



ICBO Evaluation Service, Inc.

A subsidiary corporation of the International Conference of Building Officials

5360 WORKMAN MILL ROAD

• WHITTIER, CALIFORNIA 90601-2299

• (562) 699-0543
FAX (562) 695-4694

ACCEPTANCE CRITERIA FOR FOAM PLASTIC INSULATION APPLIED DIRECTLY TO STEEL DECKS

AC142

April 1999

(Effective April 9, 1999)
Previously Issued September 1998

PREFACE

Evaluation reports issued by ICBO Evaluation Service, Inc. (ICBO ES), are based upon performance features of the *Uniform Building Code*[™], *ICBO Uniform Mechanical Code*[™] and related codes. Section 104.2.8 of the *Uniform Building Code* is the primary charging section upon which evaluation reports are issued. Section 104.2.8 reads as follows:

The provisions of this code are not intended to prevent the use of any material, alternate design or method of construction not specifically prescribed by this code, provided any alternate has been approved and its use authorized by the building official.

The building official may approve any such alternate, provided the building official finds that the proposed design is satisfactory and complies with the provisions of this code and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in suitability, strength, effectiveness, fire resistance, durability, safety and sanitation.

The building official shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made regarding its use. The details of any action granting approval of an alternate shall be recorded and entered in the files of the code enforcement agency.

The attached acceptance criteria has been issued to provide all interested parties with guidelines on implementing performance features of the codes. The criteria was developed and adopted following public hearings conducted by the Evaluation Committee and is effective on the date shown above. All reports issued or reissued on or after the effective date must comply with this criteria, while reports issued prior to this date may be in compliance with this criteria or with the previous edition. If the criteria is an updated version from a previous edition, solid vertical lines (■) in the outer margin within the criteria indicate a technical change or addition from the previous edition. Deletion indicators (◆) are provided in the outer margins where a paragraph or item has been deleted if the deletion resulted from a technical change. This criteria may be further revised as the need dictates.

ICBO ES may consider alternate criteria, provided the proponent submits valid data demonstrating that the alternate criteria are at least equivalent to the attached criteria and otherwise meet the applicable performance requirements of the codes. Notwithstanding that a material, type or method of construction, or equipment, meets the attached acceptance criteria, or that it can be demonstrated that valid alternate criteria are equivalent and otherwise meet the applicable performance requirements of the codes, if the material, product, system or equipment is such that either unusual care in its installation or use must be exercised for satisfactory performance, or malfunctioning is apt to cause unreasonable property damage or personal injury or sickness relative to the benefits to be achieved by the use thereof, ICBO ES retains the right to refuse to issue or renew an evaluation report.

Published by

ICBO Evaluation Service, Inc.

5360 WORKMAN MILL ROAD • WHITTIER, CALIFORNIA 90601-2298

Copyright © 1999

ACCEPTANCE CRITERIA FOR FOAM PLASTIC INSULATION APPLIED DIRECTLY TO STEEL DECKS

1.0 SCOPE

The purpose of this acceptance criteria is to establish an alternate test method to the test requirements referenced in Section 2602.5.3 of the *Uniform Building Code*[™] (UBC) for foam plastic insulation applied directly to steel roof-deck assemblies. This acceptance criteria specifies the test requirements and conditions of acceptance for a large-scale fire test of steel roof-deck assemblies insulated with foam-plastic insulation exposed to the fire-exposure condition represented in the standard time-temperature curve specified in UBC Standard 7-1.

The foam plastic insulation, which is a part of a Class A, B or C roof-covering assembly, is not required to meet the requirements of Sections 2602.2, 2602.3 and 2602.4 of the 1997 UBC, provided the assembly with the foam plastic insulation satisfactorily passes a test for insulated roof decks. It is the intent of this acceptance criteria that the testing establish acceptable performance of the assembly during the period of exposure, and is not to be construed as having determined suitability for its use after fire exposure.

2.0 FIRE-EXTINGUISHING SYSTEM

For roof-covering assemblies recognized under this acceptance criteria, a wet-pipe automatic fire-extinguishing system complying with Chapter 9 of the UBC shall be installed.

