UL 2221

Underwriters Laboratories Inc.

Standard for Safety

Tests of Fire Resistive Grease Duct Enclosure Assemblies

UL Standard for Safety for Tests of Fire Resistive Grease Duct Enclosure Assemblies, UL 2221

Second Edition, Dated August 13, 2010

Summary of Topics

This New Edition of UL 2221 includes editorial revisions such as reference updates, re-organization of sections, renumbering, and pagination. These revisions are considered to be non-substantive and not subject to UL's STP process.

The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

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UL 2221

Standard for Tests of Fire Resistive Grease Duct Enclosure Assemblies

First Edition – September, 2001

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August 13, 2010

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at http://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These tests are intended to determine the fire resistance of grease duct enclosure assemblies. These requirements limit the combustibility, the surface flammability, and the smoke generation potential of the coverings used to enclose the grease duct. In addition, these requirements evaluate the effectiveness of the combination of the grease duct and the enclosure as a fire rated enclosure system and through penetration firestop system, as well as the enclosure's effect on the grease duct.

1.2 The fire endurance ratings for grease duct enclosure assemblies are intended to register performance during the period of fire exposure and are not intended to be interpreted as having determined the acceptability of the grease duct assembly for use before or after fire exposure. The intent of these methods is to develop data to assist others in determining the suitability of the grease duct assembly where fire resistance is required.

1.3 These requirements are intended to evaluate the ability of grease duct enclosure assemblies specified in 1.1 to contain an internal fire or repel an external fire during predetermined test exposures. The test evaluates the grease duct assembly's resistance to fire, heat, and to a hose stream.

1.4 Requirements covering the construction and performance requirements of proprietary grease ducts are contained in the Standard for Grease Ducts, UL 1978. All ducts, both proprietary and non-proprietary, shall comply with installation requirements of the Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, NFPA 96, and the International Mechanical Code.

1.5 Under these requirements a grease duct enclosure assembly is subjected to standard internal and external fire exposures controlled to achieve specified temperatures throughout a specified time period.

1.6 During the internal fire exposure, one of two installation condition methods shall be selected to measure temperatures near or on the surface of the grease duct enclosure material away from the grease duct. One method of temperature measurement is intended for all installations except for installations within non-ventilated combustible enclosures. The second method of temperature measurement is intended for installations within non-ventilated combustible enclosures.

1.7 These exposures by themselves are not intended to be representative of all fire conditions; conditions vary with changes in the amount, nature, and distribution of fire loading, ventilation, compartment size and configuration, and heat sink characteristics of the compartment.

1.8 These requirements cover the measurement of the transmission of heat through the grease duct assembly and the passage of heat and gases hot enough to ignite cotton waste.

1.9 These requirements provide a relative measure of fire performance under these specified fire exposure conditions. Any variation from the construction or conditions that are tested, such as method of assembly and materials, is not within the scope of this test method.

1.10 The results of these tests represent one factor in assessing fire performance of grease duct assemblies. These requirements prescribe standard fire exposures for assessing the performance of grease duct assemblies. Application of these test results to predict the performance of actual building construction requires careful evaluation of test data.

2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3 Undated References

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

4 Glossary

4.1 For the purpose of these requirements, the following definitions apply.

4.2 FIRESTOP – Materials, including the grease duct, that fill the opening where the grease duct passes through the supporting construction.

4.3 GREASE DUCT – The duct shall:

a) Be constructed of steel not less than 0.055 inch (1.40 mm) in thickness, or

b) Be constructed of stainless steel not less than 0.044 inch (1.12 mm) in thickness, or

c) Comply with the requirements of the Standard for Grease Ducts, UL 1978.

The duct shall comply with requirements of nationally recognized standards and codes such as the Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, NFPA 96, and the International Mechanical Code.

4.4 GREASE DUCT ENCLOSURE MATERIALS – The insulating materials surrounding the grease duct assembly. The grease duct enclosure materials also include adhesives, encapsulating materials, facers, fasteners, and banding required to secure the insulating materials in place.

4.5 SUPPORTING CONSTRUCTION – A floor slab that seals the top of the furnace from which the grease duct assembly is suspended.

4.6 TEST ASSEMBLY – The combination of the test specimen and the supporting construction.

4.7 TEST SPECIMEN – An enclosed grease duct and, when the grease duct is suspended from the supporting construction, the firestop.

4.8 UNEXPOSED SURFACE – The surface of the test specimen exposed to ambient air.

PERFORMANCE

MATERIAL REQUIREMENTS

5 Surface Burning Characteristics

5.1 Test method

5.1.1 The grease duct enclosure materials including adhesives, encapsulating materials, and facers shall be evaluated in accordance with the Standard for Test for Surface Burning Characteristics of Building Materials, UL 723. (The requirements contained in UL 723 are also in the Standard Method of Test of Surface Burning Characteristics of Building Materials, NFPA 255, and the Standard Test Method for Surface Burning Characteristics of Building Materials, ASTM E84).

5.2 Performance criteria

5.2.1 The grease duct enclosure materials shall have a flame spread value of 25 or less.

5.2.2 The grease duct enclosure materials shall have a smoke developed value of 50 or less.

6 Serviceability

6.1 General

6.1.1 The serviceability of the insulating material used in the grease duct enclosure is to be determined by tests conducted in accordance with the Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, ASTM C411, and the Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, ASTM C518.

6.2 Hot-surface performance

6.2.1 The grease duct insulation system including adhesives, encapsulating materials, and facers shall be subjected to a service temperature in accordance with the Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, ASTM C411. The service temperature shall be the temperature on the face of the grease duct enclosure material nearest the grease duct when equilibrium, as described in 8.6.1, is obtained during the internal fire test. The service temperature shall not exceed 500°F (260°C) nor shall the ASTM C411 test temperature fall below 250°F (121°C) as specified in Paragraph 604.3 of the International Mechanical Code.

6.2.2 The grease duct enclosure materials shall not flame, glow, smolder or smoke.

6.3 Steady-state thermal transmission properties

6.3.1 Test method

6.3.1.1 Eight samples of the insulation material used in the grease duct enclosure are required.

6.3.1.2 The thickness of the samples is to be that of a single layer of insulation material used to construct the test specimens for the internal and external fire tests.

6.3.1.3 All samples are to be conditioned for a minimum of 24 hours at 75 ±5°F (23.8 ±2.7°C) at a relative humidity of 50 ±5 percent.

6.3.1.4 Four samples are to be placed vertically in a rack with a space between each sample ranging from 3/8 inch to 3/4 inch (from 9 mm to 19 mm). The rack is to be placed in an air circulating oven preheated to 500 ±5°F (260 ±2.7°C) for a minimum 12-hour period. The oven is shut off and the samples allowed to cool at 75 ±5°F (23.8 ±2.7°C) for a minimum 12-hour period. This cycle is to be repeated 10 times. After the tenth cycle, the samples are to be removed from the oven and allowed to cool for an additional minimum 12-hour period.

6.3.2 Performance criteria

6.3.2.1 When tested in accordance with the Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus, ASTM C518, the average change in thermal conductivity of the four samples placed in the oven shall not be greater than 10 percent of the average thermal conductivity of the four samples not placed in the oven. The oven shall be maintained at a temperature equal to the temperature on the face of the grease duct enclosure materials nearest the grease duct when equilibrium, as described in 8.6.1, is obtained during the internal fire test. The oven temperature shall not be greater than 500°F (260°C).

7 Noncombustibility

7.1 Test method

7.1.1 Insulation materials without surface adhesives, encapsulating materials, and facers shall be evaluated in accordance with the Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C, ASTM E136.

7.2 Performance criteria

7.2.1 The insulation materials shall meet the requirements of ASTM E136 for noncombustibility.

ASSEMBLY REQUIREMENTS

8 Internal Fire Test

8.1 General

8.1.1 One of two installation conditions is simulated during the internal fire test. Condition A represents all installation conditions except for installations within non-ventilated combustible enclosures which are represented by Condition B.

8.1.2 The test specimen is to be tested within an area having ventilation capable of maintaining the buildup of carbon monoxide to less than 50 parts per million throughout the period of any test. The area is to be free of extraneous drafts. The temperature of the test specimen is to be between 50 and 90°F (10 and 32°C) at the beginning of the tests. The room is to be constructed so that during any one test the room temperature does not increase by more than 40°F (23°C) above the room temperature recorded at the beginning of the test.

