Designation: C1146 – 09 (Reapproved 2013)

Standard Guide for Prefabricated Panel and H–bar Insulation Systems for Vessels, Ducts and Equipment Operating at Temperatures Above Ambient Air[1]

This standard is issued under the fixed designation C1146; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide describes design, fabrication, shipping, handling, jobsite storage, and installation of prefabricated panel and H-Bar insulation systems for vessels, ducts, and equipment operating at temperatures above ambient. Typical applications include, but are not limited to, air and gas ducts, steam generating units, air quality control systems, fans, storage tanks, process vessels, and coke drums

1.2 The insulation described herein is limited to systems consisting of insulating units specially designed to fit the surfaces to be insulated, and engineered for the service and environmental requirements. The insulation unit may also include special design features which facilitate the removal and replacement for maintenance and inspection.

1.3 When prefabricated panels are used, each insulation unit factory preassembled and typically comprised of the insulation, an outer lagging to which the insulation is attached, an inner retaining wire mesh, optional foil lining, and means for mechanically securing multiple units together in an assembly.

1.4 H-bar systems represent insulation units that are typically comprised of the insulation, outer lagging and a uniquely configured subgirt design which both supports the insulation and provides a means for mechanically securing multiple units together in an assembly. The design of the subgirt creates an "H" configuration which is fabricated from light gauge sheet metal. The subgirt components consist of: *(1)* a "J-bar" shape which frames the perimeter edges of the surface to be insulated, holds the insulation in place along the outer edge and provides a screen attachment point for the outer lagging; *(2)* the "H-bar" shape is placed at defined intervals. The web section of the "H-bar" supports the insulation while the exterior flange allows for the outer lagging to be attached with threaded fasteners.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *This standard does not purport to address all of the safety concerns, 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.*

NOTE 1—When prefabricated panel or H-Bar insulation systems are specified, Test Methods C167, C177 and C1061, Material Specifications A36/A36M, A463/A463M, B209, C612, and Terminology C168 should be considered.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A36/A36M Specification for Carbon Structural Steel

A463/A463M Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C167 Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations

C168 Terminology Relating to Thermal Insulation

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C612 Specification for Mineral Fiber Block and Board Thermal Insulation

C1061 Test Method for Thermal Transmission Properties of Non-Homogeneous Insulation Panels Installed Vertically (Withdrawn 1995)[3]

3. Terminology

3.1 Terminology C168 shall be considered as applying to the terms in this specification.

[1] This guide is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.40 on Insulation Systems.

Current edition approved Nov. 1, 2013. Published January 2014. Originally approved in 1989. Last previous edition approved in 2009 as C1146 – 09. DOI: 10.1520/C1146-09R13.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *convection barrier (flue stop)*—barriers to internal air flow sometimes refered to as "chimney effect") which are placed between the inner liner and the hot surface being insulated. The barriers are generally a combination of sheet metal and with the insulation material mechanically attached. Convection barriers are required when the insulation is not in direct contact with the plate surface and only on vertical and sloping surfaces of less than 45° incline.

3.2.2 *flashing*—sheet metal of the same material as the lagging, used to cover openings in the insulation typically occurring at locations, such as corners, penetrations framing of doors and closures. Flashing may be fixed (permanent) or removable to allow for inspection and maintenance, that is, expansion joints.

3.2.3 *inner liner*—the innermost surface or cover of the prefabricated panel (closest to the hot surface) composed of reflective aluminum foil and wire mesh.

3.2.4 *insulation*—essentially homogenous insulation, generally in semi-rigid board from and, in which relevant properties are not a function of position within the material itself, but may be a function of such variables as time and temperature.

3.2.5 *lagging*—the outermost cover or sheet of the prefabricated panel or H–bar system (farthest from the hot surface), which performs a structural function as well as provides protection from weather and mechanical abuse. The lagging is generally fabricated from corrugated, ribbed, or flat sheet; smooth or stucco-embossed; mill finish or painted; clad or non-clad.

3.2.6 *penetrations*—openings through a unit of insulation from the hot plate surface through to the exterior cold surface. Penetrations such as test ports should be covered with removable insulation assemblies. The insulation thickness should be equal to the surface being insulated.

3.2.7 *retaining devices*

3.2.7.1 *prefabricated panels*—metallic members passing through the insulation between the hot surface and the cold surface. Generally, these include: pins, prongs, or other acceptable means used and secured with washers and speed clips to hold the assembly together.

