Designation: C1848 – 17

Standard Practice for Installation of High-Pressure Spray Polyurethane Foam Insulation for the Building Enclosure[1]

This standard is issued under the fixed designation C1848; 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 covers the installation of high-pressure spray polyurethane foam (SPF) as an insulation for building enclosure assemblies including: walls, ceilings, attics, floors, and crawl spaces. This practice does not apply to SPF used strictly as a component for an air barrier system or for SPF used in roofing applications.

1.2 Building design criteria and selection of SPF are beyond the scope of this practice.

1.3 The use of SPF insulation covered by this practice is typically regulated by building codes or other agencies that address fire performance. Where required the fire performance of the material shall be addressed through standard fire test methods established by the appropriate governing documents.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C168 Terminology Relating to Thermal Insulation

D4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

D4449 Test Method for Visual Evaluation of Gloss Differences Between Surfaces of Similar Appearance

D4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

D5469 Guide for Application of New Spray Applied Polyurethane Foam and Coated Roofing Systems

D6226 Test Method for Open Cell Content of Rigid Cellular Plastics

D7425 Specification for Spray Polyurethane Foam Used for Roofing Applications

2.2 *European Standard:*[3]

EN 14315-2:2013 Thermal insulating products for buildings - In-situ formed sprayed rigid polyurethane (PUR) and polyisocyanurate (PIR) foam products - Part 2: Specification for the installed insulation products

2.3 *Society for Protective Coatings (SSPC):*[4]

SSPC SP 1 Society for Protective Coatings: Solvent Cleaning

SSPC SP 6 Society for Protective Coatings: Commercial Blast Cleaning

2.4 *Spray Polyurethane Foam Alliance (SPFA):*[5]

SPFA-119 Glossary of Terms

SPFA-137 Spray Polyurethane Equipment Guidelines

SPFA-143 Primers: Why, When and How to Use Them

SPFA-148 Spray Polyurethane Foam Insulation Installation Certificate

3. Terminology

3.1 Definitions are in accordance with Terminology C168.

3.2 *Definitions:*

3.2.1 Specific Definitions per SPFA-119:

3.2.2 *lift, n*—the sprayed polyurethane foam resulting from passes of foam in a specific area, as defined by its thickness and the area.

3.2.3 *pass, n*—the amount of coating or polyurethane foam applied by moving the gun from side to side and moving away from fresh material, delineated by its width, length, and thickness.

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

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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 European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, http://www.cen.eu.

[4] Available from Society for Protective Coatings (SSPC), 800 Trumbull Dr., Pittsburgh, PA 15205, http://www.sspc.org.

[5] Available from Spray Polyurethane Foam Alliance (SPFA), 3927 Old Lee Hwy. #101B, Fairfax, VA 22030, http://www.sprayfoam.org/.

4. Classifications

4.1 *Low-Pressure Spray Polyurethane Foam*—Spray polyurethane foam where the plural components (A- and B- side) are delivered a pressure of less than 1.72 MPa (250 psi), at a rate between 2.3 and 3.2 kg/min (5 and 7 lb/min) wherein the liquid components are mechanically mixed using a static mixing nozzle. Components are typically delivered in pressurized tanks.

4.2 *High-Pressure Spray Polyurethane Foam*—Spray polyurethane foam where the where the plural components (A- and B- side) are delivered at a pressure between 3.45 and 8.96 MPa (500 and 1300 psi), at a rate up to 13.6 kg/min (30 lb/min) wherein the liquid components are aerosolized and impingement mixed outside of the spray gun.

5. Significance and Use

5.1 This practice outlines general procedures that are recommended for correct installation of spray polyurethane foam (SPF) as an insulation in the building enclosure including; walls, ceilings, attics, floors, crawl spaces, attics and foundations.

NOTE 1—SPF roofing installations are not covered by this document. Users may wish to consult Guide D5469 and Specification D7425.

5.2 This practice is not all-inclusive; this practice is intended only to supplement detailed instructions from manufacturers, SPF industry best practices and safety requirements as may be established by law.

6. Substrate Requirements

6.1 *General Requirements:*

6.1.1 Installation of SPF in buildings or structures shall conform to the requirements of the applicable construction codes, regulations and standards as adopted and enforced by the relevant authority having jurisdiction or local code official.