3.0 DEFINITIONS

3.1 Allowable Extent of Flaming Droplets: When tested in accordance with this criteria, the allowable extent of flaming droplets is the observed, maximum extent of flaming droplets occurring in the test of a baseline assembly.

3.2 Baseline Test Assembly: The test assembly for which recognition is sought, except that a code-complying thermal barrier, such as 1/2-inch-thick (12.7 mm) regular gypsum wall-board, is to be installed between the steel roof decking and the foam plastic insulation.

3.3 Test Assembly: The test assembly consists of the steel decking material, the foam plastic insulation, and the roof-covering material. The combination of these materials shall provide a Class A, B or C roofing classification.

3.4 Foam Plastic Insulation: Foam plastic insulation is a plastic, for thermal insulating purposes, that is intentionally expanded by the use of a foaming agent to produce a reduced-density plastic containing spherical voids and consisting of interconnected cells distributed throughout the plastic. It has a density of less than 20 pounds per cubic foot (320 kg/m³).

4.0 REQUIRED DATA

4.1 Testing Laboratories: Testing laboratories shall comply with the ICBO ES Acceptance Criteria for Laboratory Accreditation (AC89).

4.2 Reports of Tests and Product Sampling: Test reports and product sampling shall comply with the ICBO ES Acceptance Criteria for Test Reports and Product Sampling (AC85).

5.0 TEST APPARATUS

5.1 Fire Test Structure:

5.1.1 The fire test structure is to consist of a rectangular building with interior dimensions of 20 feet (6096 mm) (width) by 100 feet (30 480 mm) (length) by 10 feet (3048 mm) (height), with one 20-foot (6096 mm) side left open. The closed end is designated the fire end, and the open end is designated the flue end. The walls, for the first 40 feet (12 192 mm) from the fire end, shall be constructed with nominal 8-inch-by-8-inch-by-16-inch concrete block complying with

ASTM C 90. The remainder of the walls shall be constructed with either a continuation of the concrete block, or with structural steel framing covered with inorganic fiber cement or calcium silicate board having a minimum 46-pound-per-cubic-foot (736 kg/m³) density and a minimum 1/2-inch (12.7 mm) thickness, fastened in a manner to ensure it remains in place during the 30-minute test. The fire-end wall and the first 40 feet (12 192 mm) of each side wall shall be protected on the interior by a minimum 1-inch-thick (25.4 mm) layer of spray-applied or hand-trowelled fire-protection material, which shall be fully cured and shall remain in place for the 30-minute duration of the test. The floor of the test structure shall be concrete, crushed stone, or packed soil with a 2-inch (51 mm) layer of sand or a 0.5-inch (12.7 mm) layer of fiberglass-faced gypsum board. See Figure 1 for a plan view of the test structure.

5.1.2 The flue end of the structure shall have a breaching wall located transversely to the test structure and positioned 4.5 feet ± 0.5 foot (1372 mm ± 152 mm) outward from the flue end. The height of the breaching wall shall not exceed the height of the roof structure by more than 3 feet (914 mm). The flue end of the test structure shall also be further enclosed by extending the 100-foot (30 480 mm) sides of the structure to connect to the breaching wall. The entire overhead space within this extension beyond the end of the structure shall remain open to permit exhausting of combustion products.

5.1.3 Observation ports shall be provided in both 100-foot (30 480 mm) walls for their entire length, and shall not be spaced more than 10 feet (3048 mm) on center. The ports shall be a maximum of 1.5 square feet (0.139 m²) in size, and shall be of sufficient dimensions and located at such an elevation that all underdeck and floor areas across the entire width and length of the test structure are visible from one or both sides.

