 139 °C (250 °F) above its initial temperature, nor the temperature of any one point on the surface including any joint, more than 181 °C (325 °F) above its initial temperature for a time period equal to that for which classification is desired.

c. In the case of load-bearing divisions of aluminum structural core, the average temperature of the structural core as measured by thermocouples as indicated in A.7.3.1.3.c.(3) shall not rise more than 200 °C (rise of 360 °F) above its initial temperature at any time during the test duration. This requirement is in addition to requirements in A.7.3.1.4.b.

d. For composite (fiber reinforced plastic) structures, the maximum average temperature on the unexposed side of the composite system shall not exceed, at any time, the critical temperature of the composite where structural properties degrade rapidly (refer to DDS-078-1). This requirement is in addition to requirements in A.7.3.1.4.b. During fire testing, deflection measurements shall be recorded and included in the test report. The structure shall not have collapsed, ruptured, or deflected greater than the values acceptable to the NTA for the period specified.

e. The hose stream test shall be conducted in accordance with Appendix C. The specimen is considered to have satisfied the criteria of the hose stream test if no openings develop during the application of the stream which allow water to pass to the unexposed face.

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. 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.

b. 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 4.5±0.5 millimeters (0.18±0.02 inch) thick. The joints of the steel plate shall be continuously welded on one side of the bulkhead.

c. Tee stiffeners shall be constructed on 101.6 by 101.6 millimeters (4 by 4 inches) stiffeners spaced 609.6 millimeters (24 inches) 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. 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.

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

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

(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.

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

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

c. Any deviations from the insulation layouts must be approved in advance by the NTA.

d. The stiffened face shall be exposed to the fire.

e. 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. 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).

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

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

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

c. Any deviations from the insulation layouts must be approved in advance by the NTA.

d. 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. Approval of the NTA shall 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. Approval of the NTA shall 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 (overhead) assemblies.

A.7.4.1 Tests of fire-containment capability of deck (overhead) assemblies. Deck (overhead) assemblies can have structural, fire containment, or other functions, or combinations thereof. The purpose of this method is to evaluate the fire containment capability.

A.7.4.1.1 Fire exposed side. The test method for deck (overhead) assemblies assumes that there will be fire impingement on only one side (underside) 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 13.4 m^2 (144 ft^2) and a width of not less than 3658 millimeters (12 feet), as shown in figure A-13. Restrain the test specimen on all four edges with a 100-millimeter (4-inch) overhang on all sides as approved by the NTA.

A.7.4.1.3 Temperature measurements during testing.

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

b. The thermocouples on the unexposed face shall be placed under dry felted pads as described in ASTM E119.

c. The surface temperatures on the unexposed side of the test specimen shall be measured throughout the fire test, using thermocouples located as shown in figure A-14.

d. Nine thermocouples shall be symmetrically located across the unexposed face of the assembly. The thermocouples (denoted as thermocouples 1 through 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. The fire-containment deck (overhead) assembly shall have withstood the fire endurance test without passage of flame for a time period equal to that for which classification is desired. The occurrence and duration of any flaming on the unexposed surface, together with the location of the flaming, shall be recorded. In cases where it is difficult to identify whether or not there are flames then the cotton-wool pad shall be applied to the area of such disputed flaming to establish whether ignition of the pad can be initiated.

(1) 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.

(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 shall be used only once.

b. Transmission of heat through the deck (overhead) 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.c, more than 139 °C (250 °F) above its initial temperature, nor the temperature of any one point on the surface including any joint, more than 181 °C (325 °F) above its initial temperature, for a time period equal to that for which classification is desired.

c. In the case of load-bearing divisions of aluminum structural core, the average temperature of the structural core shall not rise more than 200 °C (rise of 360 °F) above its initial temperature at any time during the test duration. This requirement is in addition to requirements in A.7.4.1.4.b.

d. For composite (fiber reinforced plastic) structures, the maximum average temperature on the unexposed side of the composite system shall not exceed, at any time, the critical temperature of the composite where structural properties degrade rapidly (refer to DDS-078-1). This requirement is in addition to requirements in A.7.4.1.4.b. During fire testing, deflection measurements shall be recorded and included in the test report. The structure shall not have collapsed, ruptured, or deflected greater than the values acceptable to the NTA for the period specified.

e. The hose stream test shall be conducted in accordance with Appendix C. The specimen is considered to have satisfied the criteria of the hose stream test if no openings develop during the application of the stream which allow water to pass to the unexposed face.

A.7.4.1.5 Decks (overheads) using applied insulation materials.

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

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

b. For fire-containment decks (overheads) 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 4.5±0.5 millimeters (0.18±0.02 inch) thick. The joints of the steel plate shall be continuously welded on one side of the deck.

c. Stiffeners shall be constructed of 101.6 by 101.6-millimeter (4 by 4-inch) stiffeners spaced 609.6 millimeters (24 inches) on center as shown in figure A-13.

d. The base deck (overhead) 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).

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

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

g. Any deviations from the insulation layouts must be approved in advance by the NTA.

h. The stiffened face shall be exposed to the fire.

A.7.4.1.5.2 Decks (overheads) using insulation materials applied to a non-steel structural core. Approval of the NTA shall 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 (overheads) using a non-steel structural core - no applied insulation. Approval of the NTA shall 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. A 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 shall be provided. The type, location, and orientation of all instrumentation (such as heat flux meters and thermocouple assemblies) used to monitor and control the fire exposure shall be reported.

b. For a calibration test, the heat flux incident on the test specimen and the temperature of the fire environment with measurements at intervals of 15 sec or less shall be reported. For an actual test, the temperature of the fire environment with measurements at intervals of 15 sec or less shall be reported.

c. Furnace calibration data shall include the results from the test to characterize the heat flux at different temperature levels as described in A.6.5.c.

d. Whether the fire environment resulted in an exposure that satisfied the criteria set forth herein shall be indicated, 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, the actual furnace temperatures, and furnace pressure measured during the actual fire test shall also be provided.

e. The test procedure that was followed shall be reported, and the resulting fire endurance period shall be indicated.

f. The type and location of all thermocouples used to measure the temperature of the test specimen shall be specified. All temperature measurements shall be given at intervals of 15 sec or less.

g. The type and location of all gauges used to measure the deflection of the test specimen shall be specified. All deflection measurements shall be given at intervals of 15 sec or less.

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

i. If the specimen contains passive fire protection materials used to protect bulkheads or decks (overheads), the laboratory conducting the test shall report measurements of thickness, area weight, density, and other pertinent properties of these materials used in the test specimen.

j. The report shall also contain visual observations recorded during the fire test at 5-minute intervals or less. 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.

k. For cases where an unsuccessful test had been conducted prior to the final approval test, the test report shall include an analysis of the failure modes, and description of the modifications made to the test specimen that resulted in the successful test.

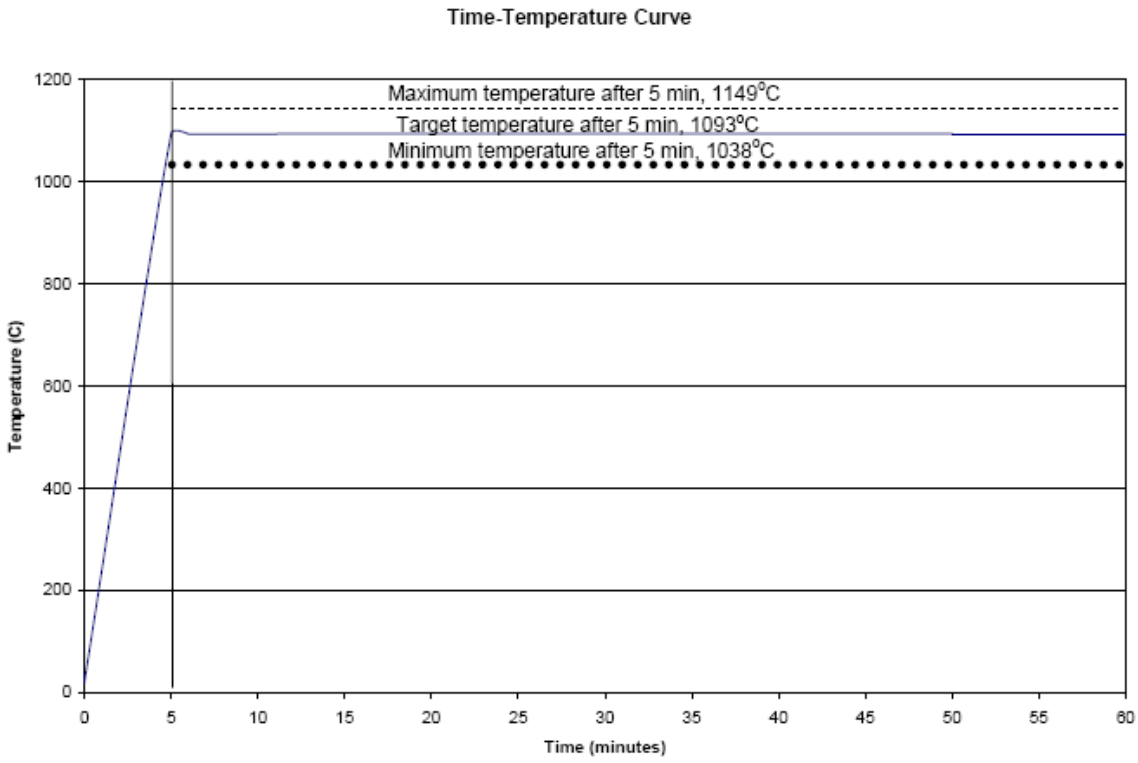
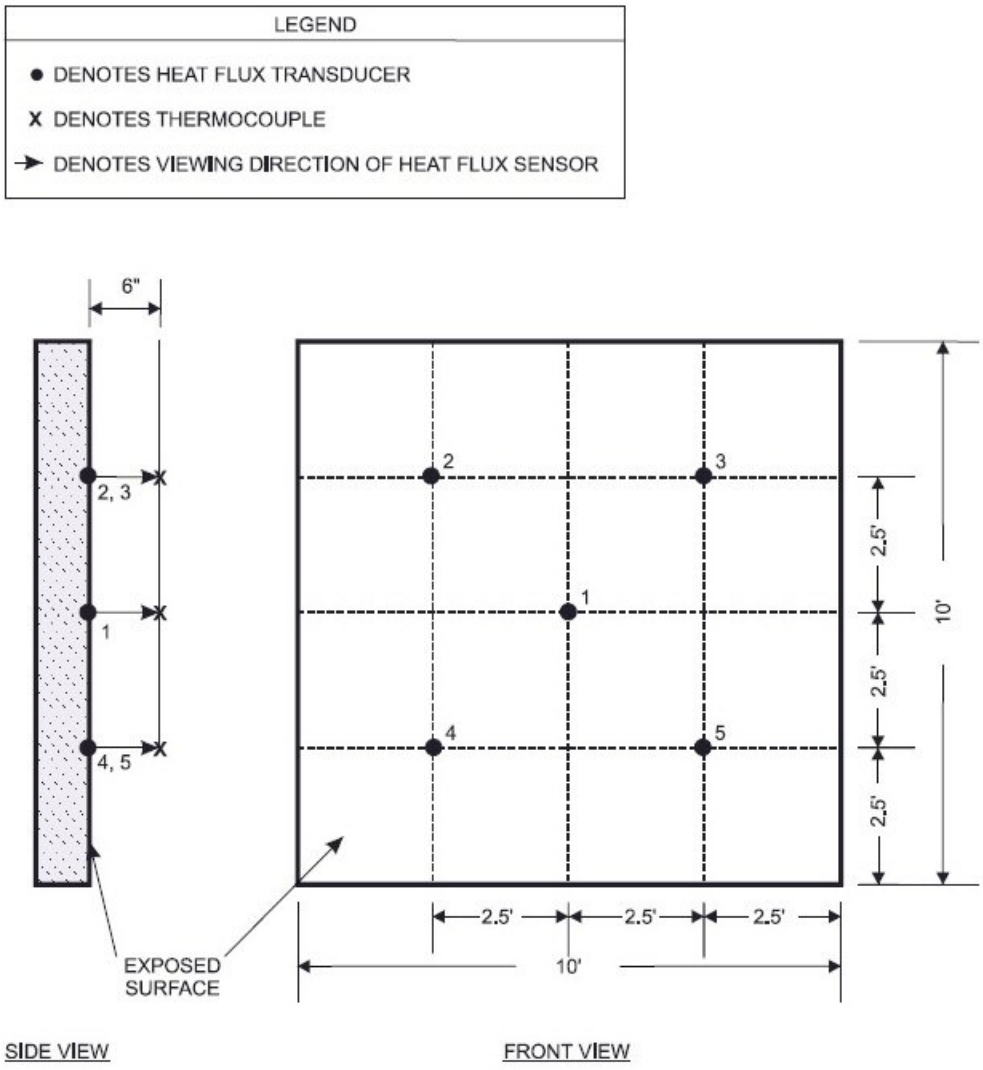


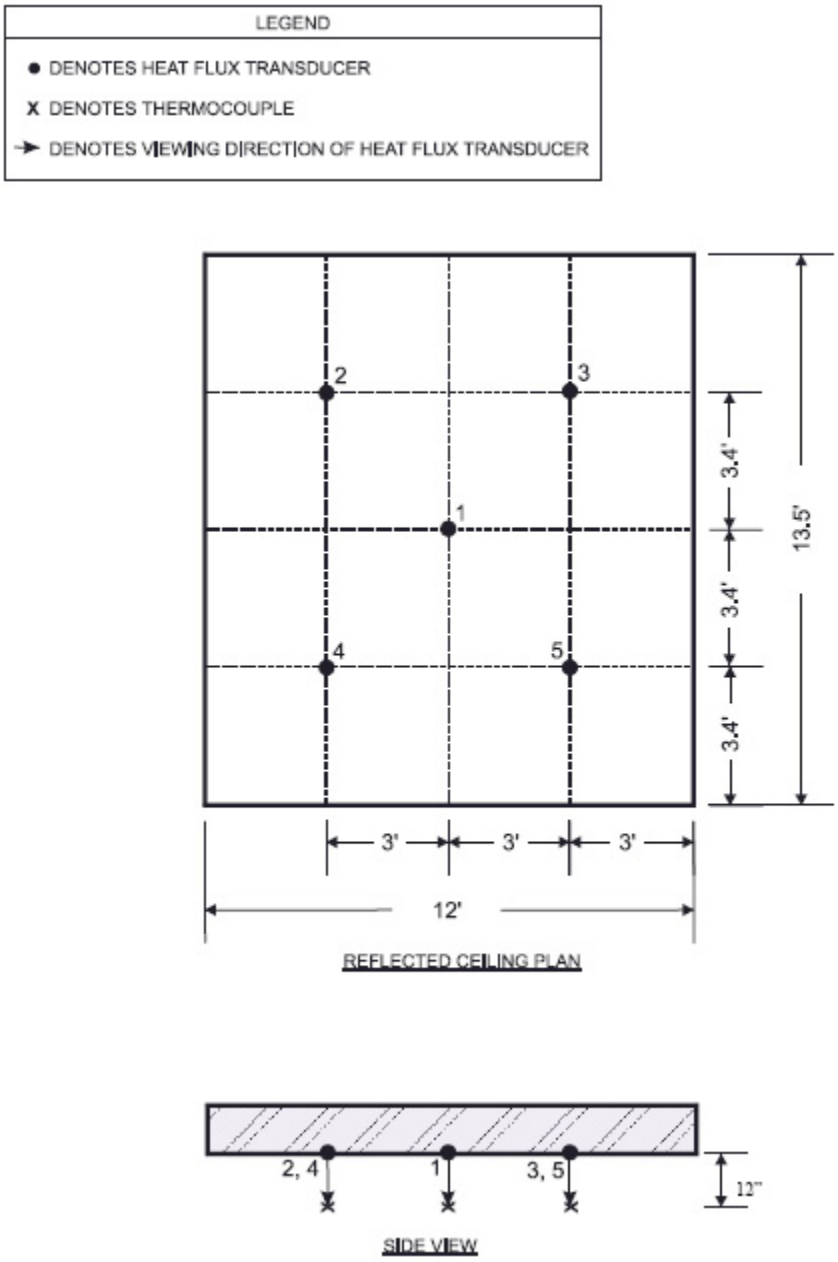
FIGURE A-1. Exposure conditions for high rise hydrocarbon liquid fires.