6.1.2 Substrate materials to receive SPF should be physically stable and resistant to movement or excessive flexure relative to the building structure.

6.1.3 All substrates to receive SPF should be clean, dry and free of contaminants that may cause poor adhesion of the SPF.

NOTE 2—If in doubt of the potential adhesion, spray a section of the substrate with SPF and test the adhesion in accordance with SPF industry guidelines. An example of a typical SPF field adhesion test procedure is provided in Test Method D4541. To assure proper bonding of SPF to the substrate, the failure surface should indicate a cohesive failure of the SPF.

6.2 *Metal:*

6.2.1 Primed or coated metal substrates should be free of dirt, loose scale, rust, weathered or chalked coatings. Such substrates should be cleaned using suitable means.

NOTE 3—Suitable means may include, but are not limited to, clean and dry compressed air, vacuum equipment, and hand or power tools.

6.2.2 Grease, oil or other contaminants should be removed with suitable cleaning solutions. An example of a specification for solvent cleaning of metal surfaces is provided by SSPC SP 1.

6.2.3 Fine condensation on some metal substrates may be difficult to visually detect. Consider using moisture-detection paper (cobalt-chloride strips) to check for condensation when metal substrate temperatures are close to the atmospheric dew point temperature.

6.2.4 Thick metal substrates, such as structural steel and walls of pressure vessels can act as a heat sink. In these cases, consult manufacturer installation instructions (MII) or contact the SPF manufacturer.

6.2.5 If the cleaned metal substrate does not allow for adequate adhesion of the SPF, primers may be needed and installed in accordance with the primer and the SPFMII. Guidance for primer selection can be found in SPFA-143.

6.2.5.1 *Ferrous Metal*—Sandblasting is recommended for iron and steel surfaces that are not shop primed, painted, or otherwise protected. Remove loose rust and unsound primer from shop-primed iron and steel surfaces. The sandblasted area should be primed the same day using an SPF-compatible primer. An example of a specification for abrasive blast cleaning procedures and condition of steel surfaces is provided by SSPC SP 6.

6.2.5.2 *Non-Ferrous Metal*—SPF Installer should clean and prime all surfaces (if required) as recommended by primer or SPF manufacturer, or both.

6.3 *Concrete or Masonry:*

6.3.1 SPF installer should verify the concrete or masonry surfaces are clean, and free of contaminants that can affect adhesion. Existing concrete should be free of spalling, scaling, loose coatings, efflorescence and other conditions that affect adhesion.

6.3.2 SPF Installer should verify the concrete is dry to obtain good adhesion of the primer or SPF, or both. Consider using Test Method D4263 or other reliable method approved by the SPF and primer manufacturer to check concrete moisture.

6.3.3 SPF installer should verify that any newly poured concrete has cured before application of SPF or primer.

NOTE 4—Most new poured concrete requires a 28-day cure time unless the concrete is specifically designed for a shorter cure time.

6.3.4 Thick concrete substrates can act as a heat sink. In these cases, consult MII or contact the SPF manufacturer.

6.3.5 Primer (as may be required) should be applied as recommended by the primer and SPF manufacturer.

6.4 *Wood:*

6.4.1 The SPF installer should verify the wood surface is clean, dry and free of contaminants that can affect adhesion.

6.4.2 Wood substrates should typically have a surface moisture content no greater than 18 % as measured in accordance with Test Method D4449. Field measurements may be obtained with hand held moisture meters.

6.4.3 Treated wood (for insects or water resistance) may provide poor adhesion and should be evaluated for adhesion. If a primer is required, it should be applied as recommended by the primer and SPF manufacturer.

6.5 *Interior Cladding Board (gypsum board, fiberboard, fiber-reinforced gypsum board, etc.):*

6.5.1 SPF installer to verify surfaces are clean, dry and free of contaminants that can affect adhesion.

6.5.2 Primer, if required, shall be applied as recommended by primer or SPF manufacturer, or both.

7. Equipment

7.1 SPF shall be metered and mixed through equipment capable of providing a fixed volumetric ratio of equal parts of A-side (isocyanate) and B-side (polyol blend) chemicals, with an accuracy of ±2 % by volume at the temperature ranges specified by the MII. The A and B side chemicals shall be provided by a single supplier and designed to work as a matched system. Typical equipment for high-pressure SPF application is shown in Fig. 1, and described in detail in SPFA-137.