5.2 Roof Deck Construction:

5.2.1 Structural I-beams are permitted to be used to support the steel roof deck construction. The beams shall be maximum M 12×11.8 I-beams, spaced 6 feet 8 inches (2032 mm) on center. Beams smaller in size and mass than the M 12×11.8 I-beams, or bar joists, are permitted to be used, provided the spacing of the beams or joists in the fire test structure is maintained at 6 feet 8 inches (2032 mm) on center. The steel deck shall be 36-inch-wide (914 mm) Type B decking having a No. 22 gage [0.030-inch (0.76 mm) base metal] thickness and 1 1/2-inch (38 mm) depth. Sidelap overlap shall be as shown in Figure 6. The sidelap of the steel decking shall be fastened with TEK No. 1 (or equivalent) screws at a maximum spacing of 40 inches (1016 mm) on center. The steel decking shall be fastened to the I-beams (or bar joists) with TEK No. 5 screws (or equivalent) at a maximum spacing of 12 inches (305 mm) on center.

5.2.2 Other types of roof deck construction shall be constructed with structural support, decking, and roof covering systems representative of the construction under evaluation.

5.3 Test Assembly:

5.3.1 The test assembly shall be representative, as to materials and components, of the construction for which recognition in an ICBO ES or NES evaluation report is sought.

5.3.2 The roof covering materials shall have perimeter terminations and flashing construction that are representative of standard practice as recommended by the roof covering material manufacturer.

5.3.3 The space between the parapet wall and the metal deck shall be filled with mineral wool insulation, to minimize migration of combustion materials.

5.4 Baseline Test Assembly:

5.4.1 The baseline test assembly shall be identical to the test assembly for which recognition in an ICBO ES or NES evaluation report is sought, except that it shall also include a code-complying thermal barrier, such as $1/2$ -inch-thick (12.7 mm) regular gypsum wallboard, placed between the metal roof decking and the foam plastic insulation.

5.4.2 The roof covering materials shall have perimeter terminations and flashing construction that are representative of standard practice as recommended by the roof covering material manufacturer.

5.4.3 The space between the parapet wall and the metal deck shall be filled with mineral wool insulation, to minimize migration of combustion materials.

5.5 Burners:

5.5.1 The exposure fire is produced by two nozzles atomizing heptane. Flow to each nozzle shall be monitored and balanced so that equal amounts of fuel are being delivered. The combined fuel rate delivered to the two nozzles is as shown in the following table:

TABLE 1—COMBINED FUEL FLOW RATES

TEST TIME (minutes)	FUEL RATE (gallons per minute)
0 to 2	1.0
2 to 4	1.5
4 to 7	2.0
7 to 17	2.5
17 to 30	2.7

For SI: 1 gallon/minute = 3.785 L/minute.

5.5.2 Air for combustion shall be furnished by a blower located outside the test structure. An air supply totaling 4,700 to 5,500 cubic feet per minute (133 to 156 m³/min) is delivered, by four ducts, through the wall at the fire-end of the test structure. Two ducts are located with their centerlines 5 feet (1524 mm) above the floor of the structure, and these ducts discharge air to the two nozzles that are positioned in front of the ducts. The other two ducts are located with their centerlines 2 feet (610 mm) above the floor of the structure. Dampers shall be provided in the blower system so as to equalize the air being discharged through each duct. The blower and ignition details are shown in Figure 2.

5.6 Instrumentation:

5.6.1 The temperature of the exposure fire shall be monitored separately by six No. 14 gage chromel-alumel (Type K) thermocouples, located 12 inches (305 mm) below the roof deck. These thermocouples shall be located within Inconel pipes and shall be supported by concrete pylons. See Figure 3 for details on the thermocouple assembly and Figure 4 for details on their location.

5.6.2 Temperature measurements shall be obtained using Type K (20-24 gage) thermocouples at the following locations (see Figure 4 for details):

5.6.2.1 Nine inches (229 mm) below the roof deck and a maximum of 6 inches (152 mm) to either side of the exposed edge of the steel deck sidelap joints (for air temperatures).

5.6.2.2 Thirty-six inches (914 mm) below the roof deck (for exit air temperatures).

5.6.3 The flow rate of heptane to each nozzle shall be monitored and recorded.

5.6.4 All temperature data shall be recorded at intervals not to exceed 30 seconds.

5.7 Documentation:

5.7.1 Photographs that can be developed to obtain color slides or photographic prints (35 mm film) shall be taken during construction of the test assembly, and during the post-test, which includes dissection of the test assembly.