3.2.7.2 *H-bar systems*—H-bar systems includes retaining devices such as a backing strap or expanded metal between the H-bar. These devices are placed midway between the insulation boards and provide support on wall applications. On top of surfaces, the H-bar retaining device may be either expanded metal or a corrugated inner-liner to hold the insulation in the H-bar track

3.2.8 *support member (subgrit)*—straps, bars, or angles attached to the plate surface or external casing stiffeners being insulated and to which the insulation units are attached.

4. Significance and Use

4.1 The purpose of this guide is to ensure that a functional system will result when considering the use of prefabricated panel or H-bar insulation systems. Both systems require a varying degree of pre-engineering and prefabrication so that the insulation will produce the specified thermal, mechanical and environmental design requirements Both the prefabricated panels and H-bar systems which can also be used in combination with each other are to be designed to:

4.1.1 Limit loss of heat from insulated surface.

4.1.2 Limit exposed surface temperatures for burn protection of personnel.

4.1.3 Maintain optimum temperatures of the insulated equipment at or above a specified minimum value required for the proper operation of the equipment.

4.1.4 Produce a system or assembly that is designed to provide allowance for thermal expansion; is structurally adequate; is of a weathertight construction; and incorporates design features that promote efficient removal for inspection, repair and maintenance where required.

5. Panel Design Specifications for Prefabricated Panel and H-bar Systems

5.1 *General:*

5.1.1 The purchase specification should clearly indicate the surfaces to be insulated. Either insulation type and thickness or average heat loss requirements shall be part of the specification.

5.1.2 The purchase specification should clearly indicate the operating temperature of the item to be insulated. When up-set or worst-case temperature conditions are to be considered, the maximum temperature excursion and time duration should be stated.

5.1.3 Heat loss through uninsulated surfaces, or increased heat loss that results when it is necessary to reduce insulation thickness to accommodate localized interferences with equipment, supports, hangers, etc., should be considered in the overall insulation design.

5.1.4 Conduction paths which produce high heat on exterior lagging or "cold spots" on plate interior and are attributed to the insulation subgrit design should be minimized. The use of "through-fasteners" or bolts where protruding heads can occur should be kept to a minimum. There should be no "rattling" or "free-play" of the exterior lagging.

5.1.5 Convection barriers (flue stops) are typically installed at 12 to 15 ft (3657 to 4572 mm) vertical centers as well as to close off the corners of plate surfaces. The materials generally consist of sheet metal welded to plate surfaces and covered with insulation of the same thickness that is used to insulate the exterior envelope. The insulation is secured to the metal convection barrier through use of pins and washers. When installed, the insulated convection barrier should produce a tight fit all around; including into the web of intersecting structural stiffeners; in order to minimize internal heat paths.

5.1.6 All components of the insulation units, as physical structures, must be capable of withstanding the temperatures and environmental design conditions to which they will be subjected without mechanical or structural failure or detrimental changes in physical properties.

5.1.7 When subjected to maximum service temperature and operating conditions insulation units should not warp, deform, shrink, or shift so as to affect their performance. The materials

should perform their functions for the specified service life and be compatible with the specified environmental conditions.

5.1.8 Since permanent deformation of the insulation can cause loss of efficiency, the design specification should define the insulated areas required to have reinforced lagging construction. Example: Roof design to accommodate a "walk load" or "foot traffic."

5.1.9 Insulation units should be provided with overlapping joints or other suitable means to form a natural watershed and preclude siphoning of water and air infiltration through open areas.

5.1.10 Insulation units, assemblies and flashing arrangements of units should be equipped with overlapping slip joints or other suitable means to provide for the differential movement between the hot surface insulated and the insulation, since the temperature of the outer lagging and flashing will be lower than that of the hot surface.

5.1.11 The insulation system is engineered and prefabricated to fit the purchaser's equipment, therefore, it is the responsibility of the purchaser to supply drawings, specifications, and pertinent operation data to the system manufacturer and installing contractor for the equipment to be properly insulated.

5.1.12 Purchase specification should make provisions to preclude galvanic action between dissimilar metals. Likewise the specification should note where any field welding to exotic alloys or lined surface is not allowed or require that special welding procedures be followed.

5.2 *Thermal:*

5.2.1 When maximum heat loss is specified by the purchaser, the purchase specification should clearly indicate the operating parameters where the average heat loss through a unit of area of the insulation is permissible. This thermal performance should be referenced to the area of the hot surface being insulated unless otherwise specified. Consideration for above average heat loss occurring through insulation joints, attachment to subgirt or high heat loss through protrusions need to be factored into the overall insulation design thickness.