152 millimeters (6 inches)
762 millimeters (2.5 feet)
3048 millimeters (10 feet)

(Note: Thermocouples are Type K)

FIGURE A-2. Bulkhead calibration assembly.



304.8 millimeters (12 inches)
914 millimeters (3 feet)
1036 millimeters (3.4 feet)
3658 millimeters (12 feet)
4115 millimeters (13.5 feet)

FIGURE A-3. Deck calibration assembly.

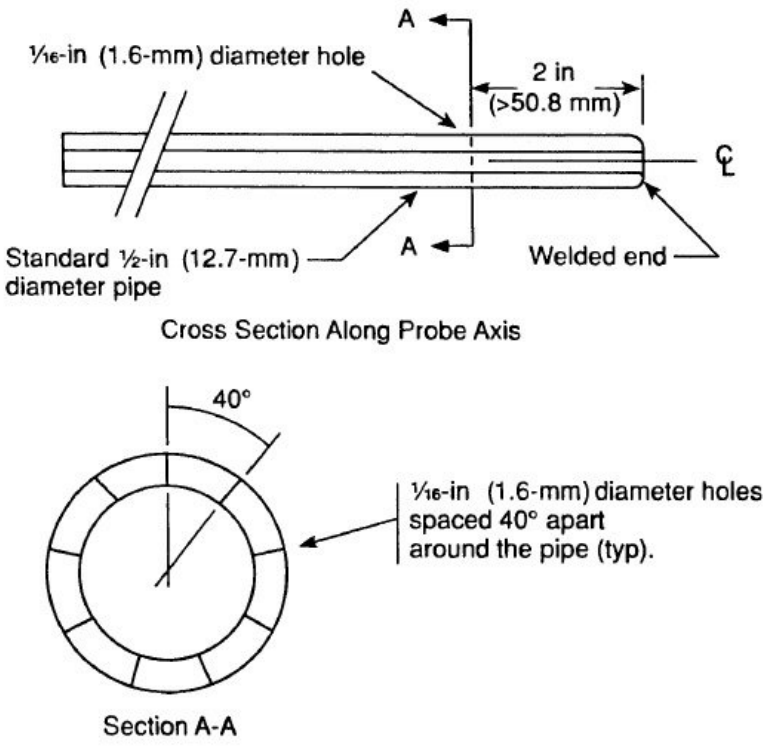
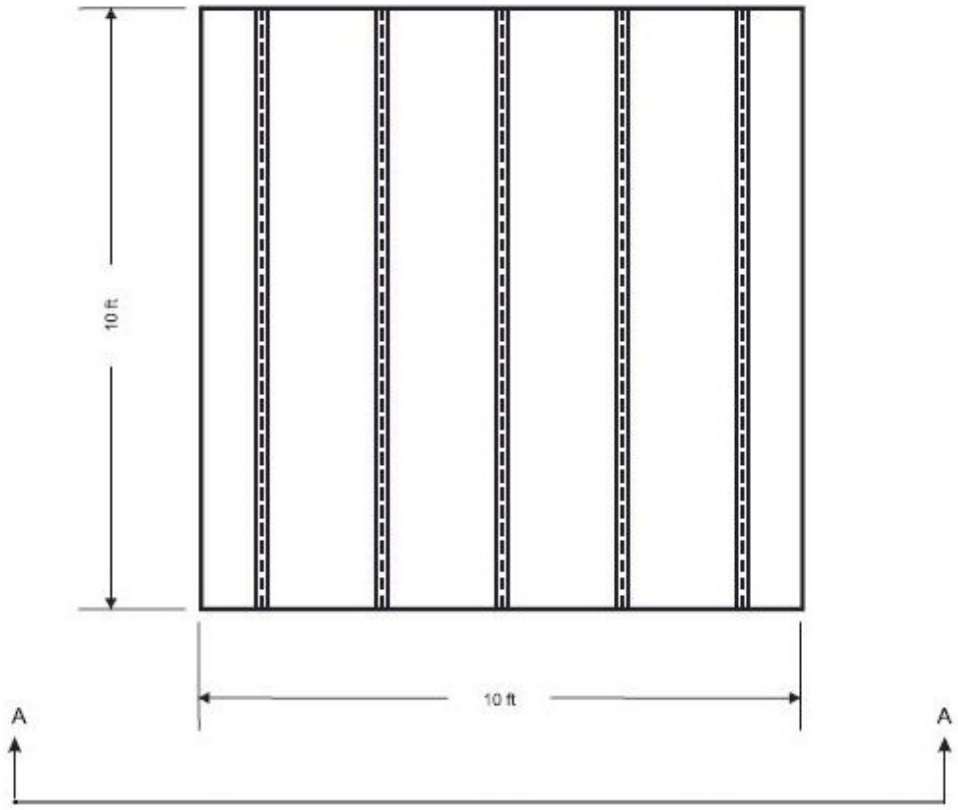


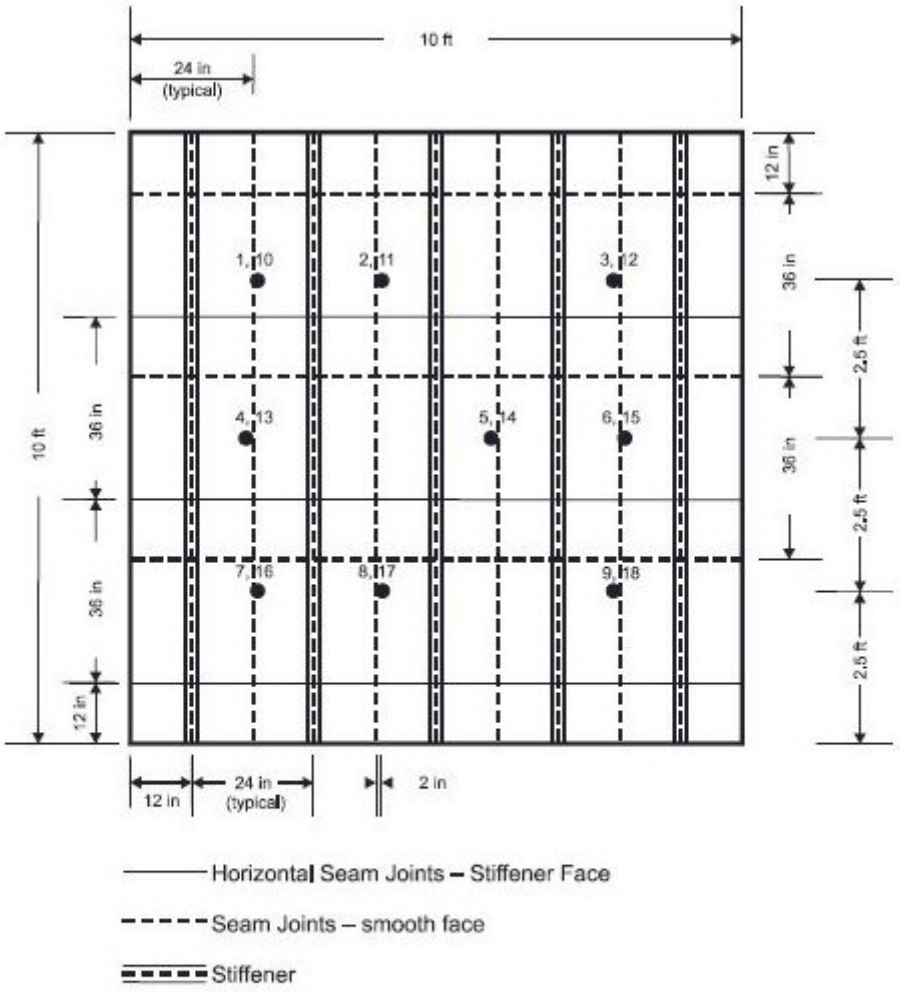
FIGURE A-4. Pressure measuring probe details.



101.6 millimeters (4 inches)
304.8 millimeters (12 inches)
609.6 millimeters (24 inches)
3048 (10 feet)

Notes: 1. Tee Stiffeners are 6.7 millimeters (0.263 inch) thick
2. Plate is 4.5 millimeters (0.18 inch) thick

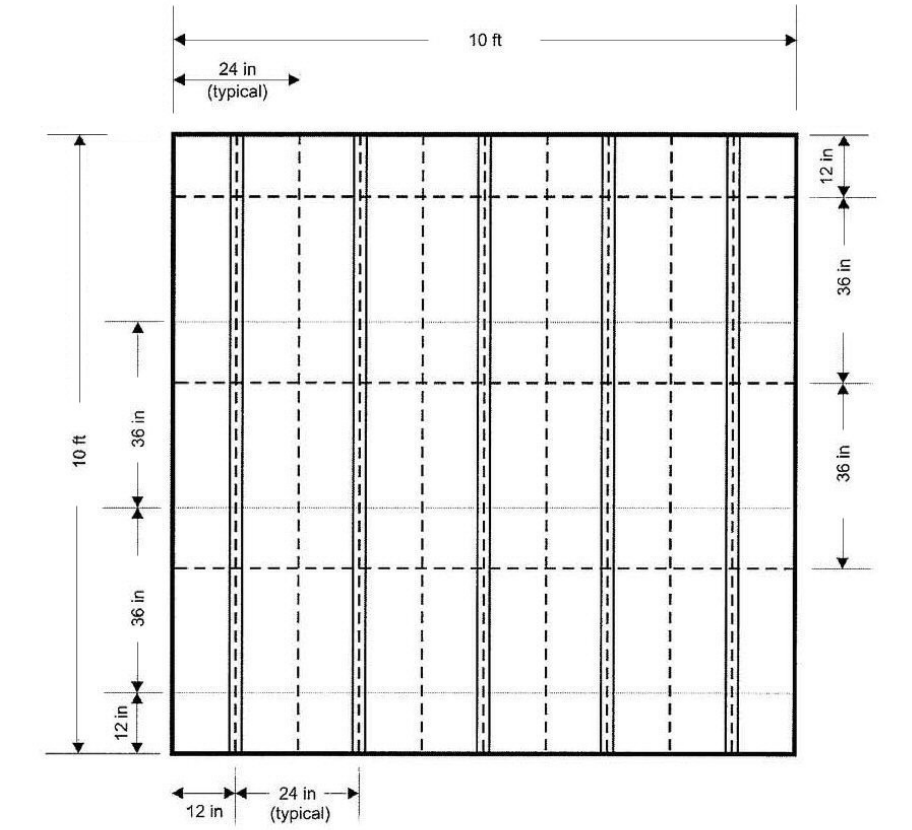
FIGURE A-5. Bulkhead assembly (stiffener face).



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

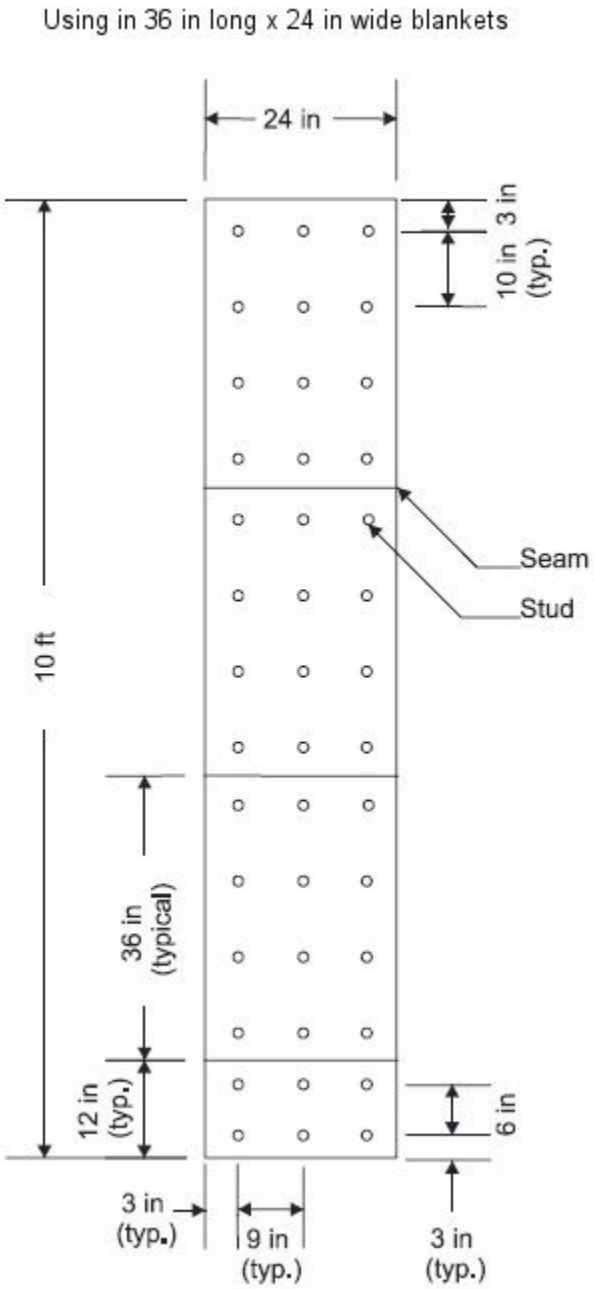
50.8 millimeters (2 inches); 304.8 millimeters (12 inches); 609.6 millimeters (24 inches)
762 millimeters (2.5 feet); 914 millimeters (36 inches); 3048 millimeters (10 feet)

FIGURE A-6. Bulkhead assembly thermocouple locations.



