Designation: C1744 – 12

# Standard Practice for Installation and Use of Radiant Barrier Systems (RBS) in Commercial/Industrial Building Construction[1]

This standard is issued under the fixed designation C1744; 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 practice has been prepared for use by the designer, specifier, builder, and the installer of radiant barrier systems (RBS) for use in commercial/industrial building construction not otherwise restricted from use. The scope is limited to instruction relative to the use and installation of RBS, including a surface(s) normally having an emittance of 0.1 or less, such as metallic foil or metallic foil deposits, mounted on substrates. Some examples that this practice is intended to address include: (1) low-emittance surfaces in vented building envelope cavities intended to retard radiant transfer across the airspace: (2) low-emittance surfaces at interior building surfaces intended to retard radiant transfer to, or from, building inhabitants; and (3) low-emittance surface at interior building surfaces intended to reduce radiant transfer to, or from, radiant heating or cooling systems.

1.2 This practice covers the installation process from pre-installation inspection through the post-installation procedure. It does not cover the production of the radiant barrier materials. (See Specification C1313.)

1.3 This practice is not intended to replace the manufacturer's installation instructions but shall be used in conjunction with such instructions. This practice is not intended to supercede local, state, federal, or international codes.

1.4 This practice assumes that the installer possesses a good working knowledge of the applicable codes and regulations, safety practices, tools, equipment, and methods necessary for installation of radiant barrier materials. It also assumes that the installer understands the fundamentals of commercial/industrial building construction that affect the installation of RBS.

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. For specific precautionary statements see Sections 5 and 7.*

1.6.1 *When the installation or use of radiant barrier materials, accessories, and systems has the potential to pose safety or health problems, the manufacturer shall provide the user appropriate current information regarding any known problems associated with the use of the product of the company and shall also specify protective measures.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation

C1313 Specification for Sheet Radiant Barriers for Building Construction Applications

2.2 *NFPA Standards:*[3]

NFPA 54 National Fuel Gas Code

NFPA 211 Standard for Chimneys, Fireplaces and Vents

2.3 *Other Document:*[4]

CPSC Product Safety Fact Sheet No. 18 "The Home Electrical System"

## 3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology C168.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *applicator, n*—person or persons who apply radiant barrier materials in buildings.

3.2.2 *conditioned space, n*—any space in a building that is served by a heating or cooling system.

[1] This practice is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.21 on Reflective Insulation.

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[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] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

[4] Available from U.S. Consumer Product Safety Commission (CPSC), 4330 East West Hwy., Bethesda, MD 20814, http://www.cpsc.gov.

3.2.3 *girts, n*—typically, 1 or 2× nominal lumber, installed over rafters or trusses, to be used for securing both the RBS and metal decking, which is used on wall assemblies for securing metal siding.

3.2.4 *open air space, n*—vented building cavity (for example, an open-ended wall or ceiling assembly) or a large conditioned or unconditioned building space.

3.2.4.1 *Discussion*—A large building space is defined as one whose minimum dimension exceeds 2 ft (0.6 m).

3.2.5 *purlins, n*—steel or wood structural members that are used to support the buildings primary structural load above the floor.

3.2.6 *radiant barrier system, RBS, n*—building construction assembly consisting of a lowemittance (0.1 or less) surface bounded by an open air space on one or both sides.

3.2.6.1 *Discussion*—Discussion—An RBS is used for the sole purpose of limiting heat transfer by radiation into or out of a building assembly. An RBS is not specifically intended to reduce heat transfer by convection or conduction.

3.2.7 *subpurlins, n*—secondary steel or wood structural members that are used primarily to support the roofing and siding of a building are often identified as "Z purlins," "C channel," "I beams," or other structural configurations based on cross-sectional appearance.

3.2.8 *thermal break, n*—low thermal conductivity product such as wood or polystyrene used to separate two higher conductivity products that are most often metal in an effort to reduce heat gain or loss and prevent the potential for condensation problems.

## 4. Significance and Use

4.1 In this practice it is recognized that effectiveness, safety, and durability of an RBS depends not only on the quality of the materials, but also on proper installation.

4.2 Improper installation of an RBS will reduce the thermal effectiveness, cause fire risks and other unsafe conditions, and promote deterioration of the structure in which it is installed. Improper installations include fires caused by: *(1)* heat buildup in recessed lighting fixtures, *(2)* deterioration or failure of electrical wiring components, and *(3)* deterioration in wood structures and paint failure as a result of moisture accumulation.