5.7.2 Color video tape recording shall be done of the fire within the structure, from the flue-end perspective. Additionally, color video tape recording of the top surface shall be done throughout the test. A clock or timer depicting "real time" shall be included in all videos. The time may be integral to the video camera, or a clock or timer may be used, provided it can be clearly viewed throughout the test.

6.0 TEST PROCEDURE

6.1 Conduct of Test: The following test procedure shall be used:

6.1.1 Instrumentation on the completed test structure and test assembly shall be verified for operation.

6.1.2 The roof surface shall be covered or otherwise protected from inclement weather before testing. The ambient air temperature at the beginning of the test shall be between 40°F and 90°F (4.4°C and 32°C). The relative humidity shall be between 20 and 80 percent. The air flow across the roof surface of the test assembly shall be less than 1,050 feet per minute (19.32 km/h) as determined by an anemometer positioned in the direction of the prevailing wind. The velocity and direction of the prevailing wind shall not restrict fire spread across the roof surface of the structure.

6.1.3 Video recording and data collection shall begin one minute before the ignition of the heptane burner.

6.1.4 Two $3/8$ -inch (9.5 mm) LP gas pilot nozzles shall be used to ignite the heptane initially and to provide a continuous source of ignition. See Figure 2 for details. Alternatively, the test may be started by other means, such as heptane-soaked fabric used to ignite the atomized heptane once the pumps are started. Once the heptane burners are ignited, combustion shall be sustained following the flow regimen specified in Table 1.

6.1.5 Visual observations of all underdeck flame fronts, flaming droplets and top-side flaming shall be recorded, including time of occurrence and location within the structure (as viewed from both sides, the flue-end and the top surface), throughout the entire 30-minute test.

6.2 Time of Testing: The testing time-period shall begin with the ignition of the heptane burners and shall be continued for 30 minutes, after which the heptane fuel supply shall be shut off.

6.3 Post-test Observation: The interior and exterior of the roof-deck construction and test assembly shall be photographed, and visual observations shall be made and recorded.

7.0 CONDITIONS OF ACCEPTANCE

7.1 The maximum extension of the steady flame front within the structure, resulting from underdeck flaming, shall not reach 60 feet (18 288 mm) from the fire-end during the 30-minute test period. The flame front can be considered to be any point having a thermocouple registering a temperature of 980°F (527°C) or higher on the underside of the steel deck for three consecutive readings.

7.2 The extension of intermittent underdeck flaming, tips of flaming along deck seams, and flaming dissociated from the main flame front within the structure shall not reach 72 feet (21 946 mm) from the fire-end, as determined by visual observation, during the 30-minute test period.

7.3 Flaming droplets from the test assembly shall not extend beyond the allowable extent of flaming droplets, as defined in Section 3.1 of this acceptance criteria.

7.4 Post-test examination of the test assembly shall show that combustive damage (burning and charring) to the roof surface has diminished at increased distances from the fire-end of the test structure. Additionally, thermal degradation (damage in the form of charring and loss of integrity) shall not extend throughout all test-assembly components at the flue-end of the structure.

8.0 REPORT OF RESULTS

8.1 Test Report: Test reports shall comply with the ICBO ES Acceptance Criteria for Test Reports and Product Sampling (AC85), and must include the following:

8.1.1 Drawings showing structural design of the roof deck construction; plan, elevation and principal cross-sections; and other sections, as needed, for clarity.

8.1.2 Description of the component materials of the test assembly and the baseline test assembly, and their placement within the assembly. The description shall be accompanied by drawings that include plan, elevation, and principal cross-sectional views, and other drawings, as needed, for clarity. The description shall also identify the foam plastic specifications and manner of installation.

8.1.3 Ambient conditions at the start of the fire test, including measured wind speed and direction in relation to the test structure.

8.1.4 Location of all thermocouples.

8.1.5 The individual and average time-temperature data for the six fire-control thermocouple assemblies. This data shall be superimposed on the standard time-temperature curve shown in UBC Standard 7-1, which observes the following temperatures at the following times: 1,000°F (538°C) at 5 minutes; 1,300°F (704°C) at 10 minutes; and 1,550°F (843°C) at 30 minutes.