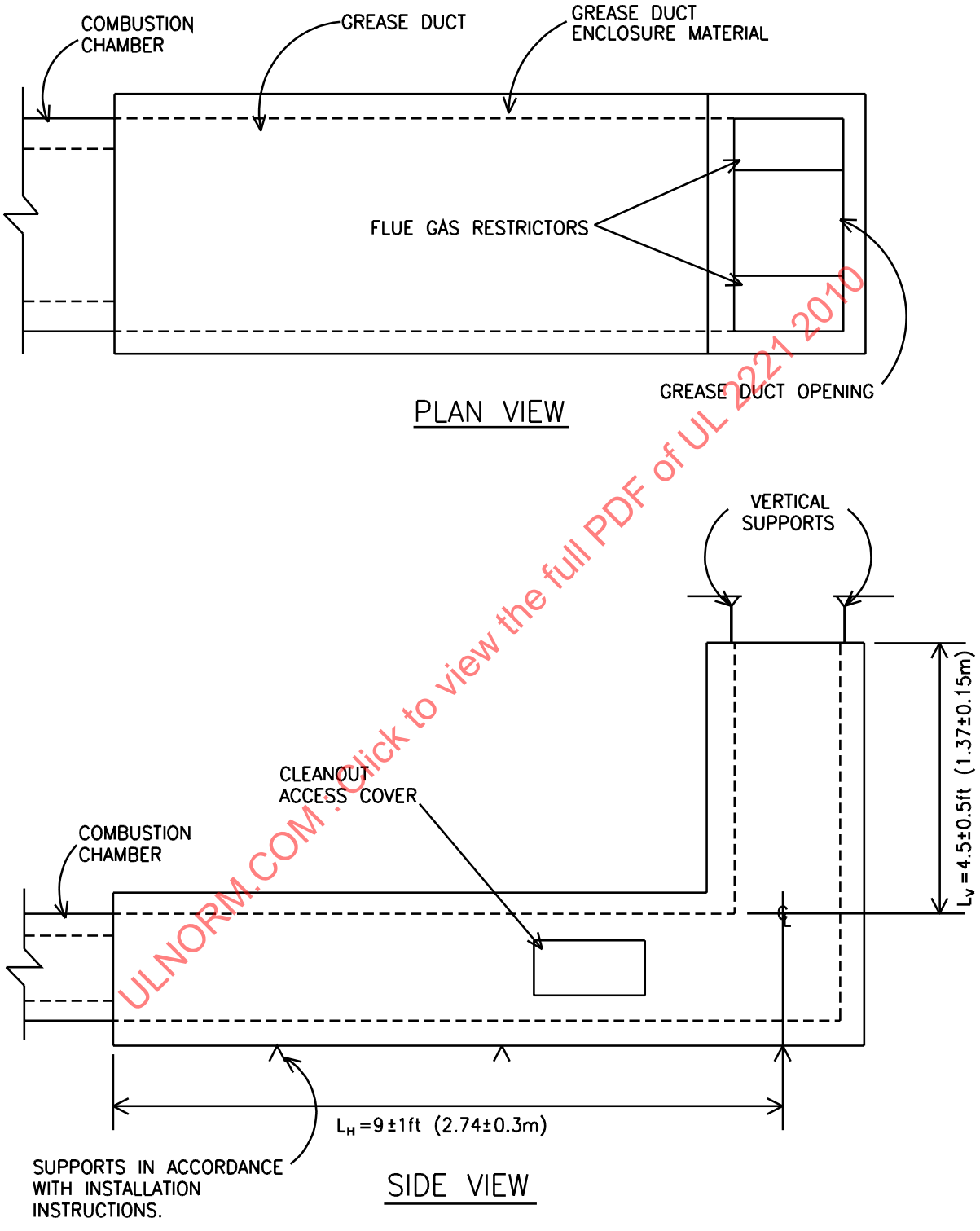
8.1.3 The room temperatures are to be determined by a shielded thermocouple located centrally within a vertically oriented 6-inch (152 mm) length of aluminum painted 2-inch diameter (50.8 mm) steel pipe open at both ends. The shielded thermocouple is to be located 24 ±2 inches (610 ±51 mm) from the vertical unexposed surface nearest the thermocouple grid used to measure the internal duct temperature. The elevation of the thermocouple is to be within 1 inch (25 mm) of the centerline of the horizontal portion of the test sample.

8.2 Test specimen

8.2.1 The test specimen is to consist of a grease duct constructed of steel, not less than 0.055-inch (1.40-mm) thick, or stainless steel, not less than 0.044-inch (1.12-mm) thick, with liquid tight welded or brazed joints or seams and the bracing and supports in accordance with the specifications of the International Mechanical Code, NFPA 96, or comply with the requirements of the Standard for Grease Ducts, UL 1978. The grease duct is to be representative of the largest cross-sectional area and maximum width-to-height ratio to be used.

8.2.2 The horizontal section of the grease duct is to be 9 ±1 feet (2.74 ±0.3m) long and the vertical section 4.5 ±0.5 feet (1.37 ±0.15 m) in length. The horizontal section of the grease duct is to include supports at maximum spacing, at least one access opening, and at least two joints, as shown in Figure 8.1. The weight of the grease duct on the supports is to represent the maximum load to be applied on the grease duct enclosure materials. The grease duct is to include all fittings for which special methods of insulation are required.

Figure 8.1
Grease duct assembly



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8.2.3 The test specimen is to be representative of the complete duct assembly, including insulation. Insulation systems are to be installed in accordance with the manufacturer's installation instructions.

8.2.4 Prior to the test, the test specimen is to be representative of the condition that does exist in similar construction in buildings. The condition is to be established by storage in air having 50 percent relative humidity at 73°F (23°C). When conditioning to this level is not possible, the test is to be conducted when the dampest portion of the test specimen has achieved an equilibrium moisture content corresponding to drying in air having 50 to 75 percent relative humidity at 73 ±5°F (23 ±3°C).

Exception: These requirements are not required when:

a) An equilibrium condition is not achieved within a 12-month conditioning period, or

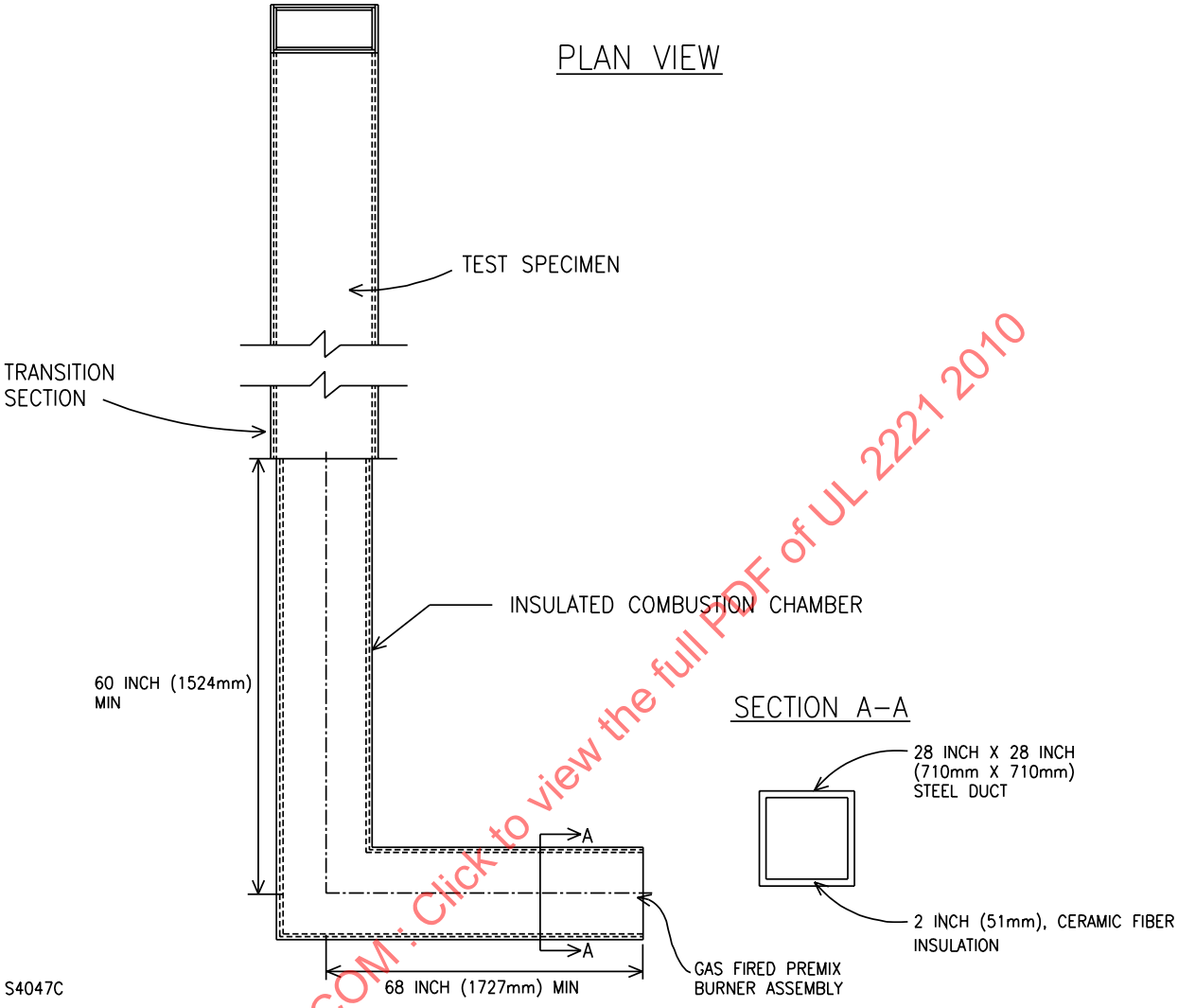
b) The construction is such that drying of the interior of the test specimen is prevented by hermetic sealing of the construction materials.