4.3 This practice provides direction for the installation of RBS products in a safe and effective manner. Actual conditions in existing buildings vary greatly and care shall be taken to ensure safe and effective installation.

4.4 In this practice, requirements are presented that are both general and specific in nature and practical. They are not intended as specific instructions unless so indicated. The user shall consult the manufacturer for application and installation methods. The requirements in this practice shall be the minimum material and installation requirements for RBS.

## 5. Pre-Installation Inspection and Preparation

5.1 The applicator shall wear proper clothing and equipment as specified by the manufacturer and shall follow all local, state, and federal codes and safety regulations for building construction sites, for example, hard hats, safety goggles respiratory protection, and other safety items.

## 6. Safety Precautions

6.1 *Pre-Installation Inspections: New and Retrofit Buildings:*

6.1.1 Inspect the roof, wall, ceiling, and floor building materials, in both steel and wood structures, to identify areas in which previous or existing moisture problems have caused paint peeling, lumber warpage, staining, rusting, corrosion, visible fungal growth, rotting, or other structural damage. Do not install the RBS in such areas until the owner/builder has been informed and has certified that these conditions have been corrected and the cause of the condition repaired.

6.1.2 In areas where an RBS is to be installed, components of the electrical system shall be in good condition. When there is reason to believe the electrical system is faulty, do not install RBS in such areas until the owner/builder has been informed and qualified inspection and repair has been accomplished.

NOTE 1—The CPSC Product Safety Fact Sheet No. 18 has identified the following signs of potential electrical deficiencies: lights dimming, fuses blowing, circuit breakers tripping frequently, electrical sparks and glowing from receptacles, lights flickering, and cover plates on switches and outlets that are warm or hot to the touch.

6.1.3 In areas where an RBS is to be installed, the applicator shall locate and plan for installation around ventilation openings. The applicator shall not install RBS that will obstruct or block existing ventilation openings, such as gable ends, dormers, ridge, off ridge, soffit vents, or any others.

6.2 *Preparations:*

6.2.1 All electrical wiring at, or near, radiant barrier material attachment surfaces shall be either moved, or protected, to ensure that fasteners used to install the radiant barrier material will not contact the electrical wiring system.

6.2.2 When soffit ventilation exists in wood frame construction, and new or existing ceiling insulation will be compromised by the installation of an RBS, vent baffles shall be installed at the soffits.

## 7. Installation Guidelines

7.1 *Material Handling:*

7.1.1 The radiant barrier material shall be handled in accordance with the manufacturer's instructions, shall be kept dry, and shall not be in contact with the ground or sources of water.

7.1.2 The radiant barrier material shall not be placed in contact with corrosive building materials.

7.2 *Performance Considerations:*

7.2.1 The performance of the RBS depends on adherence to manufacturer's specifications. Manufacturer's installation instructions and all applicable building codes shall be followed. The manufacturer shall provide the product information sheet(s) that specify the product's intended use(s), application method(s), health and safety requirements, and material properties per Specification C1313.

7.2.2 The performance of the RBS is dependent on the presence of an open airspace adjacent to at least one low-emittance surface.

7.2.3 The performance of the RBS will be adversely affected by foreign materials on the low-emittance surface. Before installation, foreign materials shall be removed using manufacturer's instructions, taking care not to damage the radiant barrier material.

7.2.4 The performance of a radiant barrier will be reduced by a corrosive environment. In some instances, severe pollutants react with the low-emittance surface causing an increase in the emittance of the material. When such conditions exist, the owner/builder shall be informed that these conditions have the potential to result in material degradation and a decrease in RBS performance.

7.2.5 In some instances, the performance of a radiant barrier will be reduced by the presence of moisture on the low-emittance surface. Such conditions are potentially temporary or long term and the manufacturer shall be consulted to determine the applicability of RBS when these conditions are expected to occur.

7.2.6 The performance of the RBS will be adversely affected by the accumulation of dust over time on the low-emittance surface. RBS shall be installed to avoid the settlement of dust on the radiant barrier surface. Dust is not a concern on a downward facing RBS.