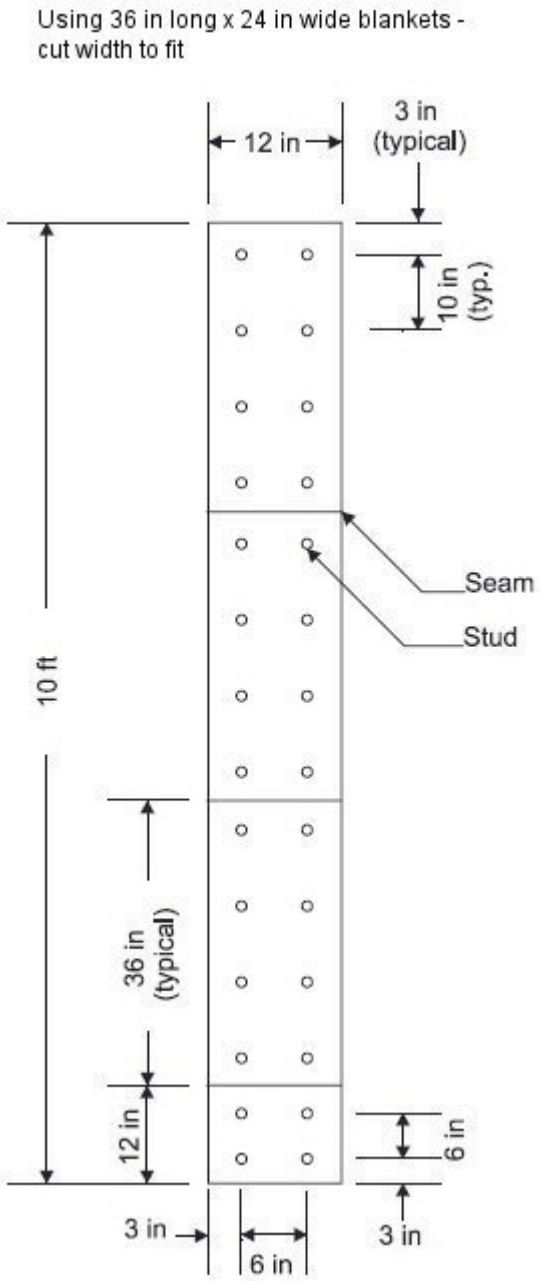
304.8 millimeters (12 inches)
609.6 millimeters (24 inches)
914 millimeters (36 inches)
3048 millimeters (10 feet)

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



76.2 millimeters (3 inches); 152.4 millimeters (6 inches); 228.6 millimeters (9 inches)
254 millimeters (10 inches); 304.8 millimeters (12 inches); 609.6 millimeters (24 inches)
914 millimeters (36 inches); 3048 millimeters (10 feet)

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



76.2 millimeters (3 inches); 152.4 millimeters (6 inches); 254 millimeters (10 inches)
304.8 millimeters (12 inches); 609.6 millimeters (24 inches)
914 millimeters (36 inches); 3048 millimeters (10 feet)

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

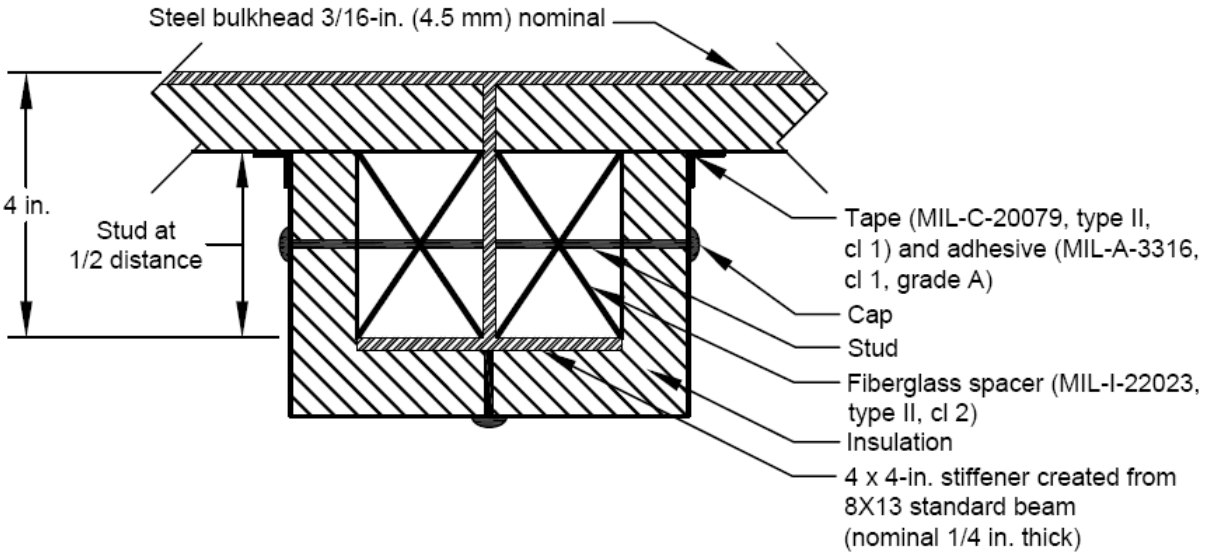
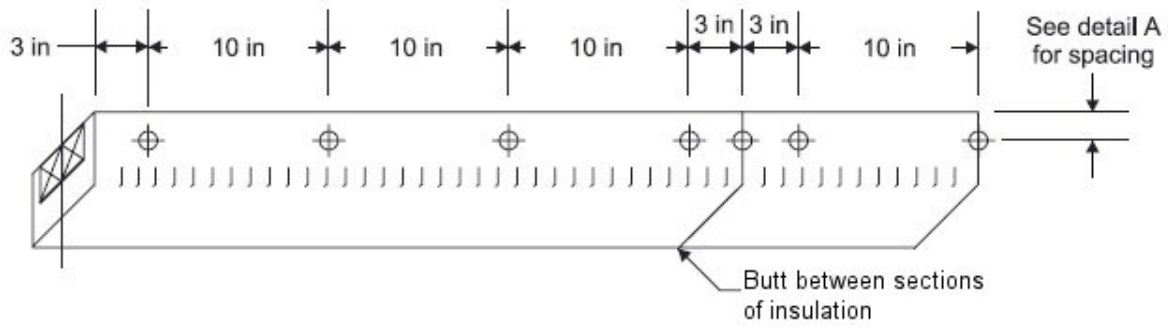
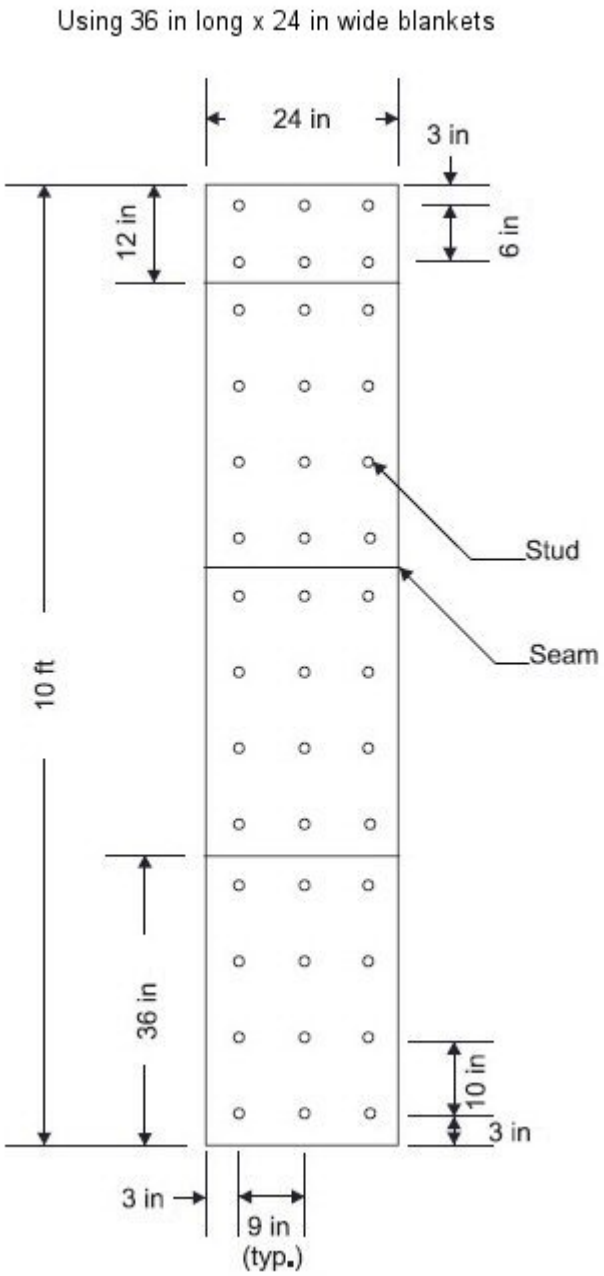


FIGURE A-10. Detail A – insulation attachment on stiffeners (sectional view).



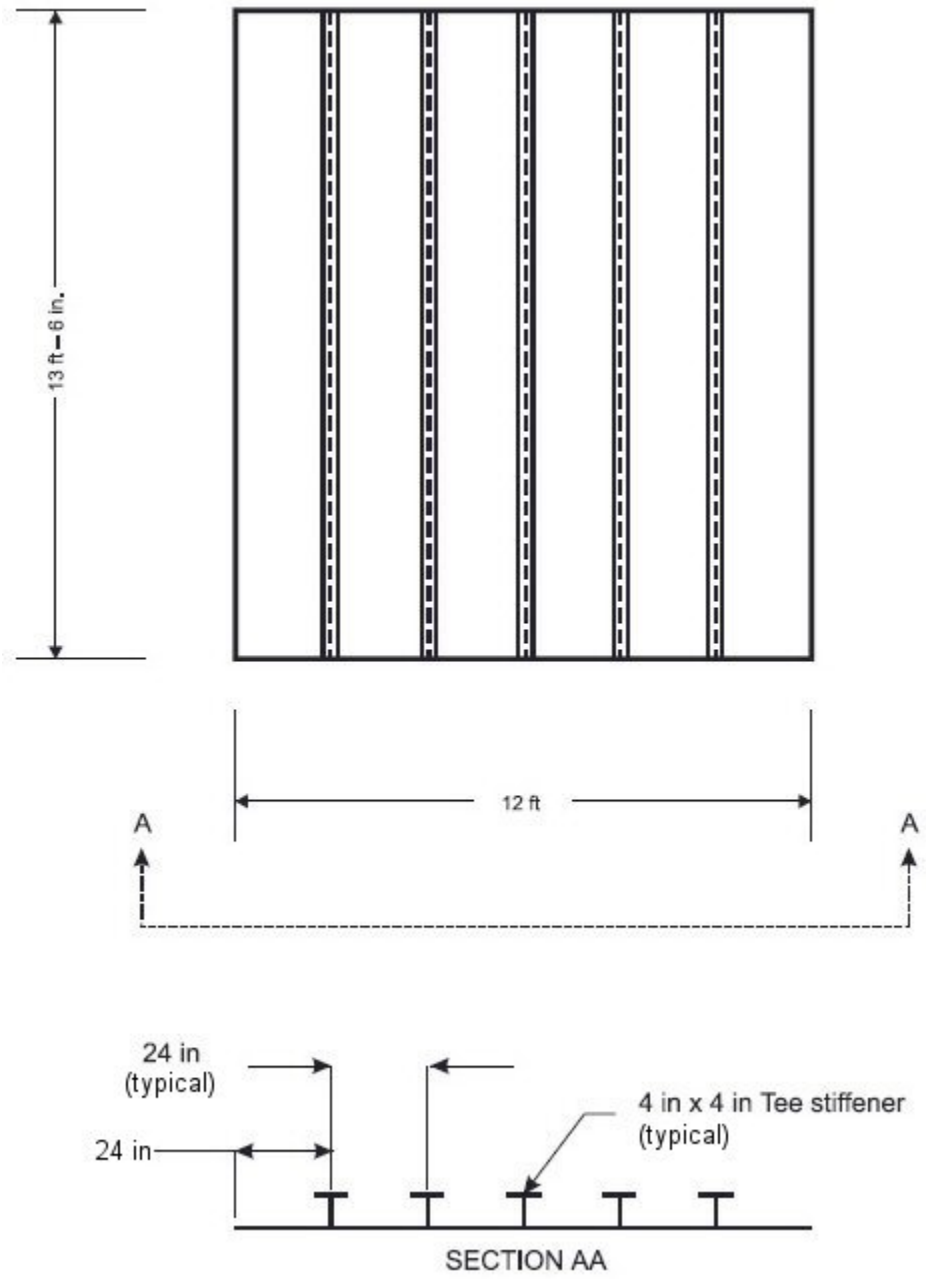
76.2 millimeters (3 inches)
101.6 millimeters (4 inches)
254 millimeters (10 inches)

FIGURE A-11. Detail B – stud spacing on 101.6 by 101.6-millimeters (4 by 4-inch) stiffener (projection view).