8.1.6 Recorded time-temperature data for each thermocouple within the roof-deck construction.

8.1.7 Record of visual observations of all flaming, including time of occurrence and location within the structure (as viewed from both sides, the flue-end and the top surface), throughout the entire 30-minute test.

8.1.8 Photographic and video documentation of the assembly, taken before, during, and after testing.

8.1.9 A statement of compliance with, or of specific points of deviation from, test standards.

8.2 Analysis of Performance: The test report shall provide an analysis of the performance of the test assembly with respect to each of the conditions of acceptance specified in Section 7.0. The test report shall also provide an analysis of the performance of the test assembly and baseline assembly with respect to the conditions of acceptance specified in Section 7.3.

9.0 QUALITY CONTROL AND PRODUCT IDENTIFICATION

9.1 Quality Control Program: Foam plastic products shall be manufactured under a quality control program administered by a quality control agency accredited by ICBO ES or recognized by the NES. A quality control manual, developed in consultation with the approved agency, and complying with the ICBO ES Acceptance Criteria for Quality Control Manuals (AC10), shall be submitted.

9.2 Quality Control Details: Details of the quality control program administered by the quality control agency shall be specified in the quality control manual, and shall comply with the requirements for quality control specified in the ICBO ES Acceptance Criteria for Foam Plastic Insulation (AC12).

9.3 Labeling and Identification:

9.3.1 Packages and containers of foam plastic insulation delivered to the jobsite shall bear the label of an agency accredited by ICBO ES or recognized by the NES, and shall include the manufacturer's name and product identification.

9.3.2 The wording "When used in re-roofing applications, limits exist for coverboard and membrane. See ICBO ES Evaluation Report ER-xxxx before re-roofing" and the words "THIS SIDE UP" shall be printed on, or included on a permanent label affixed to, one face of each insulation board.

9.3.3 Permanent placards bearing the following words shall be attached to roof hatches and where other roof accesses are located:

This roof covering includes foam plastic insulation applied directly to a steel deck. The existing roofing membrane and cover boards must be removed before re-roofing. Limits also exist for coverboards and membranes. See ICBO ES Evaluation Report ER-xxxx before re-roofing.

See Figure 5 for an illustration of a suggested placard.

10.0 EVALUATION REPORT RECOGNITION

The evaluation report shall include the following:

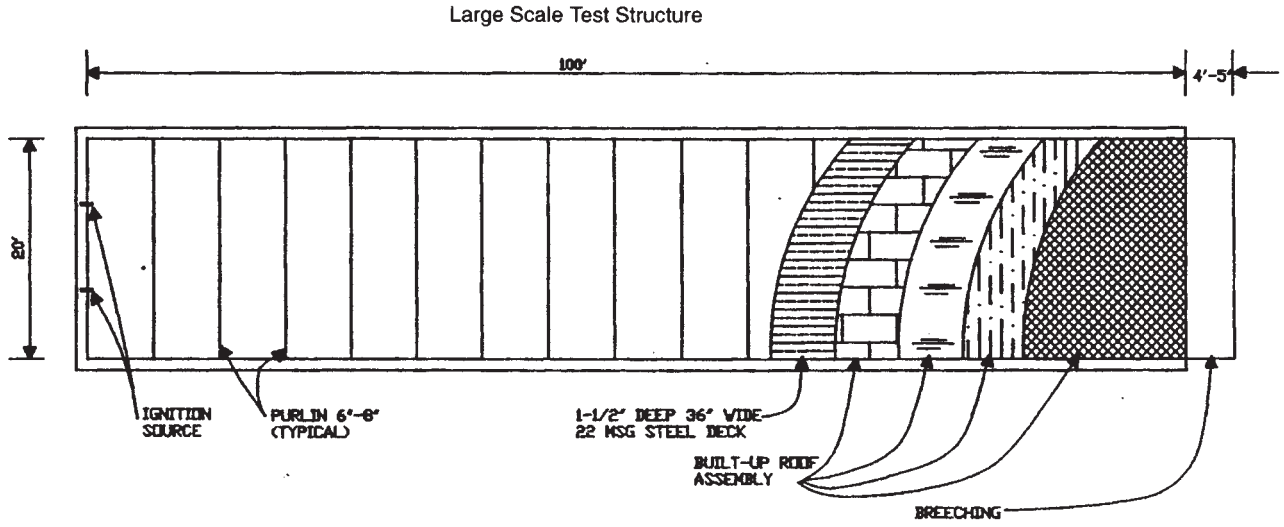
10.1 The foam plastic insulation's maximum thickness and density.