7.2.7 Damaged areas will result in loss of performance and shall be repaired in accordance with the manufacturer's instructions.

7.3 *Precautions:*

7.3.1 In areas in which radiant barrier materials are to be installed, the applicator shall provide clearance around lighting fixtures, motors, fans, blowers, heaters, flues, chimneys, and other heat-producing electrical and mechanical devices.

7.3.1.1 The applicator shall provide 3-in. (75-mm) minimum clearance around all sides of recessed lighting fixtures unless such fixtures are approved for installation in direct contact with radiant barrier materials. Such fixtures include fixture wiring compartments, ballasts, and other heat-producing devices. These devices shall not be covered unless they are specifically approved for operation when covered.

7.3.1.2 The applicator shall provide the minimum clearances specified in NFPA 54. Provide a 2-in. (50-mm) minimum clearance from the outside face of the masonry around masonry chimneys or masonry enclosing a flue. For vents, vent connectors, and chimneys other than masonry, provide minimum clearances as specified in NAPA 211.

7.3.1.3 The operative material of most RBS is a metallic foil or vapor deposition of a metal on a substrate. Therefore, there is a potential for radiant barrier materials to provide an extremely high resistance to water vapor transmission. Radiant barriers shall not be installed so as to lead to moisture accumulation and deterioration in the structure. Some radiant barriers are produced to provide low resistance to water vapor transmission. High vapor permeable house wraps and perforated products are examples.

7.3.1.4 In wood or steel framed buildings (new or retreofit), a perforated radiant barrier shall always be used when insulation is installed (warm-winter side), such as in the roof or sidewall installations (Fig. 9), in direct contact with the radiant barrier (cold-winter side). When the radiant barrier is below, or next to, an unfaced insulation, in the wall or roof (warm-winter side), a nonperforated radiant barrier shall be used.

7.3.1.5 Regardless of construction type, all radiant barrier materials that are installed with the low-emittance material(s) in direct contact with other metals shall be separated by an acceptable thermal break.

7.4 *Installation Requirements:*

7.4.1 Determine that the RBS material and installation meet the following criteria:

7.4.1.1 *Testing and certification*—The materials shall meet all the requirements of Specification C1313 as well as comply with all certification and codes governing the use and installation of radiant barriers.

7.4.1.2 *Ventilation*—In all installation methods, regardless of the type of framing or roofing, materials, or methods of installation, inspect all ventilation openings and pathways to be sure they are not blocked by the installation of the RBS systems.

7.4.1.3 *Venting ratio*—Typically, a minimum net-free ventilation of not less than 1 $ft^2$ (0.09 $m^2$) of vent area for each 150 $ft^2$ (14 $m^2$) of floor area (ground level only) be used in both new and retrofit construction whenever practical.

## Installation

7.5 The installer or applicator shall install the RBS according to the manufacturer's installation guidelines. In addition, the following minimum guideline shall be used when installing an RBS in specific areas of the structure such as:

7.5.1 *Wood frame buildings with wood roof decks*—There are various methods of installing an RBS:

7.5.1.1 Factory applied (laminated) or field-applied RBS (stapled) to the underside of the roof deck facing towards the interior (Fig. 1). A perforated (vapor permeable) RBS is always required for this type of installation. A single- or double-sided radiant barrier material shall be used in the deck-applied installation, as long as a low-emittance surface (dull or shiny) faces downward;

7.5.1.2 Draped over the rafters or trusses (top chord) before sheeting the roof (Fig. 2);

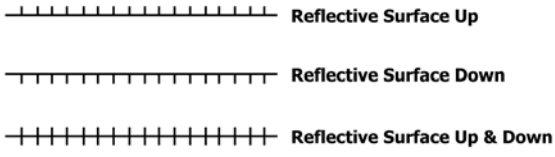
7.5.1.3 Installed between the rafters or top chords of the trusses (Fig. 3);

7.5.1.4 Secured to the bottom surface of the rafters or truss (top chord) (Fig. 4); and

7.5.1.5 Shall maintain a minimum 1½-in. (3.8-cm) airspace at the center of the truss/rafter span between the radiant barrier surface and the underside of the roof deck in installations *(b)* through *(d)*, and a perforated radiant barrier is not required in these installations (Figs. 2-4). Gable end walls, division walls, and all other vertical surfaces above the ceiling insulation, such as in offices and retail building spaces, shall be covered by either a single- or double-sided radiant barrier, perforated (vapor permeable) or not (non vapor permeable), installed with a low-emittance surface facing the ceiling cavity for visual inspection purposes regardless of construction materials (Fig. 7).