7.2 SPF foam ratio control should be monitored by proportioner equipment, which indicates constant pressure and also by observing the uniform color and spray pattern of the spray applied foam.

7.3 SPF equipment shall provide temperature control of the A and B components to within an accuracy of 2.8°C (5°F).

8. Installation Personnel

8.1 Installation of high-pressure SPF requires training and experience. All SPF installers should be trained on the proper operation of the equipment and installation of the SPF materials. Training may be provided by manufacturers, distributors or third-party organizations. Certifications or licensing programs, or both, may be available.

9. Safety Requirements

9.1 All handling, storage and installation safety precautions shall be as defined by the Safety Data Sheet (SDS) and other applicable documents provided by the material supplier.

9.2 SPF installers shall conform to all applicable state, local and federal government regulations and SPF industry best practices, including use of appropriate engineering controls and personal protective equipment during and shortly after SPF installation. All personnel inside the designated spray zone must wear proper personal protective equipment. Other trades must be kept outside of the spray zone until it is deemed safe to re-enter. Re-entry time should be clearly posted on warning signage at all entry points to the spray zone.

NOTE 5—Designated spray zone is a clearly-marked isolated volume that is properly ventilated during and shortly after SPF installation.

NOTE 6—The time to re-enter or re-occupy the spay zone should be specified by the SPF manufacturer. If this time is not provided by the manufacturer, the time to re-enter or re-occupy the spray zone shall be 24 h.

9.3 Prior to installation, SPF contractor shall review all safety requirements for SPF installation with building owner, general contractor and other trades.

10. Products

10.1 *Spray Polyurethane Foam*—The SPF contractor should procure and install the SPF products as specified in the construction documents, architectural specifications or contract.