8.3 Temperature exposure

8.3.1 A gas fired premix burner assembly is to be used to supply flue gases to the test specimen.

8.3.2 The burner assembly is to be placed at the inlet of an insulated combustion chamber assembly, as illustrated in Figure 8.2.

Figure 8.2
Insulated combustion chamber assembly



8.3.3 The minimum total length of the insulated combustion chamber is to be 150 inches (3810 mm).

8.3.4 Combustion is to be complete within the combustion chamber assembly. The insulated combustion chamber assembly is to be connected to the grease duct by means of bolted or clamped flanges. The flanges are to be welded to the combustion chamber and to the grease duct. A flow restrictor, at the outlet of the grease duct, is to be used to adjust the flow rate of the flue gases to assist in obtaining the required temperatures within the grease duct.

8.4 Temperature measurements

8.4.1 Flue gas temperatures are to be determined by a thermocouple grid as illustrated in Figure 8.3. The thermocouples are to be located within the grease duct as illustrated in Figure 8.4. The thermocouples are to be No. 18 gauge, Type K or Type S inconel sheathed thermocouples with tips projecting 1/2 ±1/16 inch (25.4 ±1.5 mm) from the inner ends of the support tubes or an ungrounded thermocouple with a 1.0-mm outside diameter sheath having maximum No. 24 gauge, Type K lead wires.

Figure 8.3
Thermocouple locations flue gas temperatures

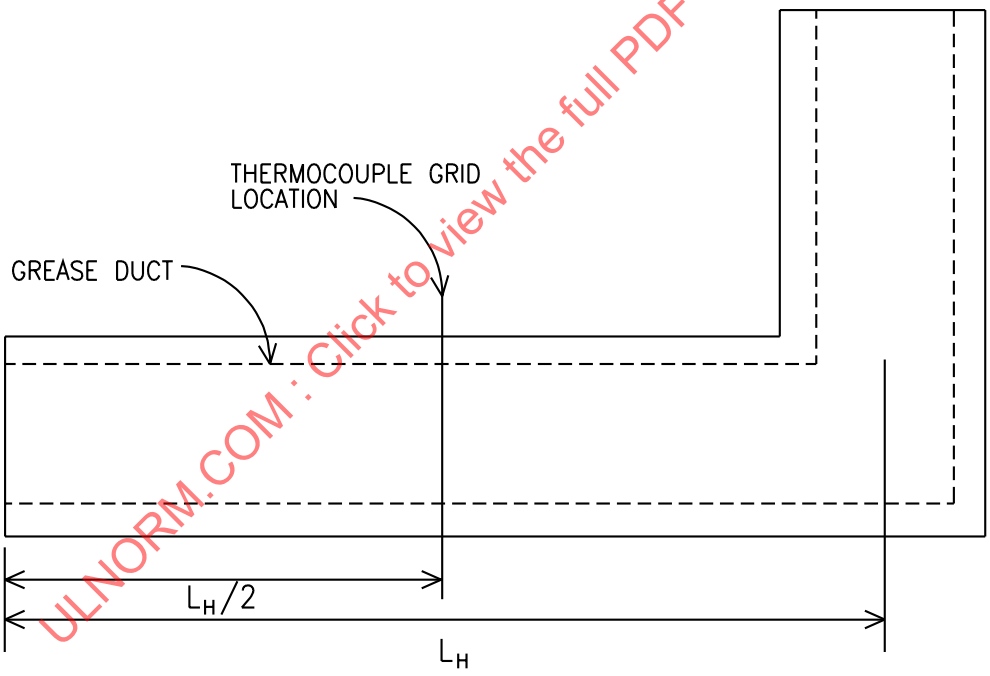


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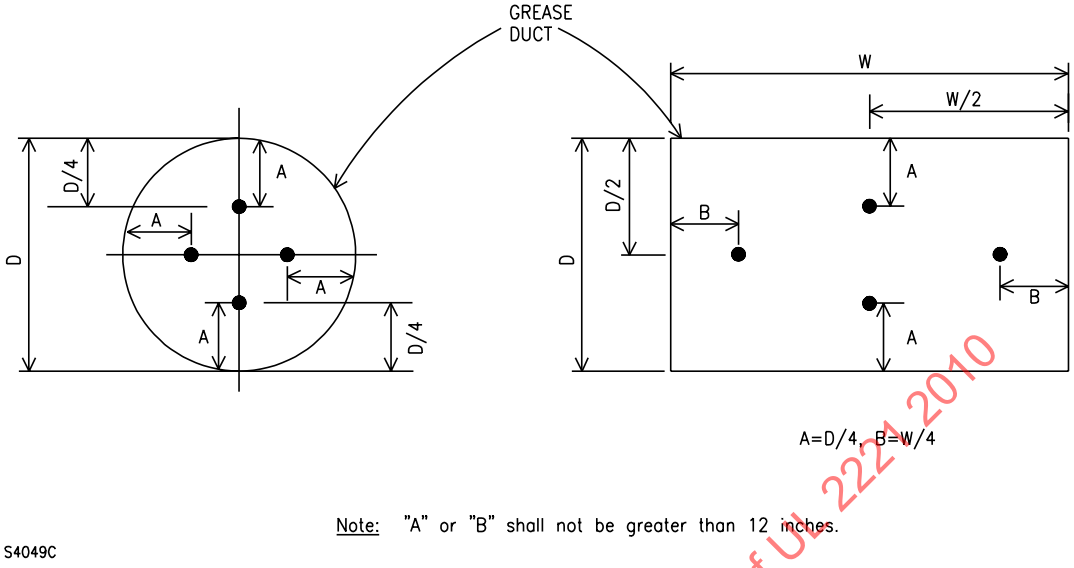
Figure 8.4
Thermocouple locations flue gas temperatures