7.5.2 *Wood frame buildings with a metal roof (without oriented strand board (OSB) or plywood sheathing beneath)*—There are various methods of installing an RBS:

RADIANT BARRIER INSTALLATIONS




RBS Legend

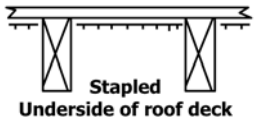



FIG. 1

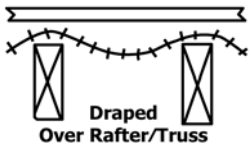



FIG. 2

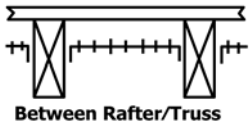



FIG. 3

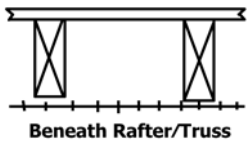



FIG. 4

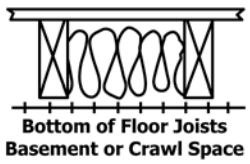



FIG. 5

7.5.2.1 Draped over the rafters, trusses (top chord), or girts before applying metal roofing as long as there is a proper thermal break, such as polystyrene or wood, between the bottom of the metal roof and the top surface of the RBS to prevent the potential for condensation at metal-to-metal points of contact in conditioned buildings (Fig. 8);

7.5.2.2 Installed between the rafters or top chords of the trusses (Fig. 3);

7.5.2.3 Secured to the bottom surface of the rafters or truss (top chord) (Fig. 4); and

7.5.2.4 Shall maintain a minimum 1½-in. (3.8-cm) airspace at the center of the truss/rafter span between the radiant barrier surface and the underside of the metal roof in installations *(b)* and *(c)*. A perforated radiant barrier is not required in these installations.

NOTE 2—In retrofit and new construction, secure a perforated radiant barrier directly to the underside portion of the roof deck over the eave or soffit so that the barrier's coverage extends at least 3 in. (7.6 cm) beyond the top plate of the sidewall without being in contact with any ceiling insulation once it is installed. In an effort to prevent blockage of eave or

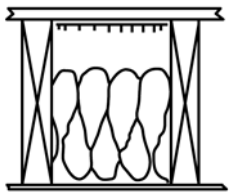



FIG. 6

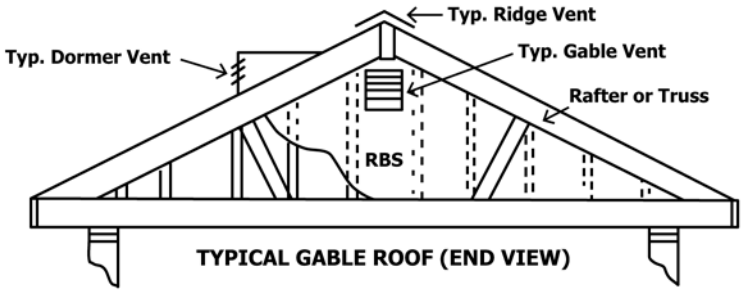



FIG. 7

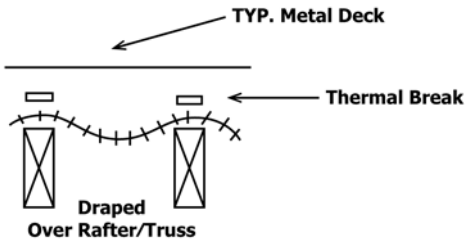



FIG. 8

soffit venting, a total vertical airspace of no less than 3½ in. (9 cm) shall be maintained between the RBS and the top of the ceiling insulation regardless of the installation method.

NOTE 3—In new construction or room additions that include vaulted or cathedral ceilings, install a perforated radiant barrier with the low-emittance surface facing downward towards the interior directly against the underside of the roof deck. When installing the insulation, allow a 1-in. (2.5-cm) minimum space between the top of the insulation and the underside of the radiant barrier. The most efficient system, either, by design or retrofit, is to vent both the upper and lower ends of these assemblies before the installation of the RBS (Fig. 6).