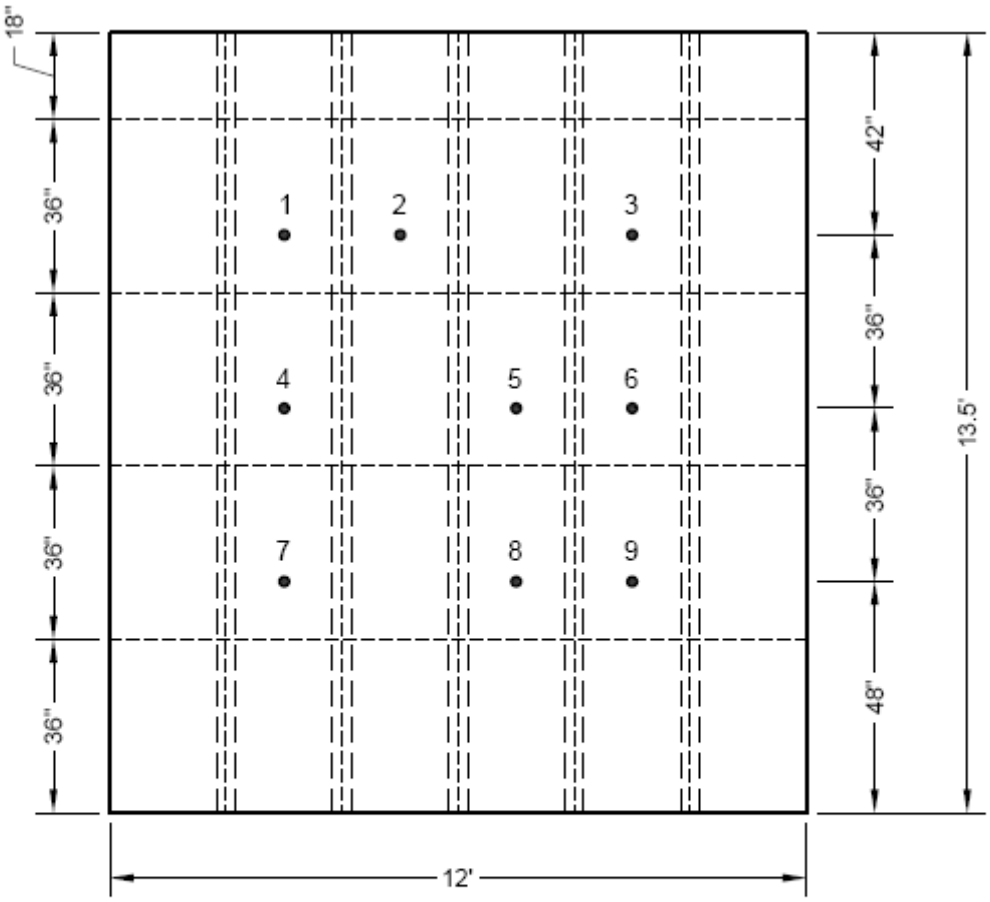
76.2 millimeters (3 inches); 152.4 millimeters (6 inches); 228.6 millimeters (9 inches)
254 millimeters (10 inches); 304.8 millimeters (12 inches); 609.6 millimeters (24 inches)
914 millimeters (36 inches); 3048 millimeters (10 feet)

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



101.6 millimeters (4 inches)
609.6 millimeters (24 inches)
3657.6 millimeters (12 feet)
4114.8 millimeters (13.5 feet)

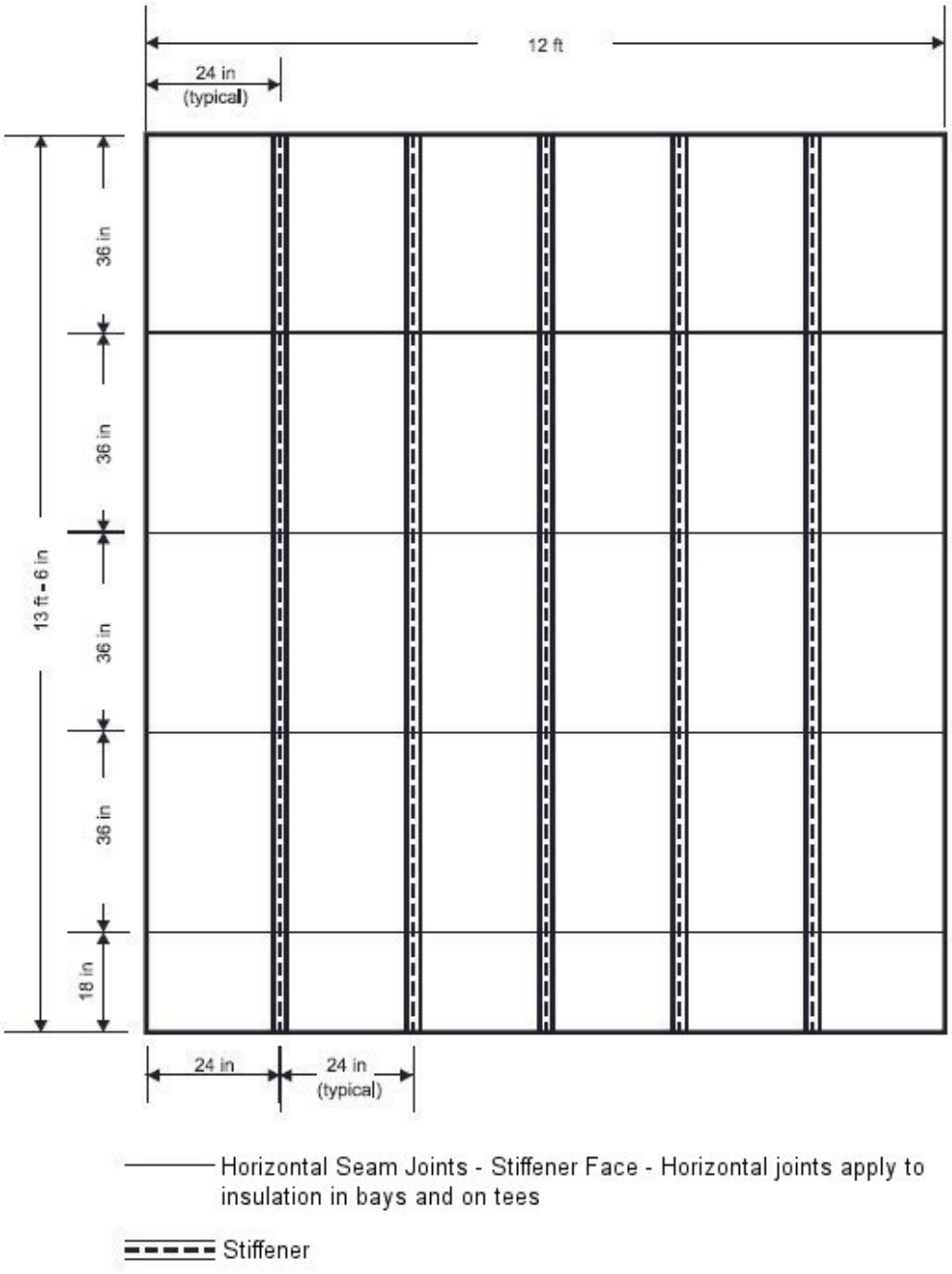
FIGURE A-13. Deck assembly (reflected ceiling plan, stiffener face).



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

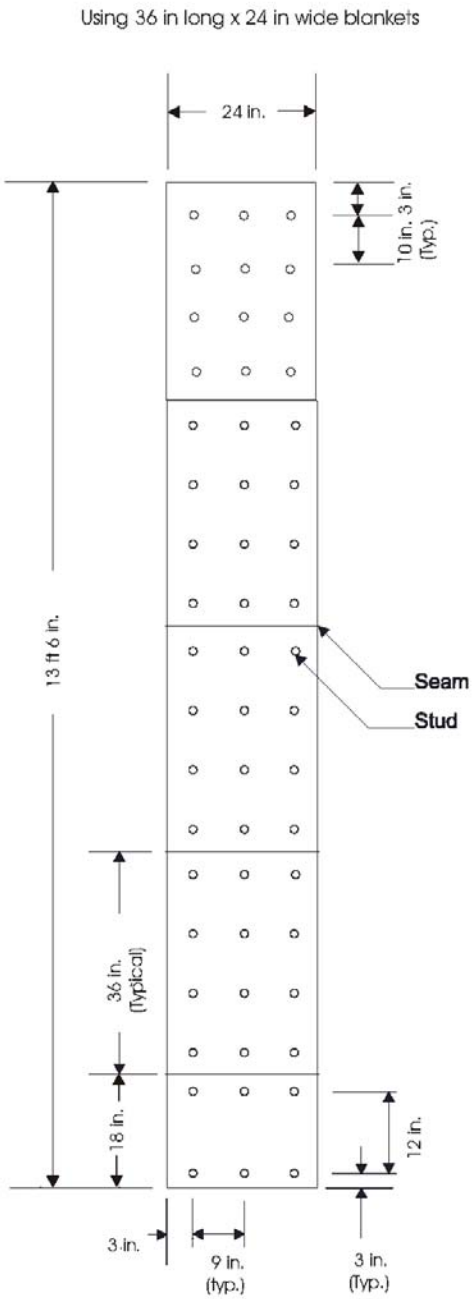
457.2 millimeters (18 inches)
914 millimeters (36 inches)
1066.8 millimeters (3.5 feet)
1219.2 millimeters (4 feet)
3657.2 millimeters (12 feet)
4114.8 millimeters (13.5 feet)

FIGURE A-14. Deck assembly thermocouple locations (unexposed face).



457.2 millimeters (18 inches); 609.6 millimeters (24 inches)
914.4 millimeters (36 inches); 3657.6 millimeters (12 feet)
4114.8 millimeters (13.5 feet)

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



76.2 millimeters (3 inches); 228.6 millimeters (9 inches);
254 millimeters (10 inches); 304.8 millimeters (12 inches);
457.2 millimeters (18 inches); 609.6 millimeters (24 inches);
914.4 millimeters (36 inches); 4114.8 millimeters (13.5 feet)

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

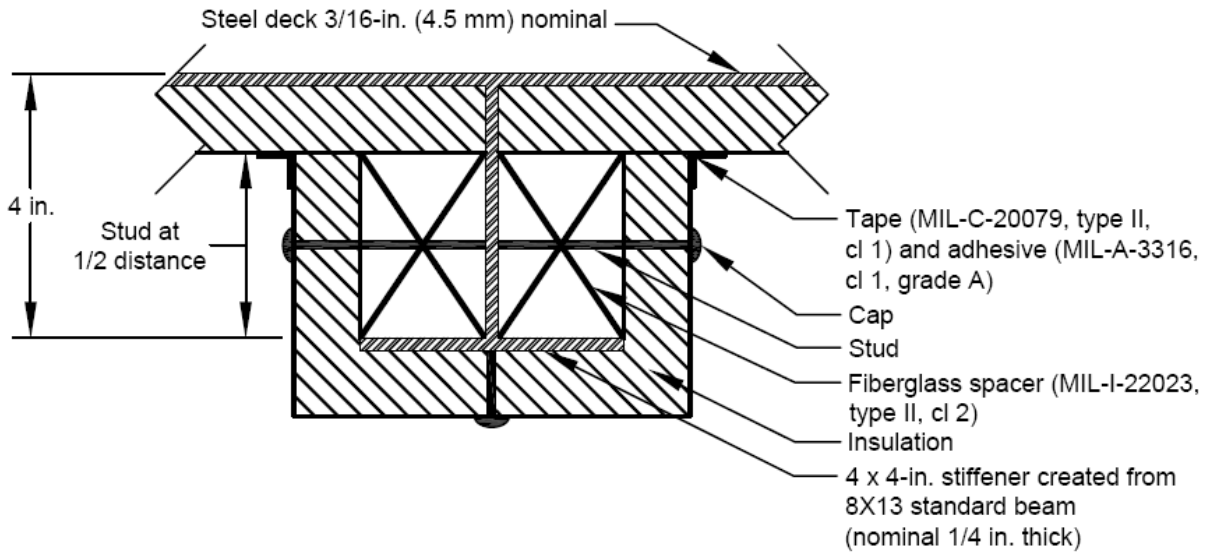
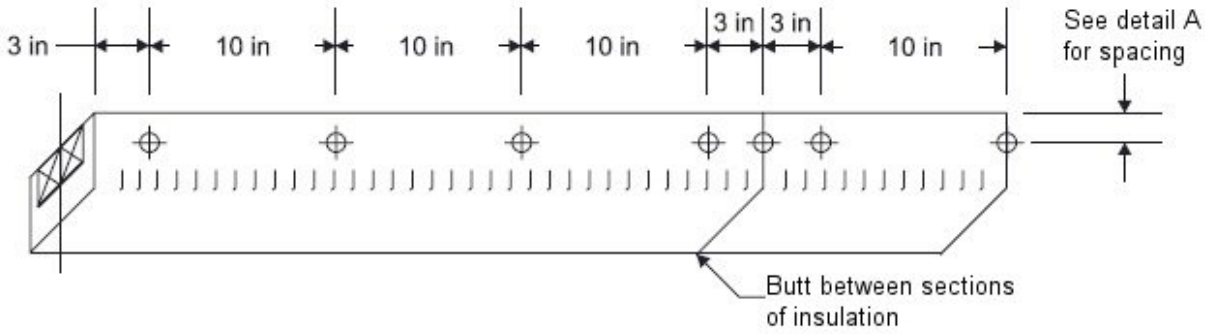


FIGURE A-17. Detail A – insulation attachment on stiffeners (sectional view).



76.2 millimeters (3 inches)
101.6 millimeters (4 inches)
254 millimeters (10 inches)

FIGURE A-18. Detail B – stud spacing on 101.6 by 101.6-millimeter (4 by 4-inch) stiffener (projection view).

PIPE AND DUCT PENETRATION TEST CONFIGURATION

B.1 SCOPE

This appendix covers pipe and duct penetration test configuration for the fire resistance test. N-Class divisions may have to be provided with apertures to allow them to be penetrated by service pipes and ducts and it is necessary to reinstate the insulation and/or integrity performance of the division at the position where it has been penetrated. NTA may have different requirements relating to the need to classify pipe and/or duct penetrations, e.g., related to the pipes' diameter and their direct attachment or not to the structural core. This appendix refers from hereon to pipe penetrations but may be read as equally applicable to duct penetrations. This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

B.2 NATURE OF TEST SPECIMENS

B.2.1 Dimensions. The maximum and minimum sizes (in terms of both the width and the height or diameter) of each type of pipe penetration for which approval is sought shall be tested in both vertical and horizontal orientation. These test dimensions shall be approved by the NTA prior to testing.