10.2 A statement indicating that the foam plastic insulation complies with Section 2602.5.3 of the *Uniform Building Code* when the foam plastic insulation is part of a Class A, B or C roof-covering assembly, provided the assembly with the foam plastic insulation satisfactorily passes the test for insulated roof decks that is specified in this acceptance criteria.

10.3 The name of the foam plastic insulation manufacturer, and manufacturing locations.

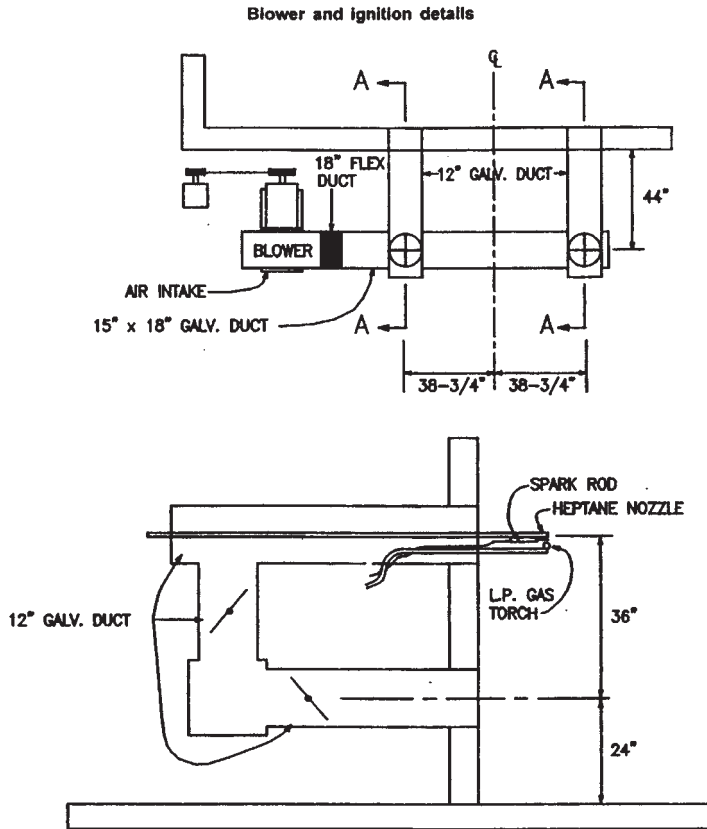
10.4 Labeling requirements for the foam plastic insulation in accordance with Section 9.3 of this acceptance criteria.