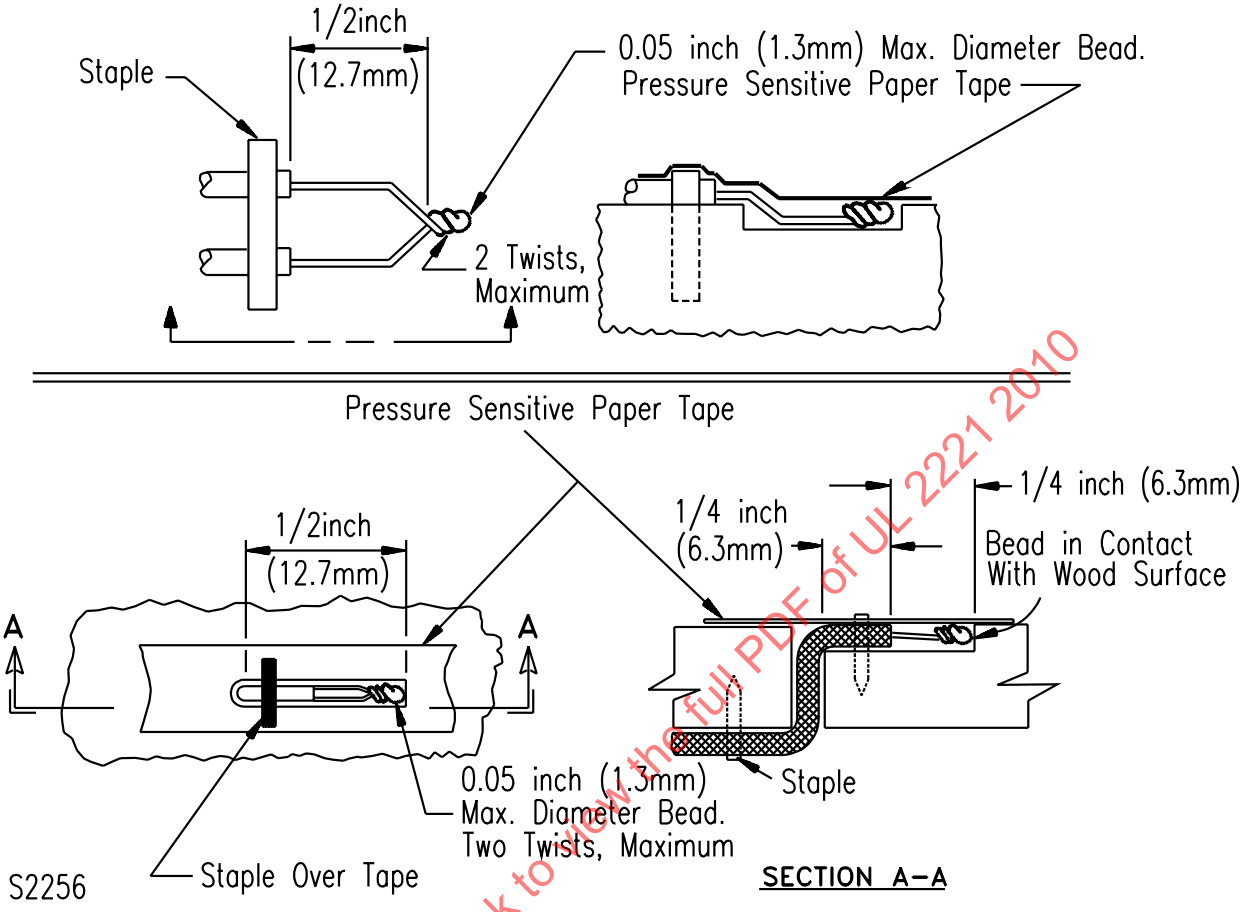
Four thermocouples located inside the grease duct to measure flue gas temperature at mid-length of grease duct assembly (see Figure 8.3).

8.4.2 Temperatures on the unexposed surfaces and temperatures within the non-ventilated combustible enclosure for Condition B are to be measured with Type K (chromel-alumel) thermocouples of 24 AWG (0.21 mm) wire. The wires are to be electrically insulated with heat- and moisture-resistant coverings capable of withstanding a minimum single point temperature of 600°F (315°C). The thermocouples not within the non-ventilated combustible enclosure are to be placed under flexible, dry, felted pads. The properties of these pads are to comply with the requirements specified in Requirements for Thermocouple Pads, Appendix B.

8.4.3 The wire leads of the thermocouple are to have an immersion under the pad and be in contact with the unexposed surface for not less than 3 inches (76 mm). The hot junction of the thermocouple is to be placed under the center of the pad. The pad is to be held firmly against the surface and is to fit closely about the thermocouple.

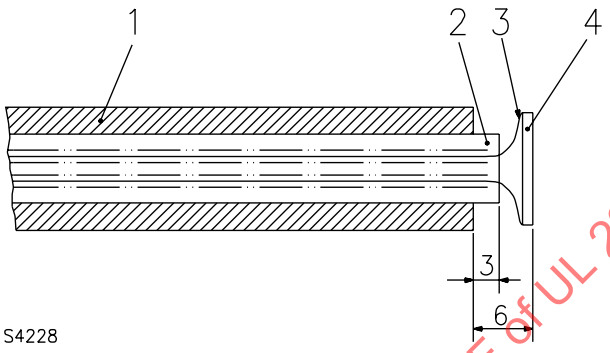
8.4.4 The thermocouples within the non-ventilated combustible enclosure are to be attached to the wood surfaces having a surface of the thermocouple adjacent to the grease duct enclosure material so as to have 1/2 inch (12.7 mm) of wire exposed. The thermocouple is to be secured to the wood surfaces by staples placed over the insulated portion of the wires. The thermocouple insulation and tip are to be depressed for a length of 1/2 inch (12.7 mm) into the wood so as to be flush with the wood surface at the point of measurement. The thermocouple is to be held in thermal contact with the surface at the point of measurement by the use of 1-inch (25.4-mm) wide high-temperature paper masking tape painted flat black after installation. See Figure 8.5.

Figure 8.5
Thermocouple installation methods on wood surfaces



8.4.5 Roving thermocouples are to be as shown in Figure 8.6. The measuring junction of the thermocouple is to consist of 1-mm diameter Type K thermocouple wire soldered or welded to a 12-mm diameter, 0.5-mm thick copper disc. The thermocouple assembly is to be provided with a handle so it can be applied over any point on the unexposed surface of the test specimen. The roving thermocouple is to be applied until temperature equilibrium is reached but is to be removed if a temperature of 300°F (149°C) is not recorded within 20 seconds.

Figure 8.6
Roving thermocouple assembly



Dimensions in millimeters.

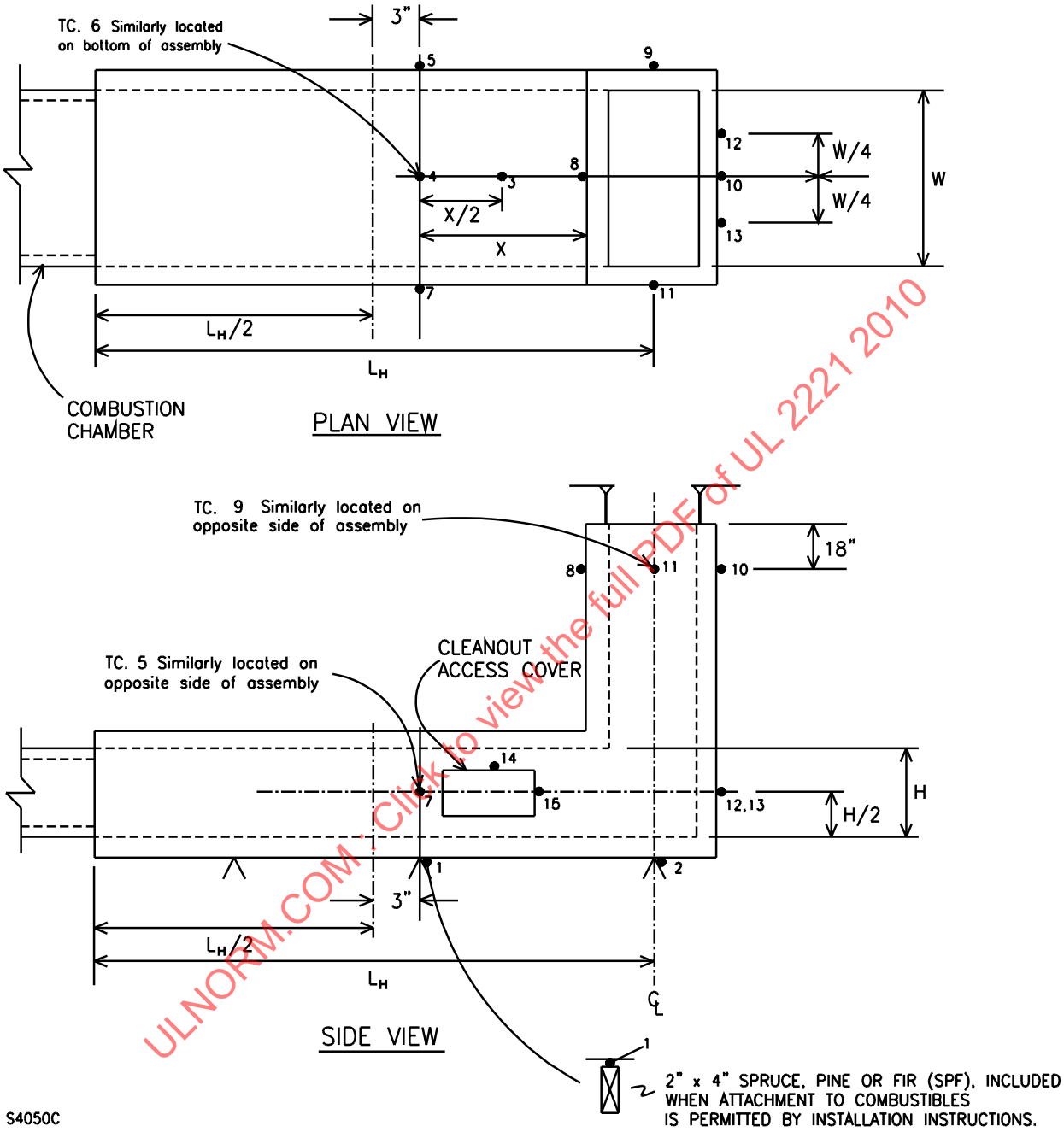
Key:

1) Heat-resistant steel support tube of 13-mm diameter
2) Twin-bore ceramic insulator of 8.0-mm diameter
3) Thermocouple wire of 1.0-mm diameter
4) Copper disc of 12-mm diameter and 0.5-mm thickness

8.4.6 For Condition A, temperature readings are to be taken at no less than fifteen points on the unexposed surface. Eight of these are to be symmetrically disposed, near the center of each side of the specimen, on the minimum thickness of protection material, on the horizontal and vertical elements of the protected duct, as shown in Figure 8.7. Two are to be placed around the edges of the cleanout access covers and two are to be placed on the assembly support system adjacent to the insulation surrounding the grease duct. The other thermocouples are to be located at the discretion of the testing body where it is anticipated maximum temperatures will occur to obtain representative information on the performance of the test specimen. These locations are to include vertical and horizontal joints in the grease duct enclosure materials.

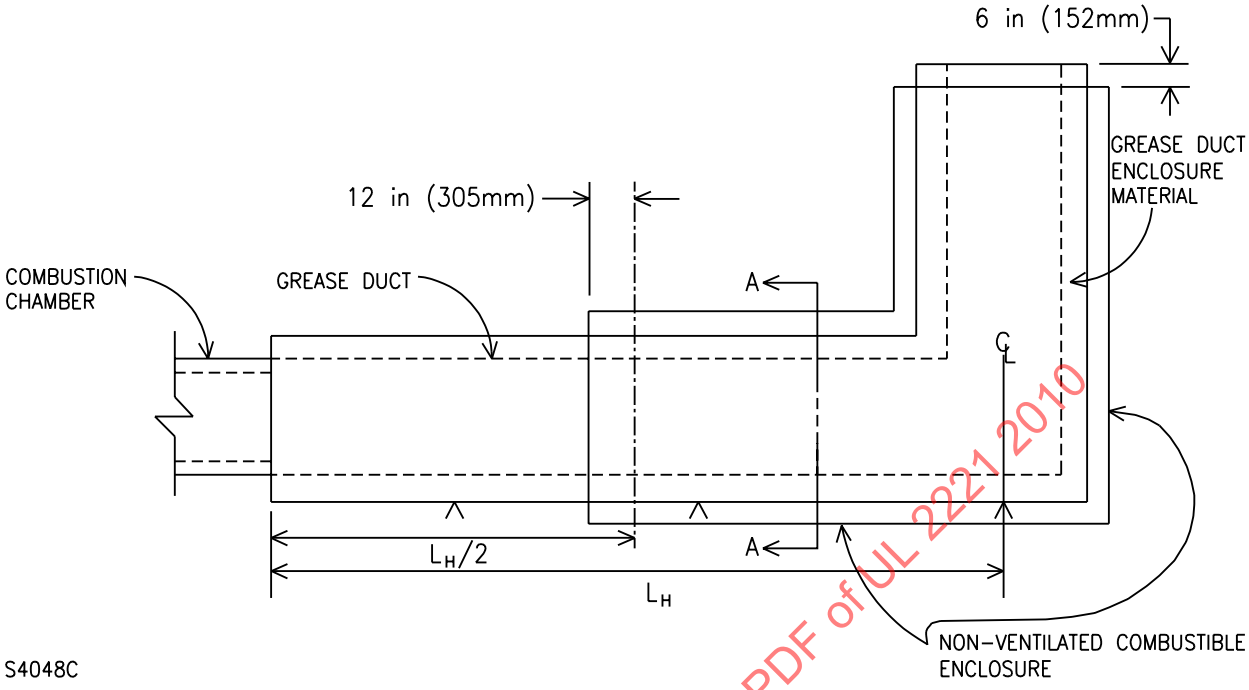
8.4.7 For Condition B, a plywood enclosure as described in Figure 8.8 shall be provided.

Figure 8.7
Unexposed surface thermocouple locations



NOTE: For Condition B, thermocouple numbers 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15 is to be secured to wood surface. See Figure 8.5.

Figure 8.8
Installation within non-ventilated combustible enclosures



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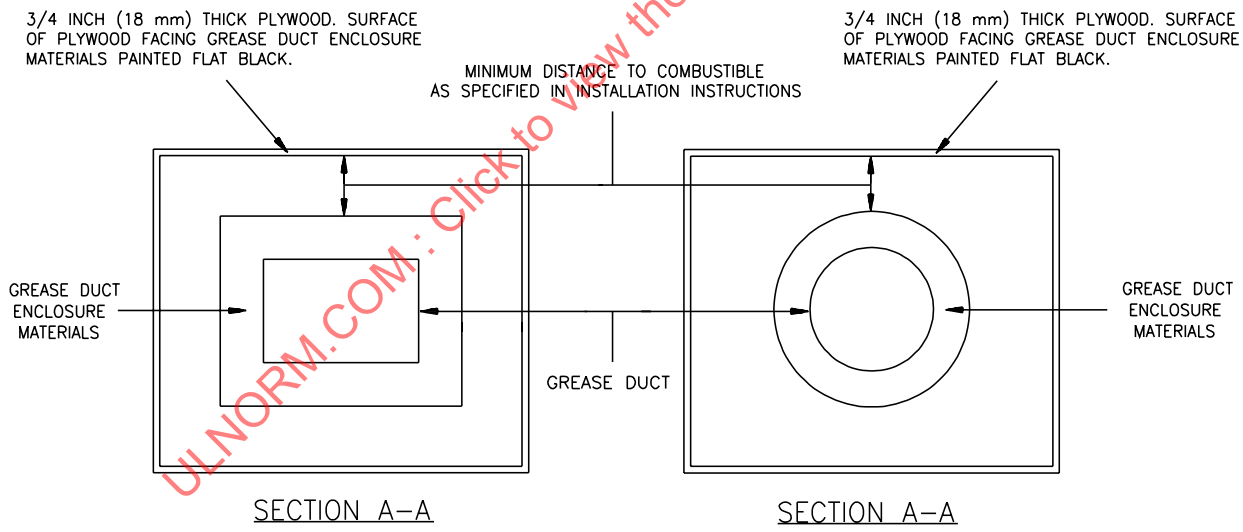

NOTE: ENDS OF PLYWOOD ENCLOSURE SEALED WITH NON-COMBUSTIBLE COMPRESSIBLE MATERIAL OF SUFFICIENT THICKNESS TO BE AT LEAST EQUAL TO THE THERMAL INSULATION RESISTANCE OF 3/4 INCH THICK PLYWOOD

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8.4.8 For Condition B, temperature readings are to be at no less than fourteen points within the enclosure as shown in Figure 8.7. Within the enclosure, the thermocouples are to be located at a distance equal to the clearance between the grease duct enclosure material and the combustibles. Two of the thermocouples are to be placed around the edges of the cleanout access covers and two are to be placed on the assembly support system adjacent to the insulation surrounding the grease duct. The other thermocouples are to be located at the discretion of the testing body where it is anticipated maximum temperatures will occur to obtain representative information on the performance of the test specimen. These locations are to include vertical and horizontal joints in the grease duct and in the grease duct enclosure materials.