B.2.2 Design.

a. A bulkhead which includes the pipe penetration shall be constructed in accordance with Appendix A and shall have a fire resistance rating equal to the rating which is desired for the penetration under test. This means that if the penetration under test is required to have an N-30 rating, then the bulkhead shall be insulated to provide an N-30 rating. A deck (overhead) which includes the pipe penetration shall be constructed in accordance with Appendix A and shall have a fire resistance rating equal to the rating which is desired for the penetration under test.

b. The pipe penetrations shall be positioned only in the top half of a bulkhead but shall not be closer than 200 millimeters (8 inches) from the edges of a bulkhead or a deck (overhead). Where more than one pipe penetration is to be tested simultaneously in a division, the separation between adjacent penetrations shall not be less than 200 millimeters (8 inches). Both measurements shall relate to the distance to the nearest part of the penetration system including any insulation which is part of the system.

c. Each pipe passing through a penetration shall project 500±50 millimeters (20±2 inches) beyond the exposed end of the penetration and 500±50 millimeters (20±2 inches) beyond the unexposed end of the penetration. The exposed end of the pipe shall be blanked off using an appropriate methodology to ensure that any fire penetration into the pipe does not occur via the end of the pipe in advance of it occurring through the exposed perimeter of the pipe.

d. Each pipe shall be firmly supported and fixed independent of the bulkhead or deck (overhead) on the unexposed side of the test specimen, e.g., by a framework mounted from the restraint frame. The support and fixing of the pipe shall restrain it from movement during the test.

B.3 INSTRUMENTATION

B.3.1 Positioning of thermocouples on the specimen.

a. For each pipe penetration, two thermocouples shall be fixed on the unexposed face at each of the following locations:

(1) On the surface of the pipe at a distance of 25 millimeters (1 inch) from the center of the thermocouples to the position where the pipe emerges from the penetration seal.

(2) On the pipe penetration at a distance of 25 millimeters (1 inch) from the center of the thermocouples to the face of the insulation on the unexposed side of the test specimen.

(3) On the surface of any insulation or filling material used between the pipe and any coaming or spigot fixed to the division (provided that the gap between pipe or any such coaming or spigot is greater than 30 millimeters (1.2 inches)), or on the surface of any collar or shroud used between the pipe and the division (e.g., vapor barrier).

b. For pipe penetrations in bulkheads, for each of the positions indicated above, one of the thermocouples shall be fixed directly above the center of the pipe and the other thermocouple shall be fixed directly below the center of the pipe.

c. Additional thermocouples may be required to be fitted dependent upon the complexity of the pipe penetration.

B.4 PERFORMANCE CRITERIA

B.4.1 General. The performance of pipe penetrations may be related to their ability to satisfy both the insulation and the integrity criteria, or may be related only to the requirements for integrity depending on the requirements of the NTA.

B.4.2 Integrity. There shall be no passage of flames on the unexposed surface for the period required for classification.

B.4.3 Insulation. Since the pipe penetration is a local weakness in the division, it shall be capable of preventing a temperature rise at any point on the unexposed surface not exceeding 181 °C (rise of 325 °F) above the initial temperature. The average temperature rise is not relevant.

B.4.4 Hose stream. The hose stream test shall be conducted in accordance with Appendix C. The specimen is considered to have satisfied the criteria of the hose stream test if no openings develop during the application of the stream which allow water to pass to the unexposed face.

HOSE STREAM TEST CONFIGURATION

C.1 SCOPE

This appendix covers the hose stream test configuration for N-Class divisions and penetrations. The N-Class divisions and penetrations are subjected to the impact, erosion, and cooling effects of a hose stream. This appendix is a mandatory part of this standard. The information contained herein is intended for compliance.

C.2 METHOD OF TEST

a. The hose stream test shall be applied to the exposed face of the specimen immediately, no later than a maximum of 3 minutes following the termination of the heating period.

b. The time period from termination of the heating period to the start of the water application to the test specimen shall be reported. If the time period to the start of the water application to the specimen is longer than 3 min following the termination of the heating period, an explanation must be provided in the test report.

c. The hose stream shall be applied in accordance with ASTM Practice E 2226, Standard Practice for Application of Hose Stream.

d. The water stream is delivered through a 64 mm (2.5 in.) fire hose and discharged through a 28.5 millimeter (1.125 in.) nozzle of tapered smooth-bore pattern without shoulder at the orifice. The nozzle orifice shall be 6 meters (20 feet) from the center and normal to the exposed face of the specimen.

e. The water pressure at the base of the nozzle shall be 207 kPa (30 psi) when measured with the water flow in progress.

f. The duration of application of the hose stream to the surface of the specimen shall be 0.11 min for each square meter of the exposed area of the specimen as specified in ASTM E 119. The stream shall be directed firstly at the center and then at all parts of the exposed face, changes in direction being made slowly.

C.3 PERFORMANCE CRITERIA

The specimen is considered to have satisfied the criteria of the hose stream test if no openings develop during the application of the stream which allow water to pass to the unexposed face.

CABLE TRANSIT TEST CONFIGURATION

D.1 SCOPE

This appendix covers all cable penetrations including cable transits, cable stuffing tubes, and other types of cable feed-throughs. N-Class divisions may have to be provided with apertures to allow them to be penetrated by cables, and it is necessary to reinstate the insulation and integrity performance of the division at the position where it has been penetrated. A cable transit consists of a metal frame, box or coaming, a sealant system or material and the cables, and it may be uninsulated, partially insulated, or fully insulated. Wherever this appendix refers to cable transits, it may be read as equally applicable to other kinds of cable penetrations typically found in the U.S. Navy ships. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

D.2 APPLICABLE DOCUMENTS

D.2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this appendix. This section does not include documents cited in other sections of this standard 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 appendix, whether or not they are listed.

D.2.2 Government documents.

D.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

DOD-STD-2003	-	Electric Plant Installation Standard Methods for Surface Ship and Submarines
MIL-DTL-24643	-	Cables and Cords, Electric, Low Smoke, for Shipboard Use, General Specification for
MIL-P-24705	-	Penetrators, Multiple Cable, for Electric Cables, General Specification for

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

D.2.3 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.

D.3 NATURE OF TEST SPECIMENS

D.3.1 Dimensions. The maximum and minimum sizes (in terms of both the height and the width) of each type of cable transit for which approval is sought shall be tested in both vertical and horizontal orientation. Test assemblies shall be approved by the NTA prior to testing.

D.3.2 Test specimen configuration.

a. A bulkhead which includes the cable transit shall be constructed in accordance with Appendix A and shall have a fire resistance rating equal to the rating which is desired for the transit under test. This means that if the transit under test is required to have unrestricted N-30 rating, then the bulkhead shall be insulated to provide unrestricted N-30 rating. A deck (overhead) which includes the cable transit shall be constructed in accordance with Appendix A and shall have a fire resistance rating equal to the rating which is desired for the transit under test.

b. The cable transits shall be positioned only in the top half of a bulkhead but shall not be closer than 200 millimeters (8 inches) from the edges of a bulkhead or a deck (overhead). Where more than one cable transit is to be tested simultaneously in a division, the separation between adjacent transits shall not be less than 200 millimeters (8 inches). Both measurements shall relate to the distance to the nearest part of the transit system including any insulation which is part of the system. Notwithstanding, the distance between transits shall be sufficient to ensure that the transits do not influence each other during the test except that this requirement does not apply to multi-transits which are intended to be positioned adjacent to one another.

c. For conducting the shock test prior to fire resistance test (see Appendix F), the specified cables shall project at least 1.2 meters (4 feet) beyond the transit on each side of the penetration and be supported in accordance with the requirements of DOD-STD-2003. Cable direction on exit from the transit shall be: (1) 75 percent of cables to continue straight from the cable transit; and (2) 25 percent of cable to make 90 degree turns in two directions. Turns may be on opposite sides of the penetration but shall not be configured to cancel shock forces and shall not utilize the same cables. Cable hangers and associated cable banding shall be installed 813 millimeters (32 inches) from the penetration in each direction in accordance with DOD-STD-2003 for the cables which continue straight through the penetrator. For those cables making a 90 degree bend, the cables shall be banded on a cable hangar within 406 millimeters (16 inches).

d. After successfully completing the shock test (see Appendix F), specified cable lengths shall be trimmed to meet the cable length requirements of post-shock fire test. Care shall be exercised so as not to compromise the integrity of the penetrator.

e. For post-shock fire test, the specified cables shall project 500±50 millimeters (20±2 inches) beyond the transit on the exposed side of the division and 500±50 millimeters (20±2 inches) on the unexposed side.

f. Cable transits shall be welded or bolted into the bulkhead or deck (overhead) in accordance with the installation method in DOD-STD-2003. The cables and sealing compounds or blocks shall be incorporated in the transits with the bulkhead and deck (overhead) panels placed respectively in vertical and horizontal positions. Any insulation shall be applied to the panels and transits with the panels in the same respective positions.

g. The transit(s), stuffing tubes, and other types of cable penetrations shall be tested incorporating a range of different types of MIL-DTL-24643 cables (e.g., in terms of type of conductor, size, sheathing, and insulation material) and shall provide an assembly which represents actual parts for which qualification is sought. Figures D-1, D-2, and D-3, reproduced from MIL-P-24705, provide configuration of cables for use in shock test and post shock fire test. Armored cables in these figures shall be replaced by similar unarmored cables.

h. For multi-cable penetrator configurations other than shown in figures D-1, D-2, and D-3, no more than 40 percent of the inside cross-sectional area of each transit shall be occupied by cables and the distances between adjacent cables and between the cables and the inside of the transit shall be the minimum which is allowable for the actual penetration sealing system. For each stuffing tube family, minimum and maximum stuffing tube size shall be tested. Each selected stuffing tube size shall be tested with minimum and maximum allowable cable outside diameter. The test configuration shall also include a control stuffing tube of selected size with plugs at the end to ensure that fire resistance is not degraded if cables are removed in the future. The test configuration shall be submitted to the NTA for approval.

i. For multi-cable penetrator, stuffing tubes, and other types of cable penetrations, the test results obtained from a configuration with the largest allowable, and with the smallest allowable are generally valid for tested types of cables of size equal and between the size of the tested cables.

D.4. INSTRUMENTATION

D.4.1 Positioning of thermocouples on the specimen.

a. For each uninsulated cable transit, and other cable penetrations where applicable, thermocouples shall be fixed on the unexposed face at each of the following locations:

(1) At two positions on the surface of the outer perimeter of the frame, box or coaming at a distance of 25 millimeters (1 inch) from the unexposed surface of the division;

(2) At two positions at the end of the transit, on the face of the sealant system or material at a distance of 25 millimeters (1 inch) from a cable; and

(3) On the surface of each type of cable included in the cable transit, at a distance of 25 millimeters (1 inch) from the face of the sealant system or material. In case of a group or bunch of cables the group shall be treated as a single cable. In case of horizontal cables, the thermocouples shall be mounted on the uppermost surface of the cables.

b. For those thermocouples placed on the outer perimeter of the frame, box or coaming, one thermocouple shall be fixed on each of two opposite faces which in the case of bulkheads shall be the top and bottom faces.

c. For each partially insulated or fully insulated cable transit, thermocouples shall be fixed on the unexposed face at equivalent positions to those specified for an uninsulated transit as illustrated in figure D-4.

d. Additional thermocouples may be required to be fixed dependent upon the complexity of the cable transit.

e. When fixing thermocouples to the unexposed surface of the cables, the insulating pad shall be formed over the surface to provide good contact with the surface of the cable. The pad shall be retained in position by some mechanical means, e.g., wiring or spring clips, such that they do not become detached during the test. The mechanical retention shall not provide any significant heat sink effect to the unexposed face of the thermocouple.

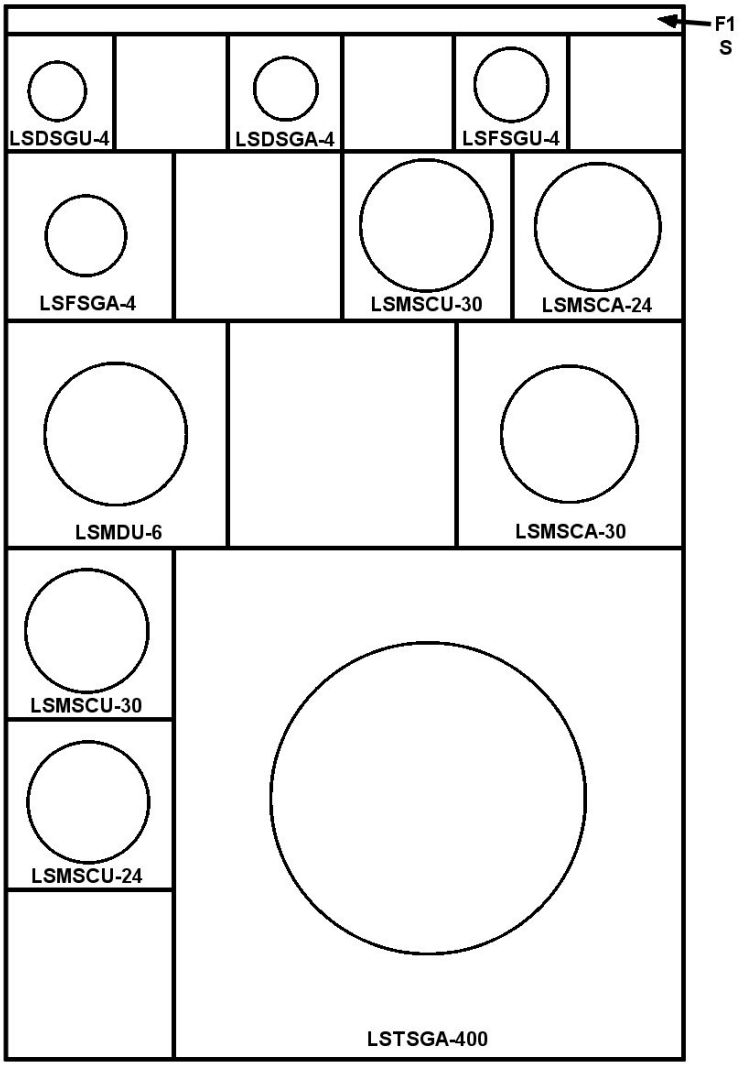
D.5 PERFORMANCE CRITERIA

D.5.1 General. The performance of cable transits, stuffing tube, or other cable penetrations may be related to their ability to satisfy both the requirements for insulation and integrity, or may be related only to the requirements for integrity depending on the requirements of the NTA.