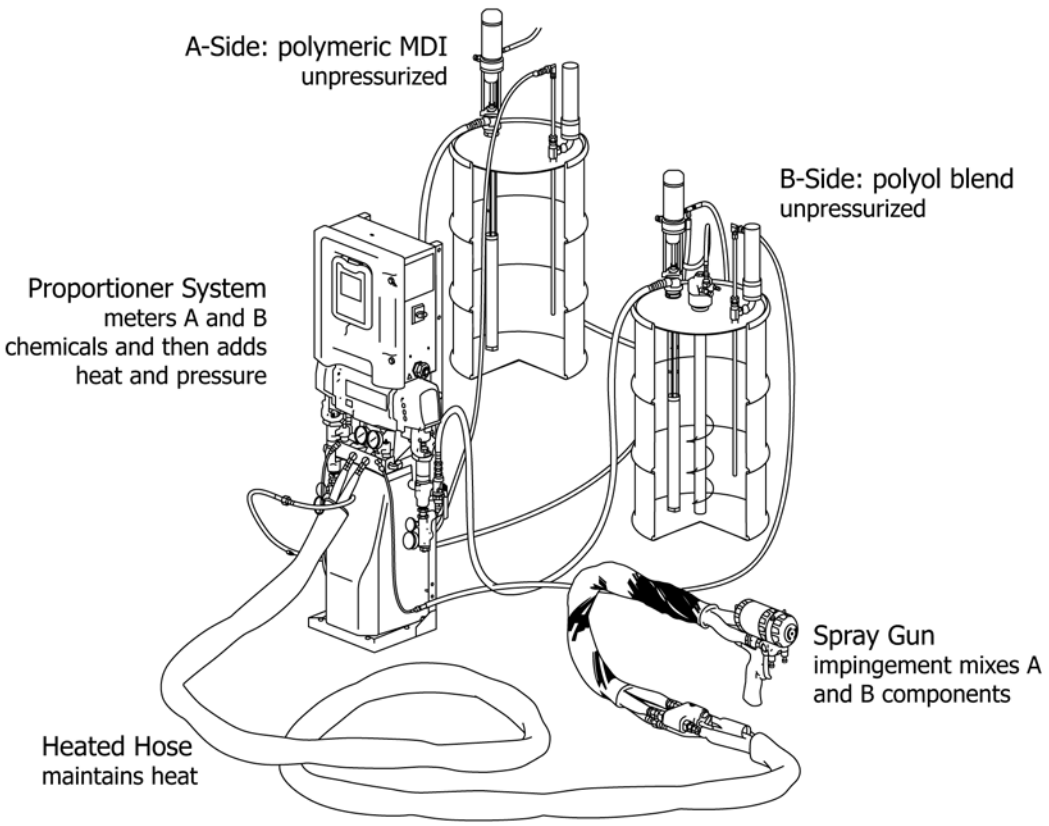

FIG. 1 Typical High-Pressure SPF Equipment

10.2 *Labeling and Marking:*

10.2.1 The SPF contractor should record the names all products and their manufacturers used, including lot or batch number, or both, and provide this information to the customer on the insulation installation certificate (see 12.3).

10.2.2 The SPF contractor should ensure all liquid components used for the SPF application are obtained from one manufacturer as a matched system, and they are within their shelf life, when applicable.

11. Protective Coverings

11.1 Depending on specific project requirements, a protective coating or covering may be needed over the exposed foam surfaces. For example, building codes may require fire protective coating or covering, or improved durability may require a UV-resistant polymeric coating. The selection and application of these materials is beyond the scope of this practice.

12. SPF Application Requirements

12.1 The SPF liquid components shall be processed in accordance with the MII for material temperature, pressure, equipment and spray gun configuration.

12.2 The SPF shall be installed according to the MII for temperature, humidity, and other environmental conditions.

12.3 *Closed Cell SPF:*

12.3.1 The closed-cell SPF lifts must be applied in a thickness of 12.5 mm (½ in.) or greater. Follow the foam MII regarding maximum lift thickness, as this may vary by product. Before installing another lift, the SPF should be allowed cool before a second lift is applied.

NOTE 7—Many manufacturers specify maximum lift thickness and cooling times between passes to avoid excessive exothermic temperatures during foam cure. Internal temperatures of the SPF can be measured with a thermometer or thermocouple. If a maximum pass thickness is not specified by the MII, use 38 mm (1.5 in.). If a cooling time between lifts is not specified by the MII, wait until the exposed foam surface is within 5°C (9°F) of ambient temperature before a second lift is applied.

12.3.2 The SPF should be installed in successive lifts until the specified total thickness is achieved.

12.4 *Open Cell SPF*—Open cell SPF may be installed in one or more lifts as recommended by the SPF manufacturer.

12.5 Before application of any coating or covering, the SPF shall be inspected.

13. Inspection

13.1 Procedures for the inspection and approval of the SPF insulation system should be determined by the owner and contractor prior to installation and such details should be included in the contract.

13.2 Inspection parameters may include:

- foam surface texture
- adhesion of the SPF to the substrate
- cohesion of the SPF
- density
- total thickness
- lift thickness
- SPF defects or anomalies
- adhesion of the thermal or ignition barrier, or both, to the SPF
- thickness of the thermal or ignition barrier, or both, to the SPF
- thermal/ignition barrier defects or anomalies

13.3 The total installed thickness of SPF is typically limited or specified for each assembly on any given project. An example procedure for SPF thickness measurement is provided in Appendix X2. SPF contractors should provide their customer with a report documenting the thickness, type, brand and lot number of SPF used, along with a description of any vapor retarder or fire protective coatings that may have been applied. SPFA-148 provides an example of a report containing this information.

14. Sampling

14.1 If specified, one core sample should be obtained from each representative building assembly.

NOTE 8—Consider a core sample per every 15 m^2 (160 ft^2).

14.2 Core samples should be a minimum of 37.5 mm (2 in.) in diameter or length and width and extend to the substrate. Appendix X1 defines a suggested tool and a procedure for core sampling.

14.3 If specified, core samples can be used to determine SPF thickness, lift thickness, compressive strength, density, cell structure (Test Method D6226) and adhesion (Test Method D4541).