8.4.9 Temperatures on the surface of the grease duct enclosure material nearest the grease duct are to be measured with 24 AWG, Type K thermocouples. The thermocouples are to be positioned beneath locations 4, 5, 6, and 7 as shown in Figure 8.7.

8.5 Integrity

8.5.1 The integrity of the test specimen is to be checked for passage of flame and hot gases using a cotton waste pad in a wire frame provided with a handle.

8.5.2 The nominal 4- by 4- by 3/4-inch (100- by 100- by 19-mm) cotton waste pads are to consist of new, undyed, and soft cotton fibers, without any admixture of artificial fibers, and each pad is to weigh 3 to 4 grams. The pads are to be conditioned prior to use by drying in an oven at 212 ±9°F (100 ±5°C) for at least 30 minutes. After drying, the pads are to be stored in a desiccator for up to 24 hours.

8.5.3 The frame used to hold the cotton waste pad is to be formed of 16 AWG (1.31 mm) steel wire and is to be provided with a handle long enough to reach all points of the test assembly.

8.5.4 The cotton waste pad is to be held directly over an observed crack or hole in the test specimen, 1 ±1/4 inches (25.4 ±6 mm) from the breached surface, for a period of 30 seconds. Small adjustments in the position of the cotton waste pad are not prohibited from being made when required to achieve the maximum effect from the hot gases.

8.5.5 When no ignition (defined as glowing or flaming) of the cotton waste pad occurs during the 30-second application, ″screening tests″ involving short duration applications of the cotton waste pad to areas of potential failure and/or the movement of a single pad over and around such areas are to be made. Charring of the pad provides an indication of imminent failure, and a previously unused cotton waste pad is to be employed in a prescribed manner for an integrity failure to be confirmed.

8.6 Conduct of fire test

8.6.1 The test is to be started with the grease duct and the test structure at room temperature. The gas fired premix burner is to be regulated to produce a minimum flue gas temperature of 430°F (239°C) above room temperature within 15 minutes, as determined by the thermocouple grid. The flow restrictor is to be adjusted so that the heat input is to be a minimum of 925 Btu/hr per square inch of the cross-sectional area of the grease duct. The test is to be continued until equilibrium temperatures are attained on the unexposed surfaces of the test specimen and, for Condition B, equilibrium temperatures are also attained within the non-ventilated enclosure. Equilibrium is determined when, after a minimum 4-hour exposure, two or more consecutive readings at 5-minute intervals show a temperature rise of no greater than 2°F (1.1°C).

8.6.2 Temperature data is to be recorded at maximum 5-minute intervals until temperature equilibrium is recorded on the unexposed surface. After equilibrium, the temperatures shall be recorded at intervals not exceeding 30 seconds.

8.6.3 After equilibrium temperatures are attained, the temperature of the flue gases entering the grease duct is to be increased to produce a minimum average flue gas temperature of 1930°F (1073°C) above initial room temperature within 15 minutes, as determined by the thermocouple grid. The flow restrictor is to be adjusted so that the heat input is to be a minimum of 4025 Btu/hr per square inch of the cross-sectional area of the grease duct. The minimum average flue gas temperature is to remain 1930°F (1073°C) above initial room temperature for a time period of 30 minutes. After the 30 minutes, the burner assembly is to be turned off.

8.6.4 For rectangular ducts, the cross-sectional area is to be modified when determining the minimum heat input specified in 8.6.1 and 8.6.3. For rectangular ducts, an equivalent diameter (D_E) is to be determined and the cross-sectional area (in square inches) would equal $3.14(D_E/2)^2$, where

$$D_E = 1.30(ab)^{0.625} / (a + b)^{0.25}$$

in which:

a = length of one side of the duct

b = length of adjacent side of the duct

8.6.5 After the burner is shut off, the temperatures are to be monitored at 5-minute intervals until a decrease in temperatures of the entire assembly is recorded.

8.7 Acceptance criteria

8.7.1 For Condition A, the test specimen shall comply with the following:

a) At or before the equilibrium temperature is reached, any temperature measured on the unexposed surface of the test specimen shall not exceed 115°F (64°C) above the initial starting temperature during exposure in accordance with 8.6.1.

b) At no time during the exposure to the flue gases shall the average temperature on the unexposed surface of the test specimen, as determined by thermocouple numbers 4, 5, 6, and 7, exceed 250°F (139°C) above the initial starting temperature, or any individual temperature exceed 325°F (181°C) above the initial starting temperature.

c) During the exposure to the flue gases at either test temperature and during the subsequent cool down period, cotton waste on the unexposed surface shall not ignite.

d) After the cool down period, the cross-sectional area of the grease duct shall not be reduced by more than 25% and there shall be any openings in the grease duct.

8.7.2 For Condition B, the test specimen shall comply with the following:

a) At or before the equilibrium temperature is reached during exposure in accordance with 8.6.1, any temperature measured on the non-ventilated combustible enclosure shall not exceed 90°F (50°C) above the initial starting temperature.

b) At no time during the exposure to the flue gases and subsequent cool down period shall the average temperature on the non-ventilated combustible enclosure, as determined by thermocouple numbers 4, 5, 6, and 7, exceed 250°F (139°C) above the initial starting temperature, or any individual temperature exceed 325°F (181°C) above the initial starting temperature.

c) During the exposure to the flue gases at either test temperature and during the subsequent cool down period, cotton waste on the unexposed surface shall not ignite.

d) After the cool down period, the cross-sectional area of the grease duct shall not be reduced by more than 25% and there shall not be any openings in the grease duct.

9 External Fire Tests, General

9.1 Conditioning

9.1.1 Prior to fire testing, the test assembly is to be representative of the condition that does exist in similar construction in buildings. The supporting construction is permitted to be conditioned independently of the test specimen. The condition is to be established by storage in air having 50 percent relative humidity at 73°F (23°C). When conditioning to this level is not possible, the test is to be conducted when the dampest portion of the test assembly has achieved an equilibrium moisture content corresponding to drying in air having 50 to 75 percent relative humidity at 73 ±5°F (23 ±3°C).

Exception: These requirements are not required when:

a) An equilibrium condition is not achieved within a 12-month conditioning period, or

b) The construction is such that drying of the interior of the test assembly is prevented by hermetic sealing of the construction materials.

In these cases, the conditioning is required to be continued only until the supporting construction has developed strength to retain the test specimen securely in position.

9.1.2 The relative humidity within hardened concrete shall be determined with a method that uses an electric sensing element.

9.2 Furnace control

9.2.1 The construction details of the test furnace are to include fuel burners, gas exhaust, observation ports, and devices for monitoring and controlling the furnace conditions. The furnace is to be equipped with an adequate number of burners arranged in such a way as to provide uniform fire exposure of the test specimen.