D.5.2 Integrity. There shall be no passage of flames on the unexposed surface for the period required for classification.

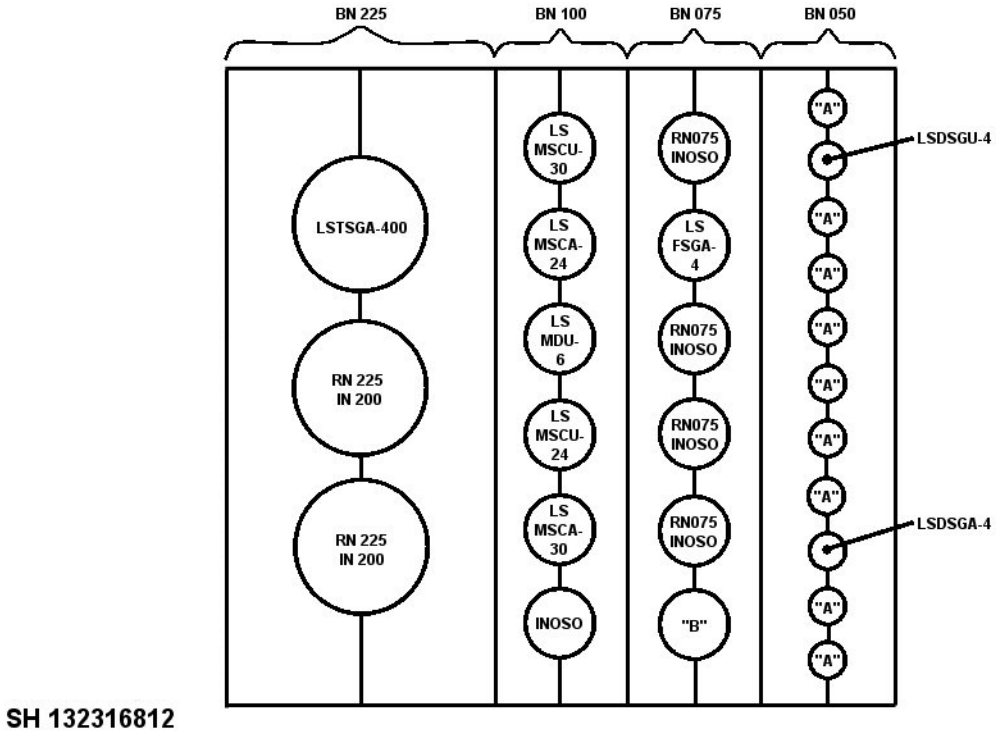
D.5.2 Insulation. Since the cable transit, stuffing tube, or other cable penetration is a local weakness in the division it shall be capable of preventing a temperature rise at any point on the unexposed surface not exceeding 181 °C (rise of 325 °F) above the initial temperature. The average temperature rise is not relevant.

D.5.3 Hose stream. The hose stream test shall be conducted in accordance with Appendix C. The specimen is considered to have satisfied the criteria of the hose stream test if no openings develop during the application of the stream which allow water to pass to the unexposed face.



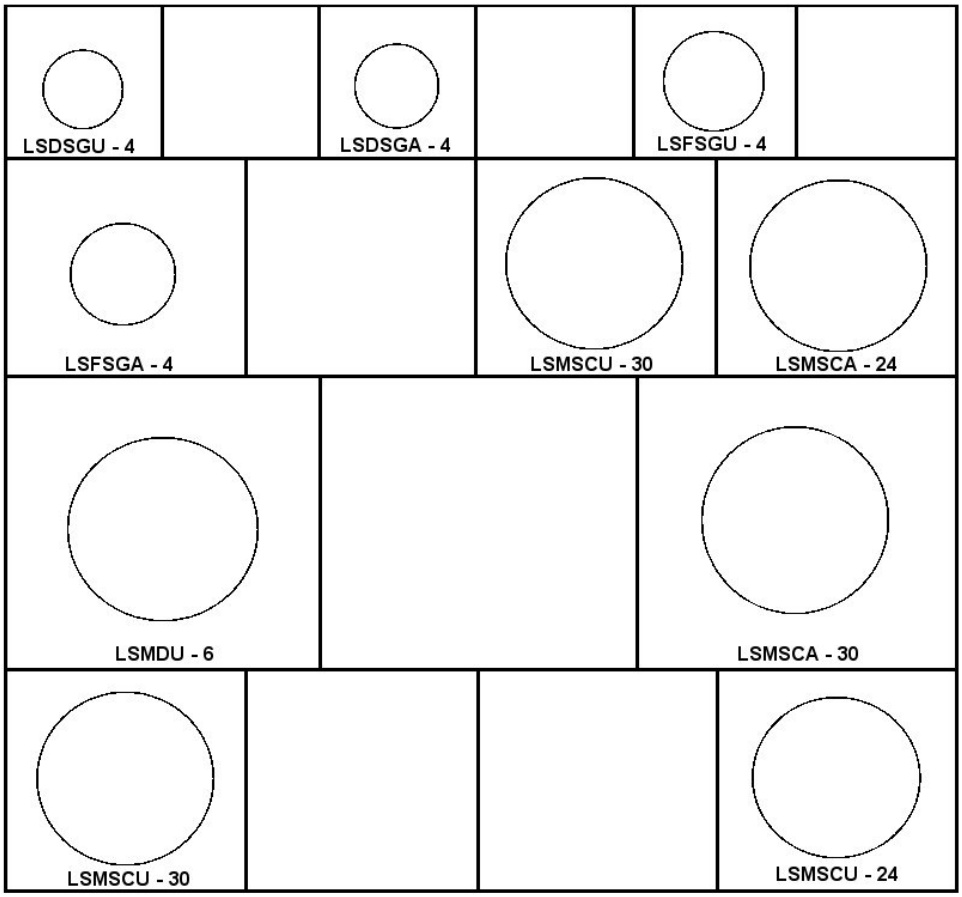
Note: All cables shall be unarmored.

FIGURE D-1. Rectangular frame multiple cable penetrator test specimen – cable configuration.



Note: All cables shall be unarmored.

FIGURE D-2. Notched multiple cable penetrator test specimen – cable configuration.



Note: All cables shall be unarmored.

FIGURE D-3. Round frame (for square-faced blocks) multiple cable penetrator test specimen – cable configuration.

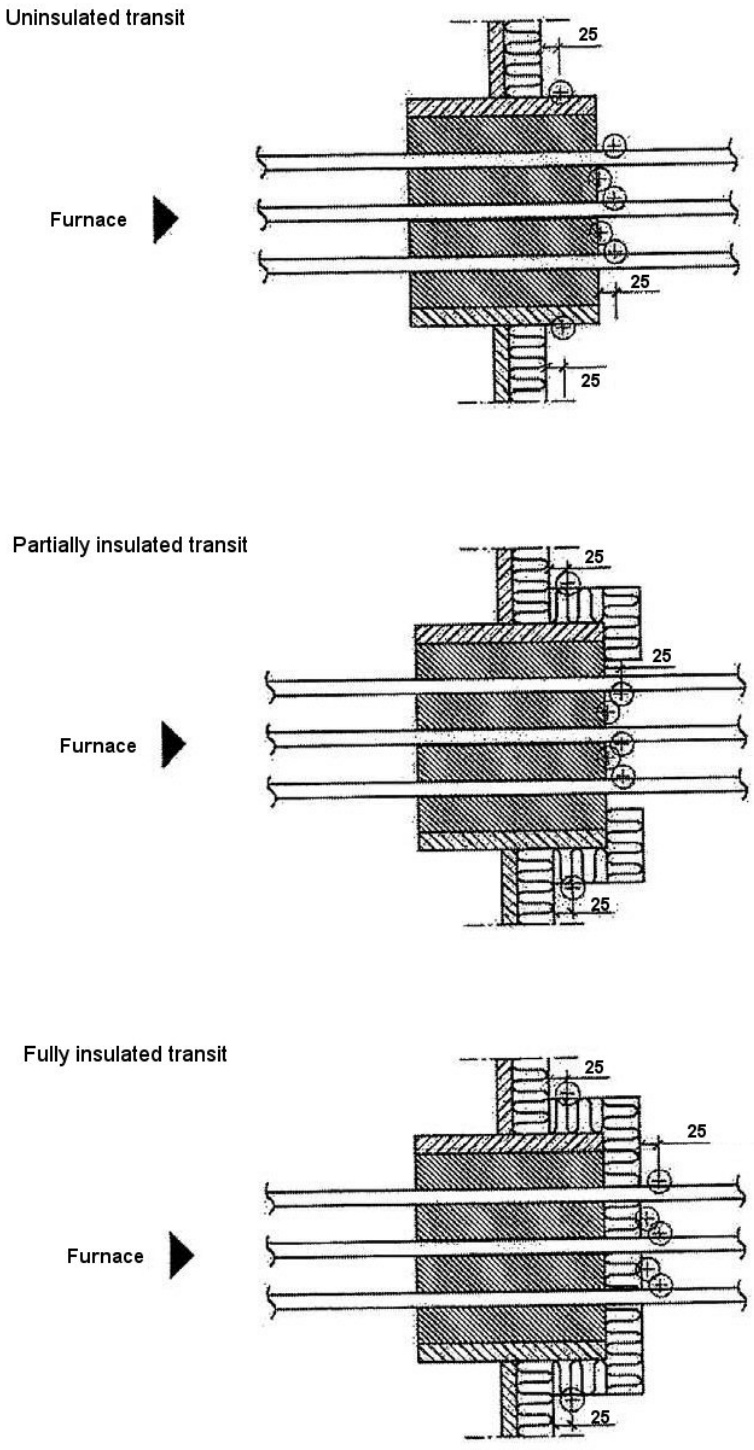


FIGURE D-4. Cable transits: position of unexposed-face thermocouples (shown for bulkhead).

BULKHEAD/DOOR ASSEMBLY TEST CONFIGURATION

E.1. SCOPE

This appendix covers the bulkhead/door assembly test configuration for the fire resistance test. N-Class divisions may have to be installed with doors, and it is necessary to ensure the insulation and integrity performance of the division/door assembly. A bulkhead/door assembly consists of an N-Class bulkhead, door frame, door, and necessary sealant systems. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

E.2. NATURE OF TEST SPECIMENS

E.2.1 Dimensions. The bulkhead shall be constructed as described in Appendix A and the door shall be the size for its intended application. The test should be conducted on the door of the maximum size (in terms of both the width and the height) of door leaf or leaves for which approval is sought. The maximum size of a door which can be tested will be determined by the requirement to retain certain dimensions of the structural core (see E.2.2.b).

E.2.2 Test specimen configuration.

a. A bulkhead which includes the door shall be constructed in accordance with Appendix A and shall have a fire resistance rating equal to the rating which is desired for the door under test. This means that if the door under test is required to have unrestricted N-30 rating, then the bulkhead shall be insulated to provide unrestricted N-30 rating.

b. The door shall be positioned in the bulkhead to accurately represent actual construction and shall be centered horizontally within the bulkhead. Unique construction features of the door shall be duplicated on the test assembly, e.g., welding, bolting, locking mechanisms, stiffeners, etc. In general, maximum dimensions of the opening may be determined by a requirement to retain a minimum width of the structural core of 300 millimeters (12 inches) to each vertical side of the opening and a minimum distance of 100 millimeters (4 inches) from the top edge of the structural core.

c. Hinged doors shall be tested with the door opening away from the heating conditions unless the NTA deems otherwise. Sliding doors shall be tested from both sides in two different tests.

d. Full constructional details shall be provided to the NTA prior to testing such as bulkhead construction, door leaf and frame construction including clearances between the door leaf and frame, the connection of the door frame to the bulkhead, the method of securing insulation and details of components used for this purpose, and fittings such as hinges, shoot bolts, latches, locks, etc.

E.3. INSTRUMENTATION

E.3.1 Unexposed bulkhead surface temperature measurements. Unexposed bulkhead surface temperature measurements shall be in accordance with Appendix A. Nine thermocouples shall be applied to the unexposed surface of the bulkhead and shall be used to calculate the average and individual surface temperatures of the bulkhead.

E.3.2 Unexposed door surface temperature measurements. Unexposed door surface temperature measurements shall be obtained with thermocouples and thermocouple pads in accordance with Appendix A. The surface temperatures on the unexposed face of the door shall be measured by five thermocouples, one at the center of the door and one at the center of each of the four quarters of the door, all positioned at least 100 millimeters (4 inches) away from the edge of the door, from any stiffeners, from any door furniture, and from any special features or specific construction details. These five thermocouples shall be used to calculate the average surface temperature of the door.

E.3.3 Furnace pressure measurements. Furnace pressure measurements shall be provided at two locations with pressure probes in accordance with Appendix A. One location will be on the vertical centerline directly beneath the bulkhead installed through the unexposed face of the test restraint frame and will protrude into the furnace at a distance of 152 millimeters (6 inches) away from the face of the test specimen. The second location shall be on the vertical centerline directly above the bulkhead installed through the unexposed face of the test restraint frame and will protrude into the furnace at a distance of 152 millimeters (6 inches) away from the face of the test specimen. The neutral plane (zero pressure differential) for the bulkhead assembly 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.

E.4. PERFORMANCE CRITERIA

a. The performance of bulkhead/door assemblies is related to their ability to satisfy both the requirements for insulation and integrity. The test is conducted in accordance with Appendix A.

b. There shall be no passage of flames on the unexposed surface for the period required for classification.

c. The door shall be capable of preventing an average unexposed surface temperature rise of 139 °C (rise of 250 °F) and the temperature rise at any point on the unexposed surface not exceeding 181 °C (rise of 325 °F) above the initial temperature for the designated period.

d. The hose stream test shall be conducted in accordance with Appendix C. The specimen is considered to have satisfied the criteria of the hose stream test if no openings develop during the application of the stream which allow water to pass to the unexposed face.