7.5.2.5 Perforated, or nonperforated, radiant barriers are options to cover the subpurlins from the peak of the roof to the base of the sidewalls and end walls at the outside, or inside, of the subpurlins in new construction and the inside face of the subpurlins in a retrofit installation. In both installations, a thermal break shall be used between the radiant barrier material, metal roofing, subpurlins, and metal exterior wall coverings to prevent the potential for condensation at metal-to-metal points of contact (Fig. 9).

NOTE 4—This practice does not intend to address all of the various commercial/industrial type building assemblies but rather those that are most commonly installed with radiant barrier products such as block wall buildings framed with either wood or steel studs, rafters, or trusses. However, the principles of proper installation are incorporated in this practice for most buildings that there is potential benefit from the installation of a radiant barrier.

7.5.2.6 *Unvented low-slope roofs*—In roof assemblies (flat roofs) that have a pitch of less than 1 in. (2.5 cm) in 12 in. (30.5 cm), do not install radiant barrier unless the high end of the roof has a ridge vent or other high-end venting capable of evacuating the excessive summer heat. Building structures such as these benefit more with added insulation, either reflective or mass, specifically in conditioned buildings.

7.5.2.7 *Exterior crawl spaces (wood frame buildings)*—When covering the underside of a floor assembly facing a crawl space cavity, use a nonperforated product, regardless of whether the floor is insulated (Fig. 5). Proper ventilation of these crawl spaces is very important. In this installation, the RBS is also a vapor retarder and it shall always be a nonperforated product. All seams and penetrations shall be properly sealed and the crawl space vented to meet necessary code requirements. To prevent damage to the insulation and structure the humidity level in crawl spaces must be maintained below a level that creates a condition for condensation to occur on the crawlspace surfaces. Treatments to prevent crawl space condensation include, but are not limited to: *(1)* Sealing the interface between the ground and the crawl space walls and

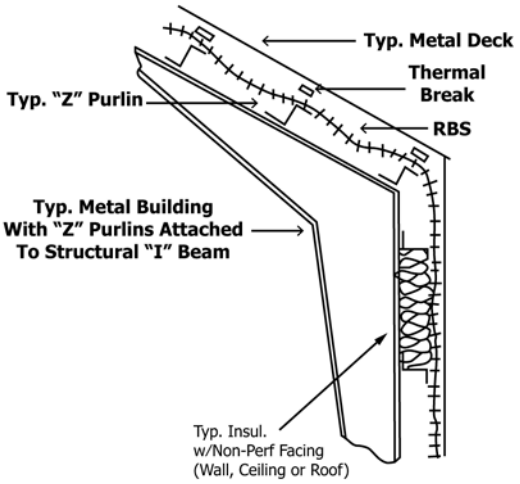



**FIG. 9**

floor; *(2)* Venting the crawl space to the outside climate, when humidity conditions require.

7.5.2.8 *Sidewalls and basement walls (wood frame buildings)*—Use a perforated radiant RBS on these assemblies only when the wall is not insulated or otherwise covered. Once the wall is covered and not vented, this assembly becomes a reflective insulation system, not a radiant barrier. Consult the manufacturer's instructions for installing reflective insulation.

7.5.3 *Steel framed buildings with a metal roof*—Typical construction of this type of building structure includes a corrugated or standing seam steel roof mounted on subpurlins of numerous designs including "Z" purlins, "I" beams, "C" channel, or various other types of structural steel. The subpurlins are attached to a steel purlin that is most commonly an "I" beam of some configuration that is typically designed to support the entire wall and roof loads.

7.6 *Post-Installation Inspection:*

7.6.1 Ensure that the proper amount of radiant barrier has been installed to achieve the greatest amount of protection from heat gain or loss according to the area covered such as: roofs, attics, ceilings, walls, floors, and crawl spaces.

7.6.2 Ensure that the RBS material does not restrict air flow in, out, around, or over exhaust and inlet venting.

7.6.3 The applicator shall provide a signed and dated statement to the owner/builder describing the RBS installation, the radiant barrier material installed in accordance with Practice C1744, and the area covered.

## 8. Keywords

8.1 aluminum foil; division walls; gable ends; low emittance; installation practices; low-slope roofs; metallic deposit; radiant barrier; radiant barrier system; RBS; thermal breaks; vapor retarder; venting ratio