9.2.2 The temperature in the test furnace shall follow the standard time-temperature curve shown in Figure 9.1. The points on the curve that determine its character are:

50 to 90°F (10 to 32°C) at 0 minutes

1000°F (538°C) at 5 minutes

1300°F (704°C) at 10 minutes

1550°F (843°C) at 30 minutes

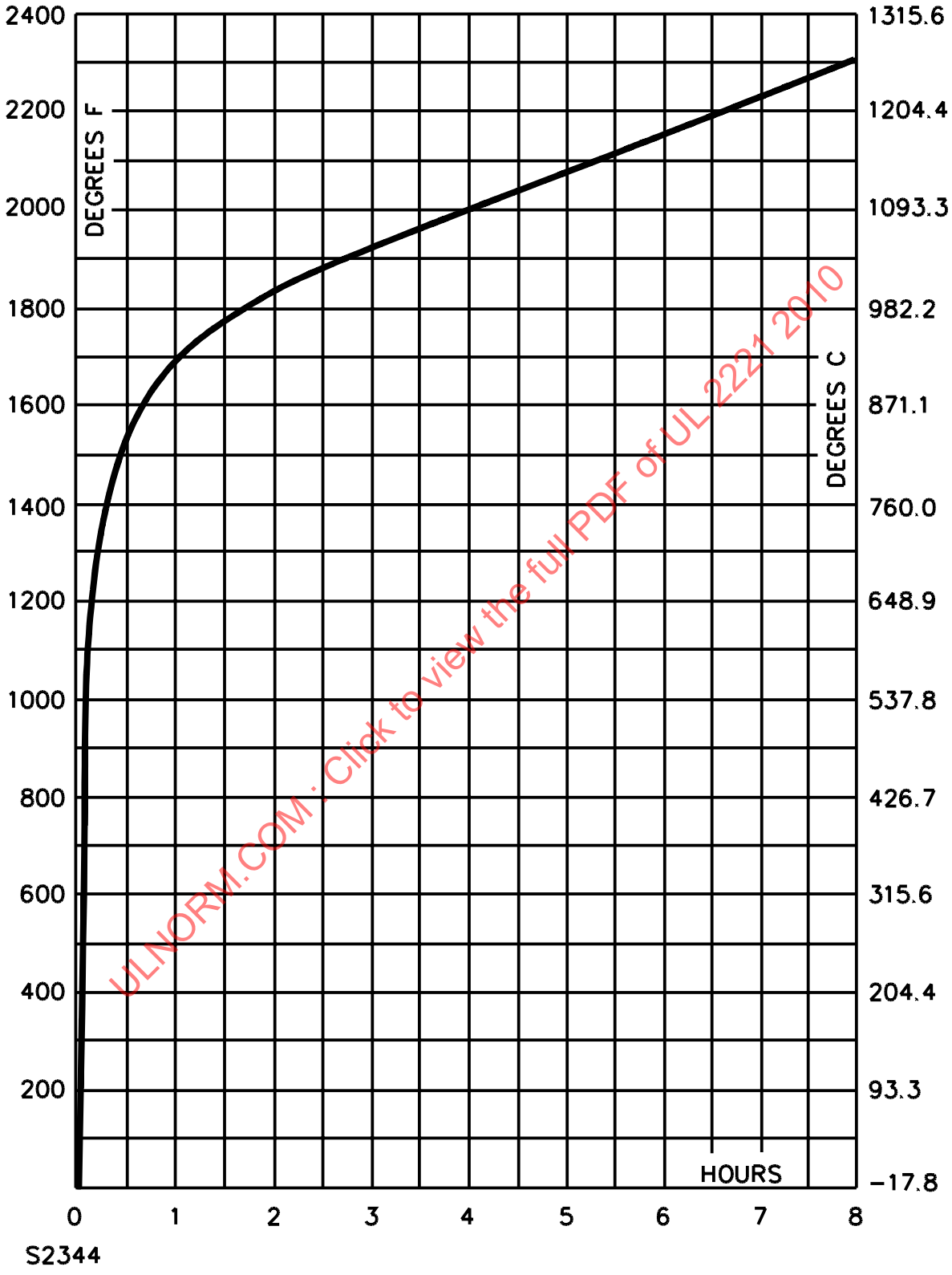
1700°F (927°C) at 1 hour

1850°F (1010°C) at 2 hours

2000°F (1093°C) at 4 hours

2300°F (1260°C) at 8 hours

Figure 9.1
Time-temperature curve



9.2.3 For a more precise definition of the temperature rise curve, see the Standard Time-Temperature Curve for Control of Fire Tests, Appendix A.

9.2.4 The measured temperature to be compared with the standard time-temperature curve (Figure 9.1) is to be the average temperature obtained from the readings of thermocouples symmetrically disposed and distributed to indicate the temperature near all parts of the test specimen.

9.2.5 At least three thermocouples are to be used with no fewer than five thermocouples per 100 square feet (9.3 m^2) of floor area. The junctions of the thermocouples are to be placed 12 inches (305 mm) from the exposed surface of the supporting construction.

9.2.6 Each furnace thermocouple is to be enclosed in a sealed protection tube. The exposed combined length of protection tube and thermocouple in the furnace chamber is to be not less than 12 inches (305 mm).

9.2.7 The time constant of the protected thermocouple assembly is to be within the range of 5.0 to 7.2 minutes. A typical thermocouple assembly complying with this constant requirement is capable of being fabricated by fusion-welding the twisted ends of 18 AWG (0.82 mm) chromel-alumel wires, mounting the leads in porcelain insulators, and inserting the assembly into a standard weight 1/2-inch [0.84-inch (21.3-mm) outside diameter] black wrought iron, black wrought steel or Inconel pipe, and sealing the end of the pipe that is inside the furnace. The thermocouple junction is to be inside the pipe, 1/2 inch (12.7 mm) from the sealed end.

9.2.8 The temperatures are to be read at intervals not exceeding 5 minutes throughout the fire test.

9.2.9 The temperature of the furnace is to be controlled so that the area under the measured time-temperature curve (Figure 9.1), obtained by averaging the results from the thermocouple readings, is within:

a) 10 percent of the corresponding area under the standard time-temperature curve for fire tests of 1 hour or less duration,

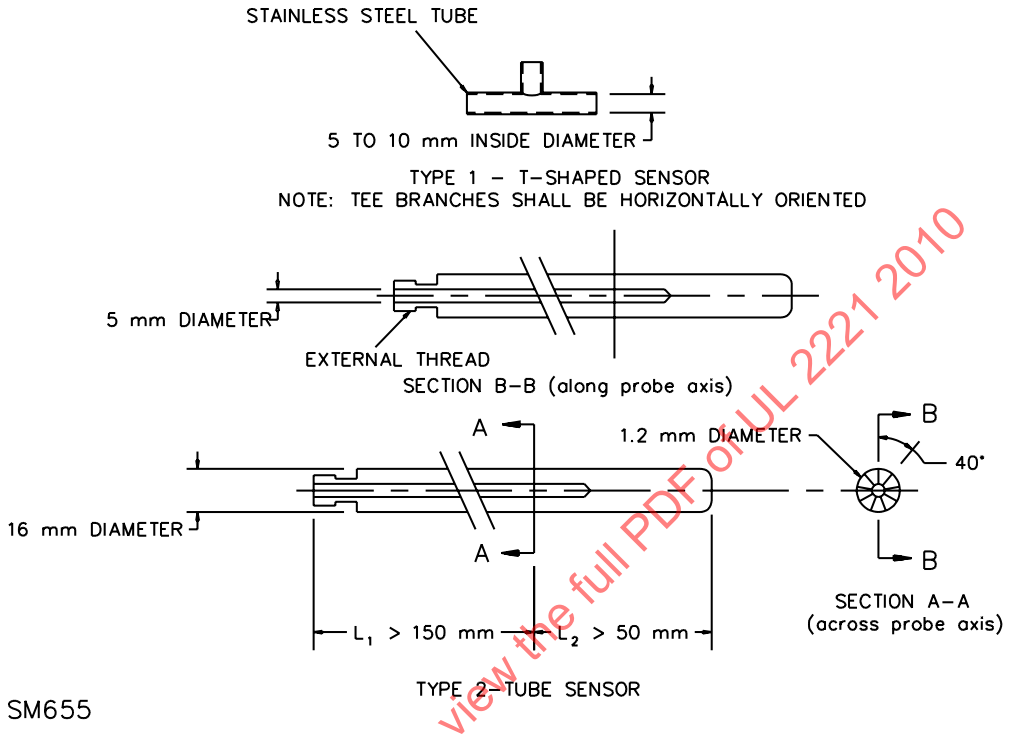
b) 7.5 percent of the corresponding area under the standard time-temperature curve for fire tests longer than 1 hour and not longer than 2 hours, and

c) 5 percent of the corresponding area under the standard time-temperature curve for fire tests exceeding 2 hours in duration.