SHOCK TEST PRIOR TO FIRE RESISTANCE TEST CONFIGURATION

F.1 SCOPE

This appendix covers the shock test prior to fire resistance test requirements. The shock test is conducted in accordance with MIL-S-901, and fire resistance test is conducted in accordance with Appendix A of this document. N-Class divisions may have to be installed with penetrations, and passive fire protection materials with associated attachments. It is necessary to ensure that the fire resistance obtained from the passive fire protection system is not degraded in a combat environment. This test does not evaluate the shock related structural properties of the division. The testing shall be performed by applying the passive fire protection system to a standard test specimen. The specific shipboard mounting and location shall be determined and adequately represented in the shock test. All divisions with structural fire protection requiring testing shall be approved by the Navy Technical Authority prior to testing. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

F.2 TEST OVERVIEW

F.2.1 Summary. The shock test prior to fire resistance test shall be conducted in accordance with MIL-S-901 (medium weight, Grade A) with intermediate scale 3048 by 1219-millimeter (10 by 4-foot) insulated bulkhead or deck (overhead). Successful shock testing is followed by fire testing of shocked test specimen and unshocked test specimen side-by-side in an intermediate scale fire resistance test. Upon successful completion of post shock intermediate scale fire resistance test, the full scale fire resistance test in accordance with Appendix A, which requires test specimens 3048 by 3048 millimeters (10 by 10 feet) or greater, is still required for the designated period for N-Class qualification.

F.2.2 NTA approval. NTA approval shall be obtained prior to conducting shock tests. Depending upon the nature of insulation (e.g., blankets, rolls, etc.), attachment methods (e.g., pins and caps), and material of construction (e.g., steel, aluminum, composites), changes may be required in test methods, construction of fixtures, number of thermocouples, etc.

F.2.3 Test specimens. Four (4) 1219 by 3048-millimeter (4 by 10-foot) specimens, two (2) each for steel bulkhead and deck (overhead) (see figure F-1), shall be constructed and insulated. Test specimens shall include penetrations consistent with shipboard installation.

F.2.4 Shock test. One of the two specimens, for each bulkhead and deck (overhead), shall be shock tested in accordance with F.3. The medium weight shock test is a mechanical impact of a 1,361-kilogram (3,000-pound) hammer swinging through an arc and then hitting the anvil mounted on the underside of the table which holds the specimens to be shock tested. The displacement of the table is limited to either 76 millimeters (3 inches) or 38 millimeters (1.5 inches). The table impacts a mechanical stop to limit the travel. A shock force is generated at impact of the hammer and up into the test specimen when the table hits the mechanical stops. The medium weight shock test machine can test specimens with mounting attachment up to a weight of 3,357 kilograms (7,400 pounds). A full shock test for each specimen (bulkhead or deck) requires a total of nine (9) blows, three (3) blows for each orientation of the sample. The test is videotaped and photographs are taken after each of the hammer blows. Changes in the test specimens are noted for the inclusion in the shock test report.

F.2.5 Post-shock test. Upon successful completion of the shock test, both the shocked and non-shocked specimens shall be crated and sent to an approved fire testing facility.

F.2.6 Post shock fire resistance testing. The fire testing facility shall test both shocked and unshocked test specimens side-by-side in a non-load bearing restraint frame in accordance with Appendix A. The purpose of the fire test is to evaluate degradation, if any, in the fire resistance of the shocked versus non-shocked specimens.

F.3 SHOCK TEST PROCEDURE

F.3.1 Submittal of shock test procedure. For each shock test, the shock or fire test laboratory shall submit a detailed shock test procedure, prior to testing, for approval by the NTA. The shock test procedure shall include all mounting, fixturing, bolting, insulation, installation, and thermocouple location details.

F.3.2 Excerpts from MIL-S-901. The shock test shall be conducted in accordance with MIL-S-901, Medium Weight, Grade A. Selected sections from MIL-S-901 are excerpted below for explanation.

F.3.2.1 Shock Grade A. "Withstand shock test… without unacceptable effects upon performance and without creating a hazard". A hazard is the result of a physical projectile occurrence during the test. Any metal or rigid pieces of insulation or fixing devices like pins, caps and clips which become adrift shall be a hazard. No material can become a hazardous projectile during the shock test. The function of the insulation is to protect the division in the event of a fire. This is determined by conducting a fire test on the specimen after the shock test.

F.3.2.2 Equipment classification. Class I. "Equipment which, in this case is an insulated bulkhead or deck (overhead) specimen, with or without penetration, is required to meet the shock requirements without the use of resilient mounting…". The test specimen shall be hard mounted to the shock table. The bottom edge of the test specimen shall bear on the steel table.

F.3.2.3 Test classification. Medium weight in accordance with MIL-S-901. The maximum weight on the anvil table shall not exceed 3,357 kilograms (7,400 pounds).

F.3.2.4 Type A. Per MIL-S-901, "(Type A) is a test of the principal unit.…Principal units are those items which are directly supported by the ship structure". The insulation is installed on a structural load bearing division and is therefore Type A.

F.3.3 Method of mounting.

a. Shock testing shall be performed in accordance with MIL-S-901. The specific shipboard mounting and location shall be determined and adequately represented in the shock test. The test specimen construction, orientations, fixture and assembly details are provided for guidance in figures F-1 through F-6.

b. The bulkhead and deck (overhead) test specimen shall be fixed at the ends. The top 51 millimeters (2 inches) and the bottom 51 millimeters (2 inches) of the test specimen shall not be insulated as shown in figure F-1. This area is reserved for fixing the ends. If the test specimen is insulated over the full area, it is probable the insulation would be damaged during fixing for the shock test. Crushing, cracking, and delaminating may start prior to shock testing. The 51 millimeters (2 inches) of the uninsulated test specimen will allow fixing for the fire test. The edges of the specimen will be insulated by the lab personnel at the approved fire testing laboratory with ceramic blanket to eliminate any edge effects during fire resistance testing.

c. The bulkhead specimen will be fixed vertically at the top and bottom by using six 12.7-millimeter (½-inch) diameter bolts spaced 203 millimeters (8 inches) on center to the bulkhead fixture. The hold-down bolts shall be constructed of cadmium or zinc-plated steel, Grade 5, and torqued to 59 foot-pounds. The deck (overhead) specimen will be fixed horizontally in a similar manner. It may be necessary to fix the bulkhead and deck (overhead) test specimen on all four sides if the specimen is made of thin aluminum or steel.

d. The test procedure shall be approved by the NTA prior to any testing.

e. The method of mounting is only good for specific shipboard applications that are similar in environment. Different shipboard applications may require different fixture designs due to the flexibility or stiffness of the shipboard foundation, which may excite other failure mechanisms of the structural fire protection that would not be excited with the proposed test fixture (i.e. polymer composite). All divisions with structural fire protection requiring testing shall be approved by the Navy Technical Authority prior to testing.

F.3.4 Shock test orientation.

F.3.4.1 Bulkhead. The bulkhead shall be subjected to one vertical phase and two 30-degree inclined phases, turned 90 degrees from each other on the inclined surface as shown in figure F-2. Three hits or impacts of the hammer shall be applied for each phase.

F.3.4.2 Deck (overhead). The deck (overhead) shall be subjected to one horizontal phase and two 30-degree inclined phases, turned 90 degrees from each other on the inclined plane as shown in figure F-3. Three hits or impacts of the hammer shall be applied for each phase.

F.3.5 Test sequence. Test shall be conducted in the sequence shown in MIL-S-901. One Shock Data Sheet shall be completed for each phase of testing. Each Shock Data Sheet shall record the three blows applied per phase.

F.3.6 Recording results. A video of the test shall be recorded by the test laboratory. The panels shall be visually inspected after each blow and observations shall be recorded. Observations of insulation bulging, sagging or tearing by connection points, and pins becoming loose or coming adrift shall be recorded and documented with photographs.

F.3.7 Test report. A test report shall be written by the test laboratory for each qualification test irrespective of the outcome of the test. A copy of the test report, along with a video copy, shall be submitted to the NTA.

F.4 BASIS OF ACCEPTANCE

F.4.1 Visual inspection. After shock testing, the test items shall be visually inspected to ensure that no portion of the test items or fixing devices came adrift which, when installed on a ship, could strike and injure personnel or cause significant impairment or malfunction of Grade A items or systems.

F.4.2 Pins and other mechanical fasteners. If pins and other mechanical fasteners are used to install the insulation, the performance of insulation or other passive fire protection materials shall be based on visual observations. The following are factors which would degrade the performance of the insulation. If any one of the following factors is evident, the test specimen is deemed to have failed the shock test:

a. More than 10 percent of the pins (used for holding the insulation) become loose from the bulkhead or deck (overhead) specimen.

b. Three or more adjacent pins become loose from the bulkhead or deck (overhead) specimen.

c. The insulation cracks or delaminates from the specimen visually exposing the face of the specimen.

d. The insulation becomes loose from the specimen as a result of the shock test. The insulation develops a noticeable gap or void between the bulkhead and insulation interface or within the insulation itself.

e. If at any time during the shock testing it appears that the test article has degraded to a point where it will not survive the fire resistance test, the shock test shall be aborted. A test report shall be written by the shock test facility, regardless of the outcome of the test.

F.5 DISPOSITION OF SPECIMEN

F.5.1 Test specimen. Test specimen shall be shipped to the fire test facility as agreed between the shock test laboratory and the NTA. Test specimen will be forwarded to the fire test facility only if sample meets the requirement of Grade A shock.

F.6 POST-SHOCK FUNCTIONAL TEST (FIRE RESISTANCE TEST)

F.6.1 Procedure. For bulkhead tests, an unshocked (control) test specimen shall be fire tested, side-by-side in the same vertical furnace, with a shock tested specimen. For deck (overhead) tests, an unshocked (control) test specimen shall be fire tested, side-by-side in the same horizontal furnace, with a shock tested specimen. The fire test shall be conducted in accordance with Appendix A.

F.6.2 Thermocouple location. For tests of bulkhead and deck (overhead) assemblies with insulation only on one side (i.e., fire side or exposed face), six thermocouples shall be symmetrically located on the unexposed face to determine average and maximum unexposed side temperatures. The thermocouples shall be located between the frame bays (area between the stiffeners) as shown in figure F-6. The thermocouple locations shall be included in the shock test procedure (refer to F.3.1).

F.6.3 Thermocouple type. Temperatures of the unexposed surfaces shall be measured using Type K (Chromel-Alumel) thermocouples. The thermocouples shall be in accordance with Appendix A.

F.6.4 Performance criteria. The fire insulation material and its attachment method shall be deemed to have passed the shock test without degradation in fire resistance by analyzing the average and maximum temperature rise on the unexposed face of the shock tested assembly compared to the average and maximum temperature rise of the control assembly at the end of the time period equal to that for which classification is desired.

F.6.4.1 Flaming. There shall be no passage of flame or hot gases on the unexposed face of the shock tested and control test assemblies for the time period equal to that for which classification is desired. The minimum duration for the fire resistance test is 30 minutes.

F.6.4.2 Transmission of heat. Transmission of heat through the shock tested and control test assemblies shall not have raised the average temperature on its unexposed surface, as determined by averaging the six thermocouples specified in F.6.2, more than 139 °C (rise of 250 °F) above its initial temperature, nor the temperature of any one point on the surface including any joint, more than 181 °C (rise of 325 °F) above its initial temperature for a time period equal to that for which classification is desired.

F.6.4.3 Temperature rise. The average and maximum temperature rise for both shock tested and control assemblies shall be specifically included in the test report. The difference between the average and maximum temperature rise of shock tested and control assemblies shall not be greater than the values acceptable to the NTA for the period specified.

F.6.4.4 Full scale fire resistance test. Upon successful completion of this appendix, the bulkhead or deck (overhead) assembly shall also pass the full scale fire resistance test, at the same insulation thickness and with the same attachment method, in accordance with Appendix A to obtain final NTA approval for the designated N-Class Division.

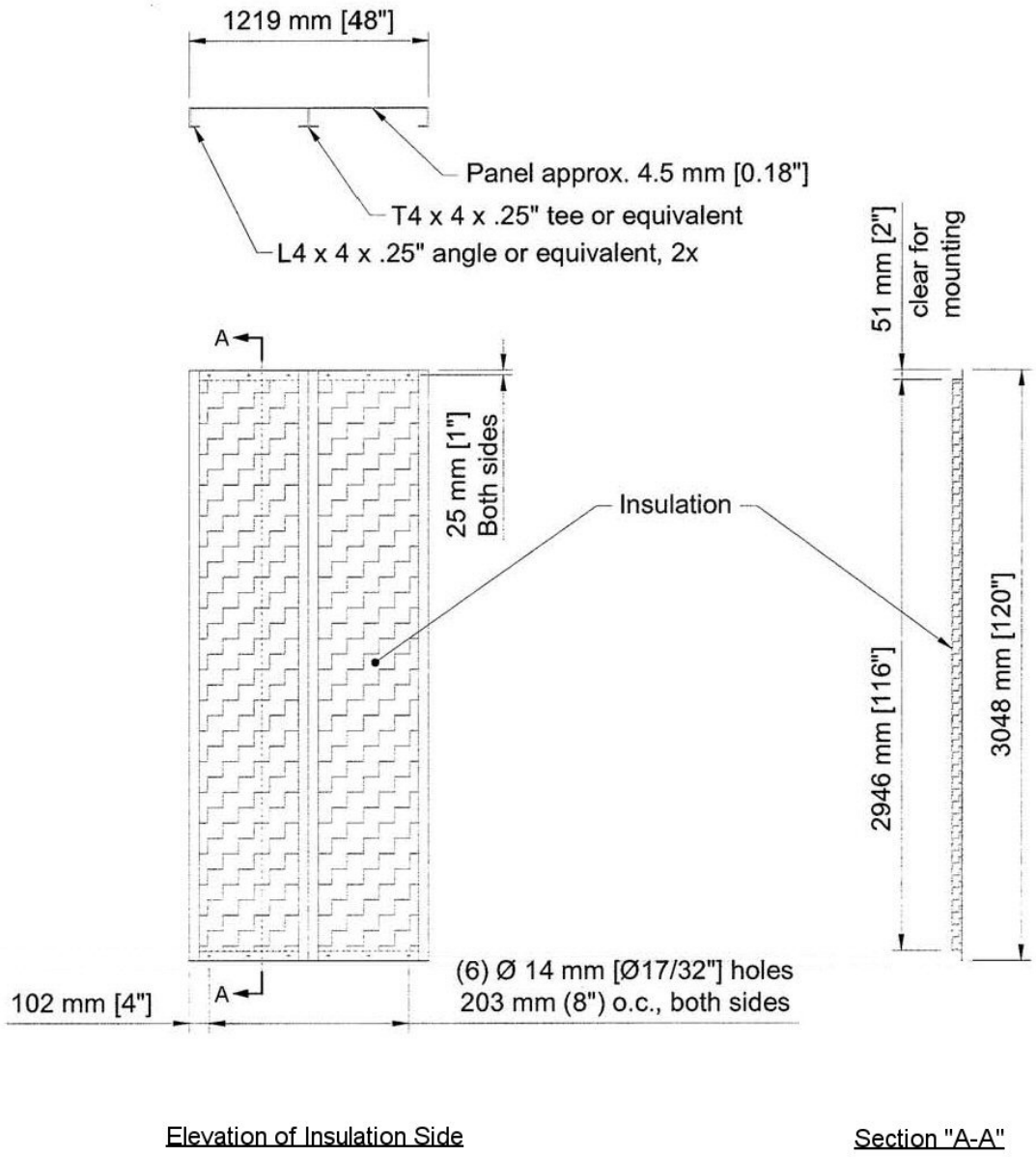


FIGURE F-1. Steel test specimen construction details.