5.2.2 When maximum temperature of exterior lagging for personnel protection is specified by the purchaser, the average mean air temperature and minimum wind velocity should also be supplied. Emissivity value of lagging should be stated along with relevant information pertaining to average-mean environmental conditions.

5.2.3 If personnel exposure to high surface temperature is considered to be a danger in limited areas, those areas should be explicitly identified and one or more of the following alternatives will be required.

5.2.3.1 External guarding, barricades,

5.2.3.2 Additional, thickness or high-efficiency insulation

5.2.3.3 High emittance outer lagging, or

5.2.3.4 Other acceptable techniques agreed to between the purchaser and the installer.

6. Shipping, Storage, and Handling of Prefabricated Panel and H-bar Systems

6.1 All insulation materials, whether prefabricated panel or H-bar system, should be packaged, shipped, stored, and handled in a manner that will result in their remaining in the same condition as they left the manufacturer.

6.2 Shipping containers should be weather-resistant, sturdy and wrapped with a protective covering to limit entrance of contaminants and damage to the insulation and "water-staining" of lagging during shipment and storage.

6.3 Shipping containers should be identified with the purchase order number, the material identification number, special shipping and handling instruction (this side up, stacking limitations), and special instructions (storage, unpacking restrictions, etc., as appropriate).

6.4 Shipping containers should be arranged in such a manner that identification markings on the outside are clearly visible from adjacent sides and using indelible markings.

6.5 Insulation should be stored and protected in its "as shipped" condition in the shipping containers to preserve its shop cleanliness level until it is ready to be installed.

6.6 Containers in storage should be sufficiently elevated above ground level to prevent surface water and drainage damage. Protective coverings should not be the type to incur UV degration when exposed to sunlight for extended periods of time

6.7 Periodic storage inspection should be conducted until the insulation is removed for installation. The frequency of the inspections should be governed by the results of previous inspection and on-site storage conditions.

7. Panel Installation Procedure

7.1 Since prefabricated panel insulation and H-bar system units are custom-made to fit the equipment to which they are to be installed, with lapping of the lagging or other mechanical means required for expansion, water shedding, and weather protection, they must be installed in proper sequence. The manufacturer of the prefabricated panel or H-bar system is expected to provide installation diagrams or procedures, or both, to show the proper sequence of installation.

7.2 Units of insulation shall be installed in proper sequence with ends tightly butted and lagging arranged to shed water.

7.3 Normally, any substantial modifications to the insulation units should be referred to the manufacturer. Field cutting or fitting should be done in a workmanlike manner with cuts clean and neat and caulked (where required) and flashed to prevent water entrance. Pre-molded closures should be installed to restrict air flow in or out of the insulation.

7.4 Insulation and support member should be handled in such a manner that prevents damage to the insulation, the insulation supports, and the items being insulated.

7.5 Both prefabricated panel and H-bar system units should be fabricated and installed so that they will resist typical mechanical abuses, vibration, wind or other environmental considerations.

7.6 Convection barriers (flue stops) should be installed where excessive convection currents may occur. Typical placement of barrier is 12 to 15 ft (3657 to 4572 mm) vertical on

center. Minimum number of barrier shall include at least two (top and mid-point of wall). See 3.2.1.

7.7 Where screws are used for securing the insulation units, they should be installed in properly drilled holes, unless "self-drilling" fasteners are used. Units should be erected with screws, plumb and securely tightened to prevent loosening under vibration or other movement. Metal-backed neoprene washers are to be used on all threaded fasteners. Care is to be taken not to over tighten the washer causing it to flatten and lose its ability to seal the opening.

7.8 Where subsequent removal of units is involved, they may be secured by bands and seals, hinges and snap-locks, or sheet-metal screws. Where removals are anticipated for frequent inspection, the units should be secured by buckles or other clamping devices. Use of stainless steel fasteners should be considered for exterior locations.

7.9 After installation is completed, there should be a final inspection to ensure that there are no excessive heat losses though the insulated surfaces. The utilization of thermographic techniques may provide valuable information as part of a final acceptance procedure when agreed upon by purchaser and installer (if different from the manufacturer) as well as manufacturer (if different than installer).

8. Keywords

8.1 H-bar insulation assemblies; insulation units; panel insulation units