10.5 Sprinkler requirements in accordance with Section 2.0 of this acceptance criteria.



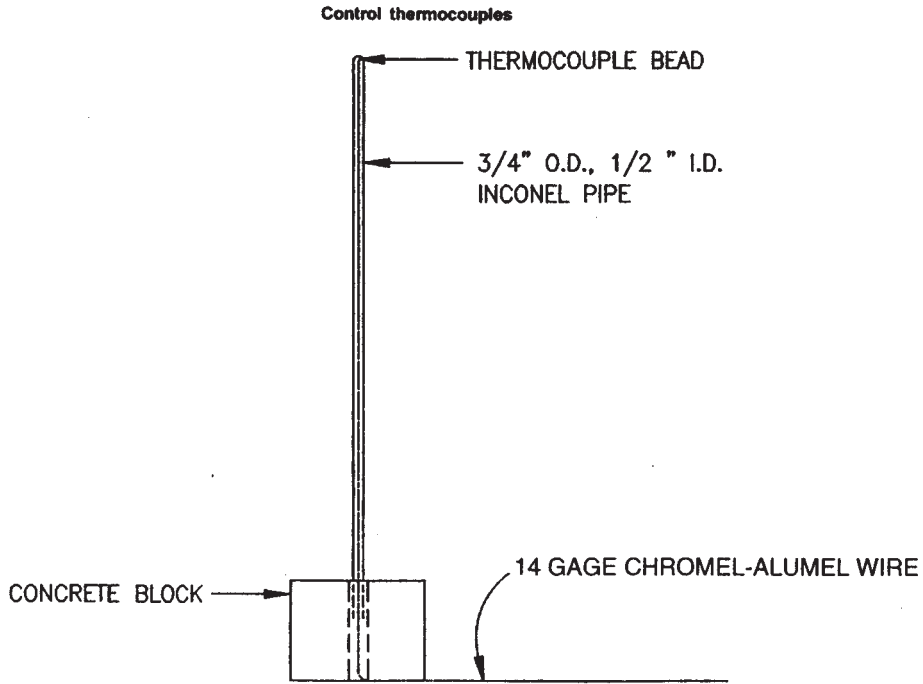
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE 1



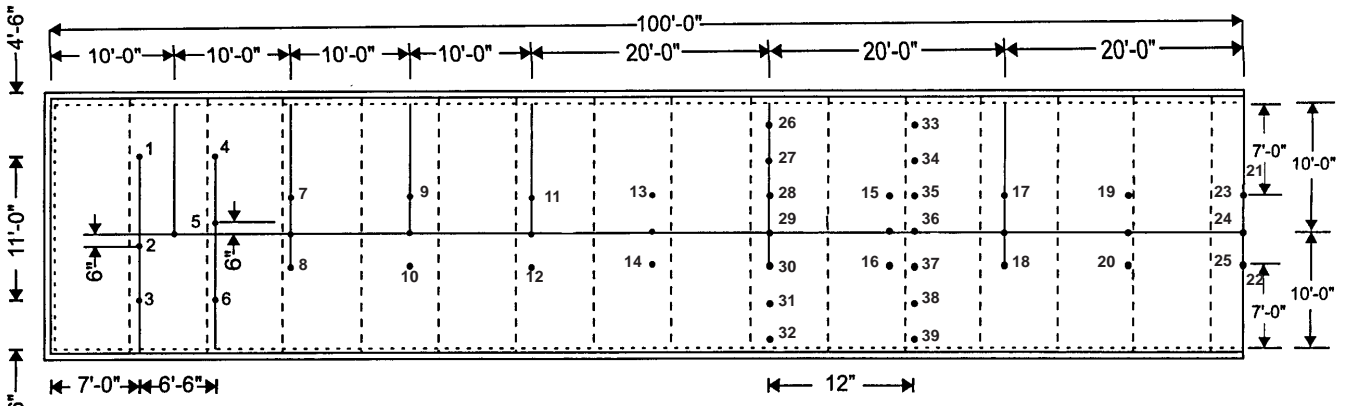
For SI: 1 inch = 25.4 mm.

FIGURE 2



For SI: 1 inch = 25.4 mm.

FIGURE 3



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

Thermocouple Nos.	Location
1-6	In air 1'-0" below steel roof deck (fire control)
7-22	In air 9" below steel roof deck
23, 24, 25	In air 3'-0" below steel roof deck
26-39	In air, 9" below roof deck, each TC centered under individual roof panels