14.4 Holes left by removal of the core samples should be repaired with specified material compatible with the SPF.

15. Keywords

15.1 best practices; inspection; insulation installation; SPF; SPF equipment; spray polyurethane foam; substrate preparation

APPENDIXES

(Nonmandatory Information)

X1. CORING TOOL DIAGRAM AND PROCEDURE

X1.1 Diagram

X1.1.1 See Fig. X1.1.

X1.2 Procedure

X1.2.1 Ensure the cutting edge of the coring tool is sharpened to a knife-edge. Serrated edges or other roughness may damage the side surfaces of the foam core that could hide the visual characteristics of the foam's cross-sectional profile.

X1.2.2 Place the coring tool perpendicular to the foam, with the knife edge in contact. Using the handle, apply moderate pressure and rotate the coring tool to cut the foam.

X1.2.3 Complete the cutting procedure until the knife edge makes contact with the substrate.

X1.2.4 Remove coring tool from the foam.

X1.2.5 Remove the foam core. If the foam core is difficult to extract, use a knife to cut away the adjacent foam and using a prying tool to help remove the core.

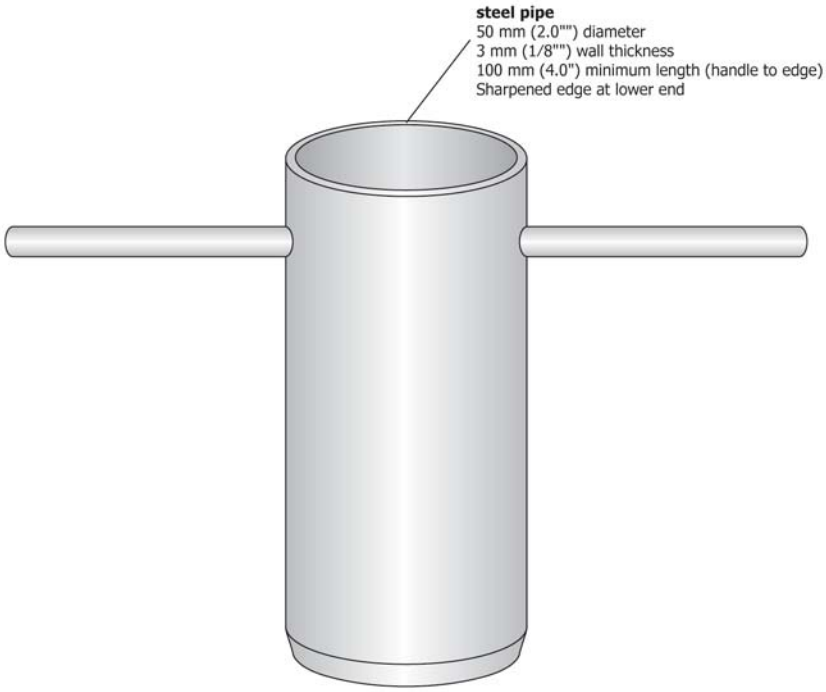

FIG. X1.1 Coring Tool

X2. METHOD OF DETERMINATION OF DECLARED INSTALLED INSULATION THICKNESS

X2.1 Tools

X2.1.1 SPF thickness is generally determined by using a thin probe inserted into the foam until contact is made with the substrate. Some devices have integral measuring scales which may limit the maximum depth to be measured. An improvised wire probe along with a ruler may also be used.

X2.1.2 A highly-undulating foam surface may make representative measurements challenging; a probe with or without a disk may need to be used. An example of probe with a disk is shown in Fig. X2.1. If using an improvised wire probe, take thickness measurements at a variety of high and low locations. Note in the inspection report the surface profile characteristics.

X2.2 Procedure

X2.2.1 Insert the probe into the foam until contact is made with the substrate.

X2.2.2 If a wire and disk probe is used, gently make contact with the exposed surface of the foam. If a disk is not used, mark top surface of the foam on the probe.

X2.2.3 Remove the probe and measure the depth of the foam to the nearest 5 mm (0.25 in.).