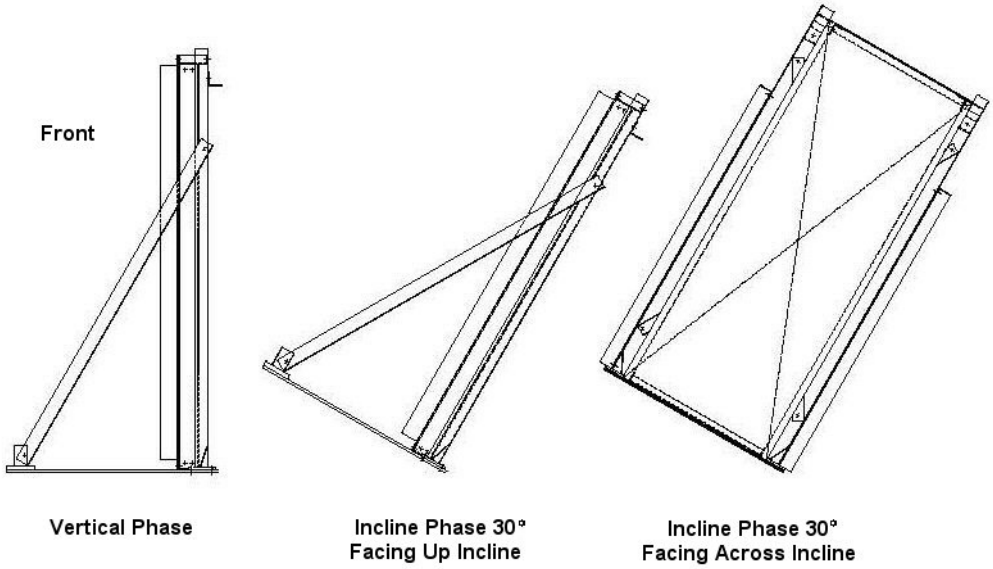


FIGURE F-2. Bulkhead orientations.

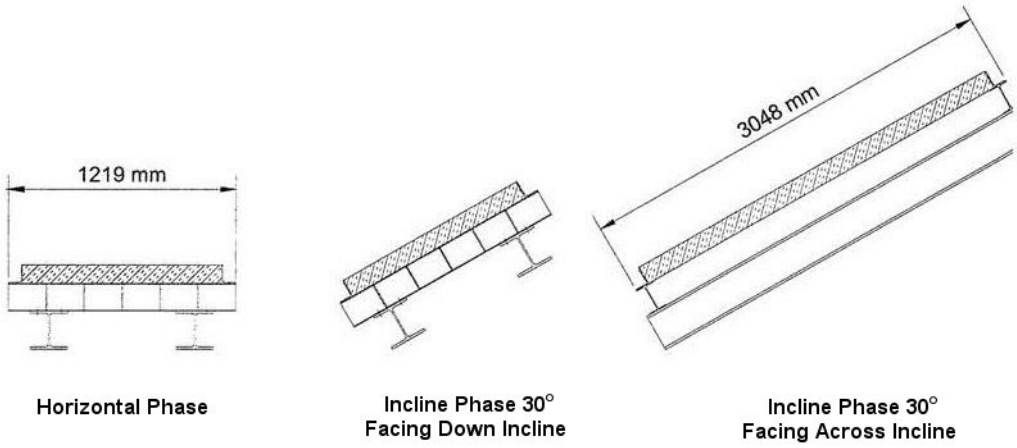


FIGURE F-3. Deck orientations.

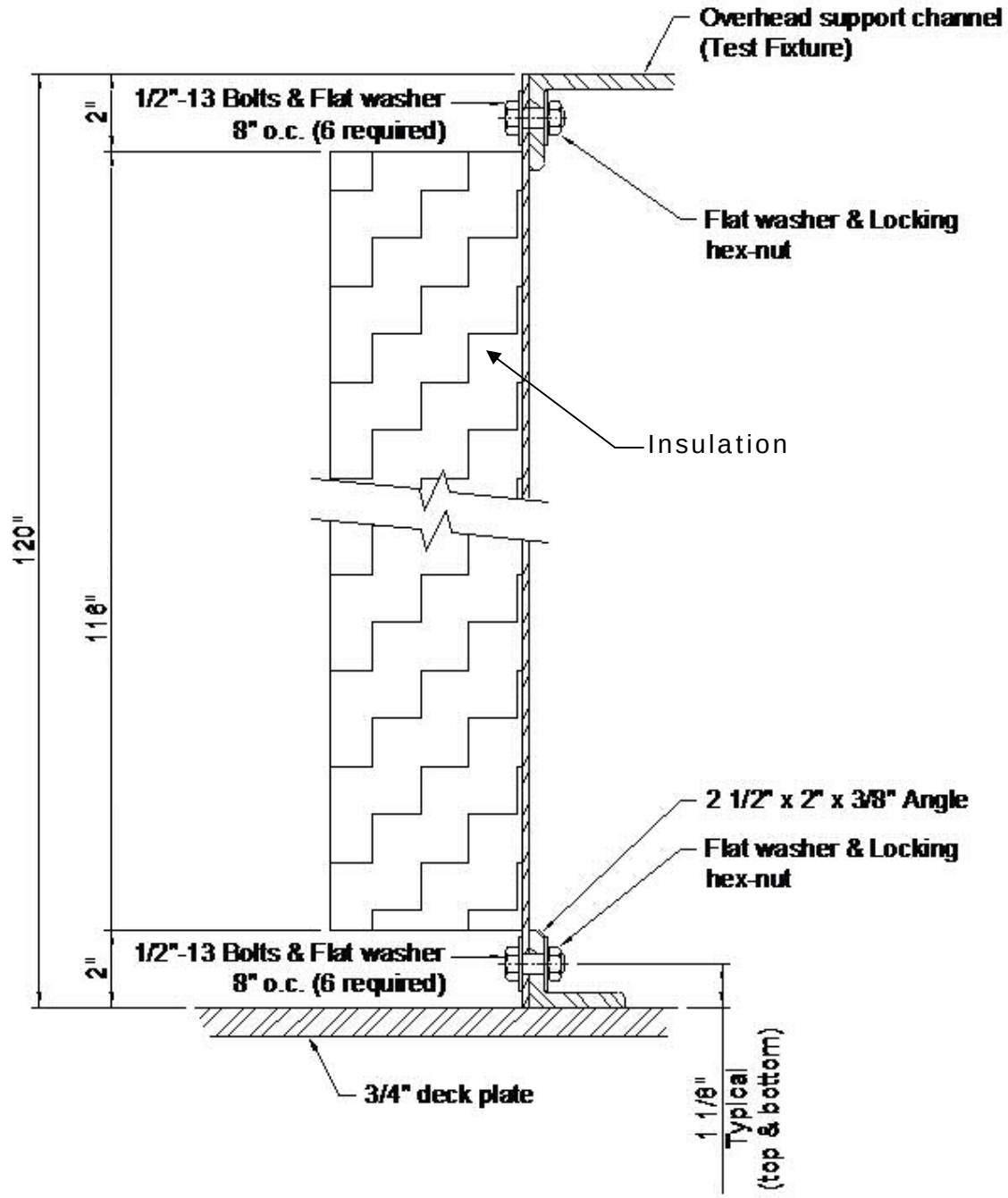


FIGURE F-4. Cross section bulkhead mounting details.

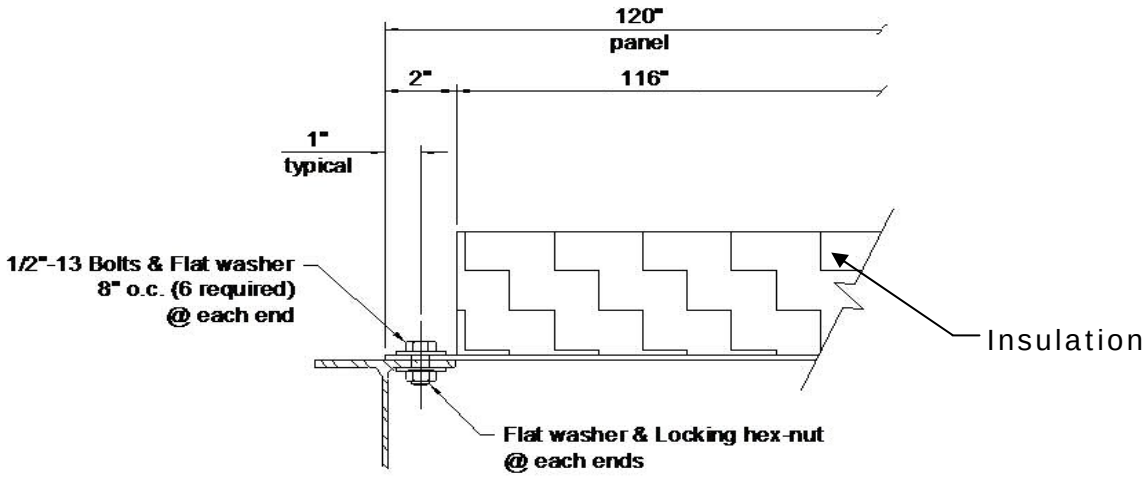
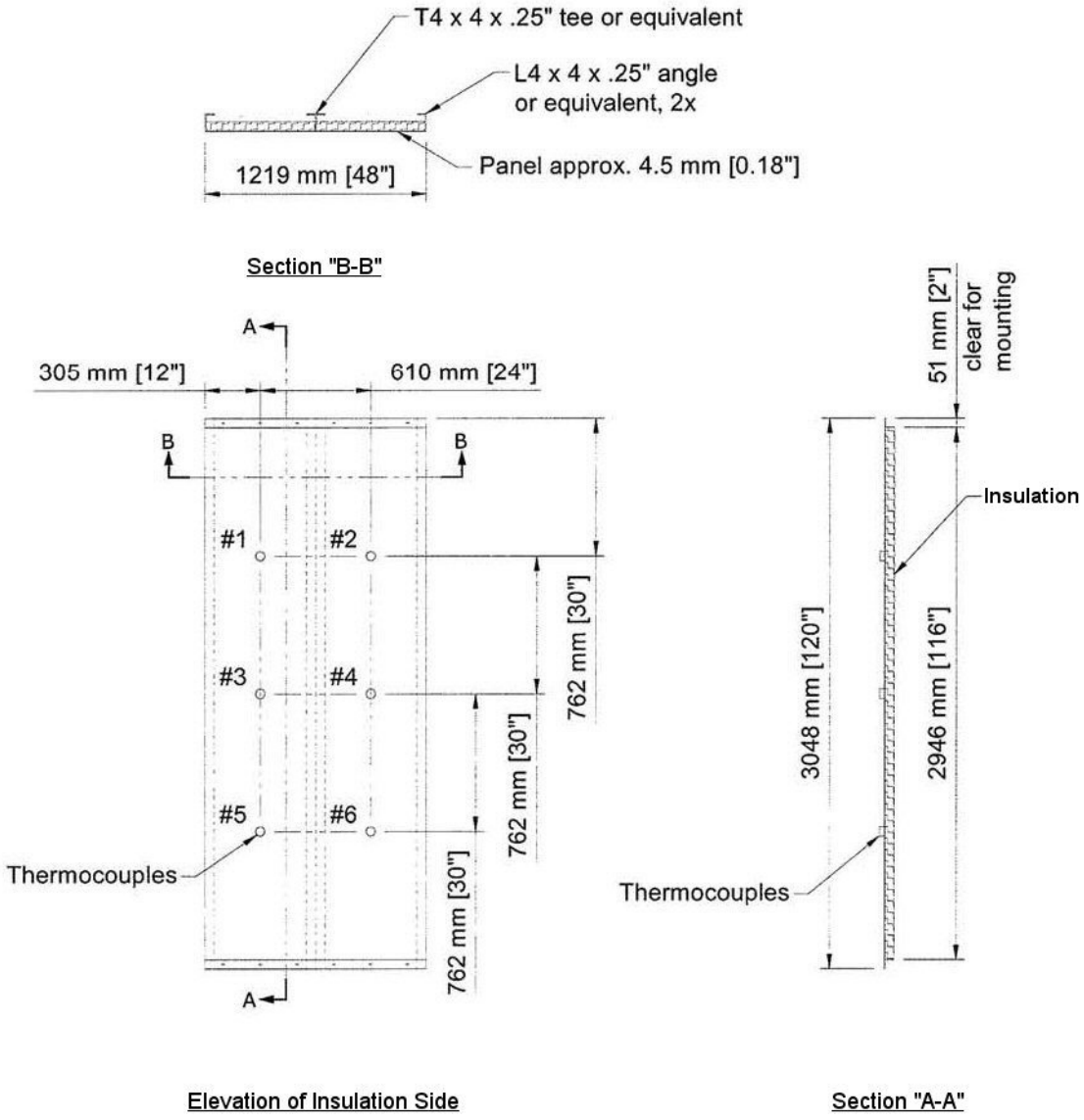


FIGURE F-5. Typical deck mounting detail.



Thermocouple Locations on Unexposed Side of Steel Shock Test Specimen

FIGURE F-6. Locations of the thermocouples.

Custodians:
Navy – SH
Air Force – 99

Preparing activity:
Navy – SH
(Project 2090-2007-001)

Review activities:
Air Force – 11
DLA – CC
GSA - FSS

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