FIGURE 4—THERMOCOUPLE LOCATIONS

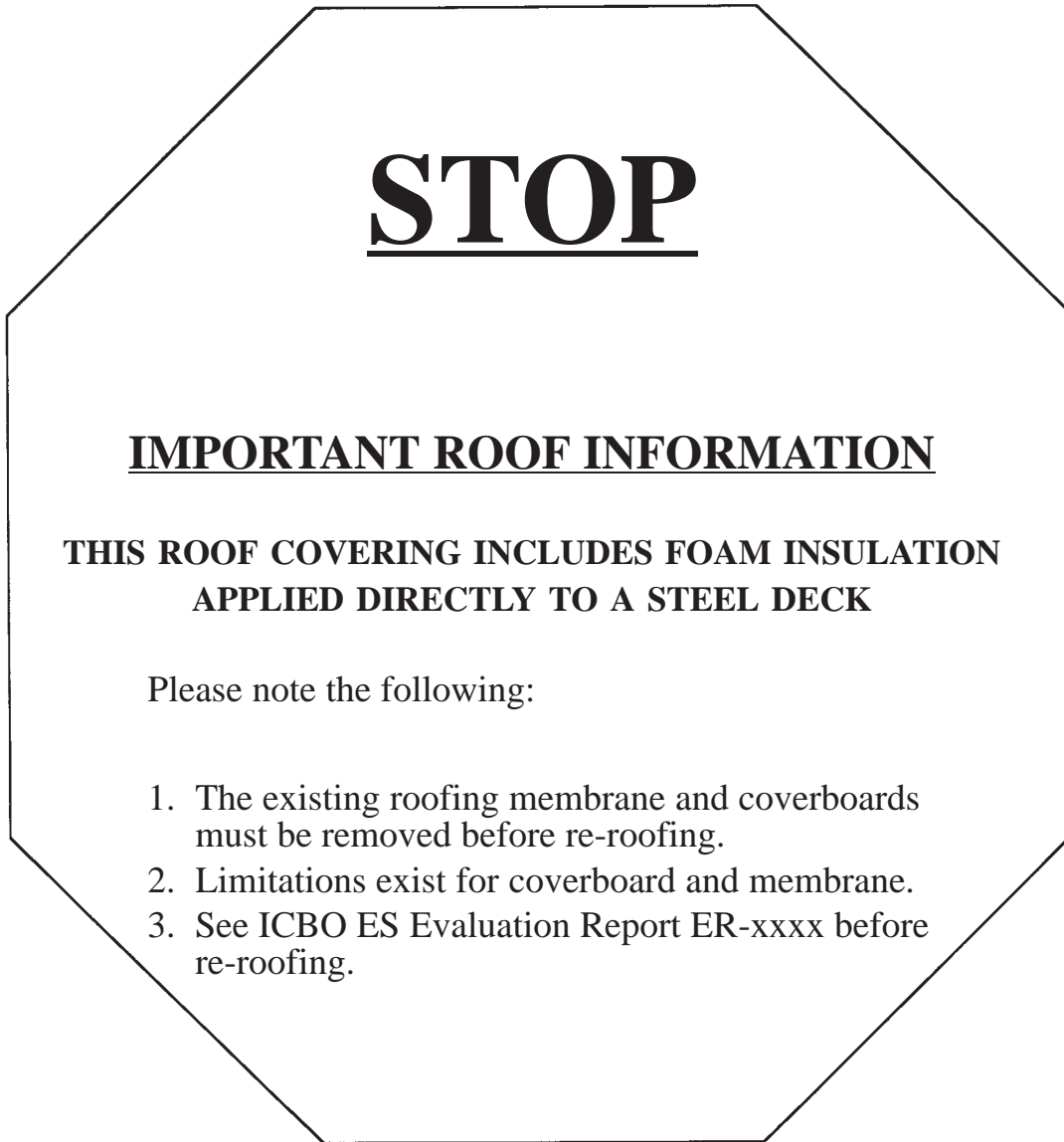


FIGURE 5—PLACARD DETAILS

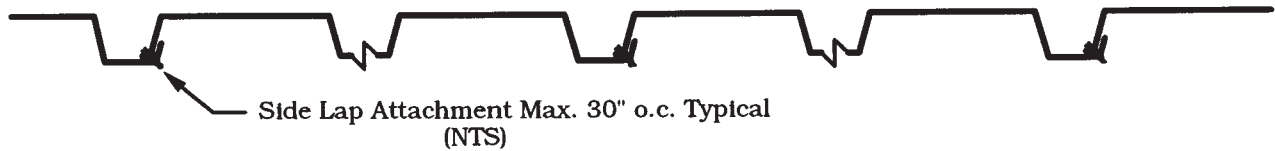


FIGURE 6—ROOF DECK SIDE LAP DETAILS