X2.3 Frequency

X2.3.1 The frequency of thickness testing, as well as thickness averaging and pass-fail criteria should be mutually agreed upon by the inspector and client prior to conducting any inspection. Certain building code jurisdictions may have specific requirements. As a general idea for inspections addressing the overall quality of an SPF project, see Table X2.1 below. These are not job specific so adjust as needed to suit the size of the project and needs and requirements of the building owner. EN 14315-2:2013 also provides a suggested thickness measurement frequency.

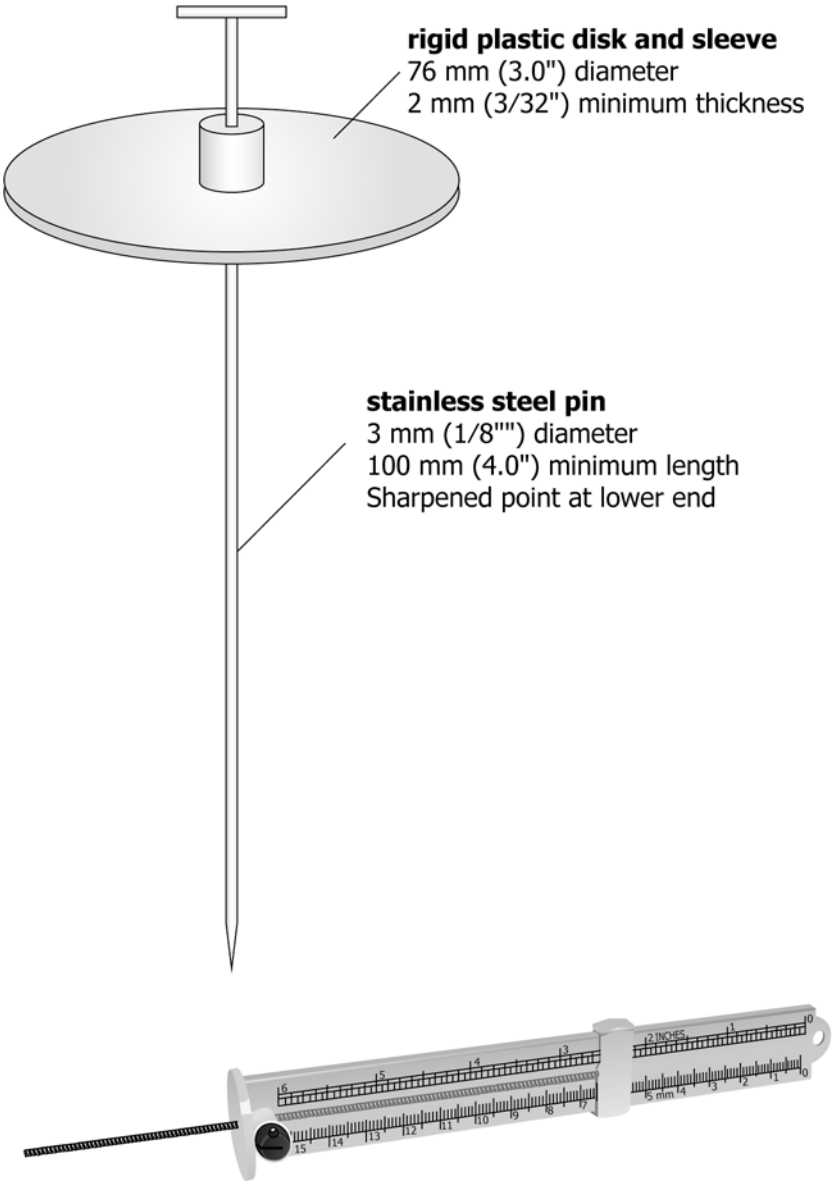

FIG. X2.1 Depth Gauge

TABLE X2.1 Suggested Thickness Measurement Frequency

Project Size	Area Assemblies	Lineal Assemblies (rim joists, etc.)	Minimum Number per Assembly Type	Minimum Number per Project
Small <1000 m^2 (<10 000 ft^2)	1 per 10 m^2 (1 per 100 ft^2)	1 per 3 m (1 per 10 ft)	6	25
Small >1000 m^2 (>10 000 ft^2)	1 per 50 m^2 (1 per 500 ft^2)	1 per 3 m (1 per 10 ft)	6	25