9.2.10 The differential pressure between the laboratory ambient air and the interior of the furnace is to be calculated based on measurements taken near the vertical centerline of two opposing furnace walls as appropriate, and based on the linear pressure gradient of the furnace. The linear pressure gradient of the furnace is to be determined by the difference in measured pressure of at least two pressure sensors separated by a vertical distance in the furnace. The pressure sensors are to be located where they are not subjected to direct impingement of convection currents. Tubing connected to each pressure sensor is to be horizontal both in the furnace and at its egress through the furnace wall such that the pressure is relative to the same elevation from the inside to the outside of the furnace.

9.2.11 The pressure sensors are to be either of the ″T″ type or the ″tube″ type as illustrated in Figure 9.2 and are to be manufactured from stainless steel or other material capable of being used.

Figure 9.2
Pressure sensors



9.2.12 The differential pressure is to be measured by means of a manometer or equivalent transducer capable of reading pressure in increments of 0.01 inch H_2O (2.5 Pa) with a measurement precision of 0.005 inch H_2O (1.25 Pa). The differential pressure measuring instrument is to be located to minimize ″stack″ effects resulting from vertical runs of pressure tubing between the furnace probe and instrument locations.

9.2.13 The differential pressures are to be read at intervals not exceeding 2-1/2 minutes throughout the fire test.

9.2.14 The average furnace pressure 12 inches (305 mm) below the surface of the supporting construction exposed to the fire shall not fall below a minimum of 0.01 inch H_2O (2.5 Pa) above atmospheric pressure after the initial 10 minutes of fire exposure. The furnace pressure shall not fall below a minimum of 0.01 inch H_2O (2.5 Pa) for any period longer than 5 minutes after the initial 10 minutes of fire exposure. The neutral pressure plane is to be below the test specimen.

9.3 Temperature measurements on test specimen

9.3.1 Temperatures on the unexposed surfaces are to be measured with Type K (chromel-alumel) thermocouples of 24 AWG (0.21 mm) wire. The wires are to be electrically insulated with heat- and moisture-resistant coverings capable of withstanding a minimum single point temperature of 600°F (315°C). The thermocouples are to be placed under flexible, dry, felted pads. The properties of these pads are to comply with the requirements specified in Requirements for Thermocouple Pads, Appendix B.

9.3.2 Roving thermocouples are to be as shown in Figure 8.6. The measuring junction of the thermocouple is to consist of 1.0-mm diameter Type K thermocouple wire soldered or welded to a 12-mm diameter, 0.5-mm thick copper disc. The thermocouple assembly is to be provided with a handle so it can be applied over any point on the unexposed surface of the test specimen.

9.3.3 Temperature readings are to be taken at intervals not exceeding 5 minutes throughout the fire test.

9.4 Protection of test assembly and test equipment

9.4.1 The test equipment and the test assembly are to be protected from any condition of wind or weather that influences the test results. The test assembly at the beginning of the test is to be within the range of 50 to 90°F (10 to 32°C).

9.5 Integrity

9.5.1 The integrity of the test specimen is to be checked on the unexposed surface for the passage of flame and hot gases using a cotton waste pad in a wire frame provided with a handle.

9.5.2 The nominal 4- by 4- by 3/4-inch (100- by 100- by 19-mm) cotton waste pads are to consist of new, undyed, and soft cotton fibers, without any admixture of artificial fibers, and each pad is to weigh 3 to 4 grams. The pads are to be conditioned prior to use by drying in an oven at 212 ±9°F (100 ±5°C) for at least 30 minutes. After drying, the pads are to be stored in a desiccator for up to 24 hours.

9.5.3 The frame used to hold the cotton waste pad is to be formed of 16 AWG (1.31 mm) steel wire and is to be provided with a handle long enough to reach all points of the test assembly.

9.5.4 The cotton waste pad is to be held directly over an observed crack or hole in the test specimen, 1 ±1/4 inch (25.4 ±6 mm) from the breached surface, for a period of 30 seconds. Small adjustments in the position of the cotton waste pad are not prohibited from being made when required to achieve the maximum effect from the hot gases.

9.5.5 When no ignition (defined as glowing or flaming) of the cotton waste pad occurs during the 30-second application, ″screening tests″ involving short duration applications of the cotton waste pad to areas of potential failure and/or the movement of a single pad over and around such areas are to be made. Charring of the pad provides an indication of imminent failure, and a previously unused cotton waste pad is to be employed in the prescribed manner for an integrity failure to be confirmed.

9.6 Observations during and after the test

9.6.1 Observations of the exposed and unexposed surfaces of the test assembly are to be made throughout the fire test. All significant observations, such as deformation, spalling, cracking, burning of the test assembly, and production of smoke, are to be recorded at maximum 15-minute time intervals.

10 External Fire Test, Fire Engulfment

10.1 Sample

10.1.1 The grease duct assembly is to be a minimum of 10 feet (3.05 m) long including an elbow and all required supports in accordance with the requirements of the International Mechanical Code, or comply with the requirements of the Standard for Grease Ducts, UL 1978. The grease duct assembly is to include at least two joints inside the furnace and at least one joint outside the furnace. The grease duct assembly is to be capped at the end inside the furnace and the end outside the furnace is to be connected to a fan assembly.

10.1.2 The grease duct is to be representative of the largest cross-sectional area and the maximum width-to-height ratio. Insulation systems are to be installed in accordance with the manufacturer's installation instructions. Supports are to be stressed to represent the maximum load anticipated based upon the manufacturer's installation instructions and provisions in the International Mechanical Code.

10.1.3 The grease duct assembly is to be as shown in Figure 10.1 or 10.2.

Figure 10.1
Location of test assembly in furnace

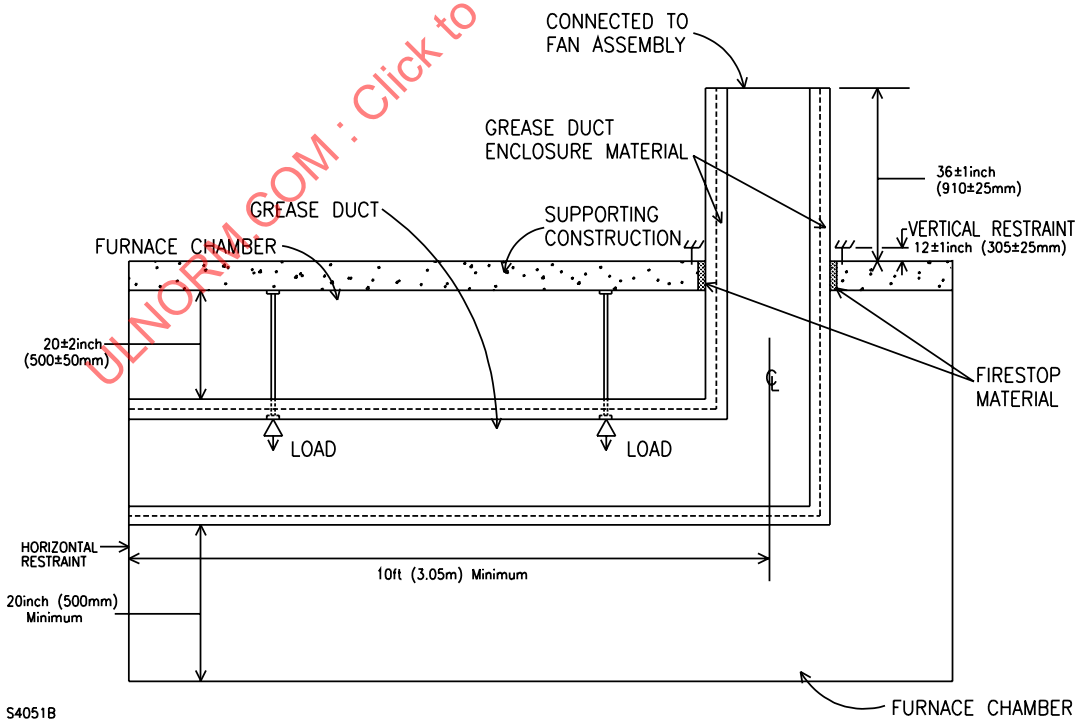
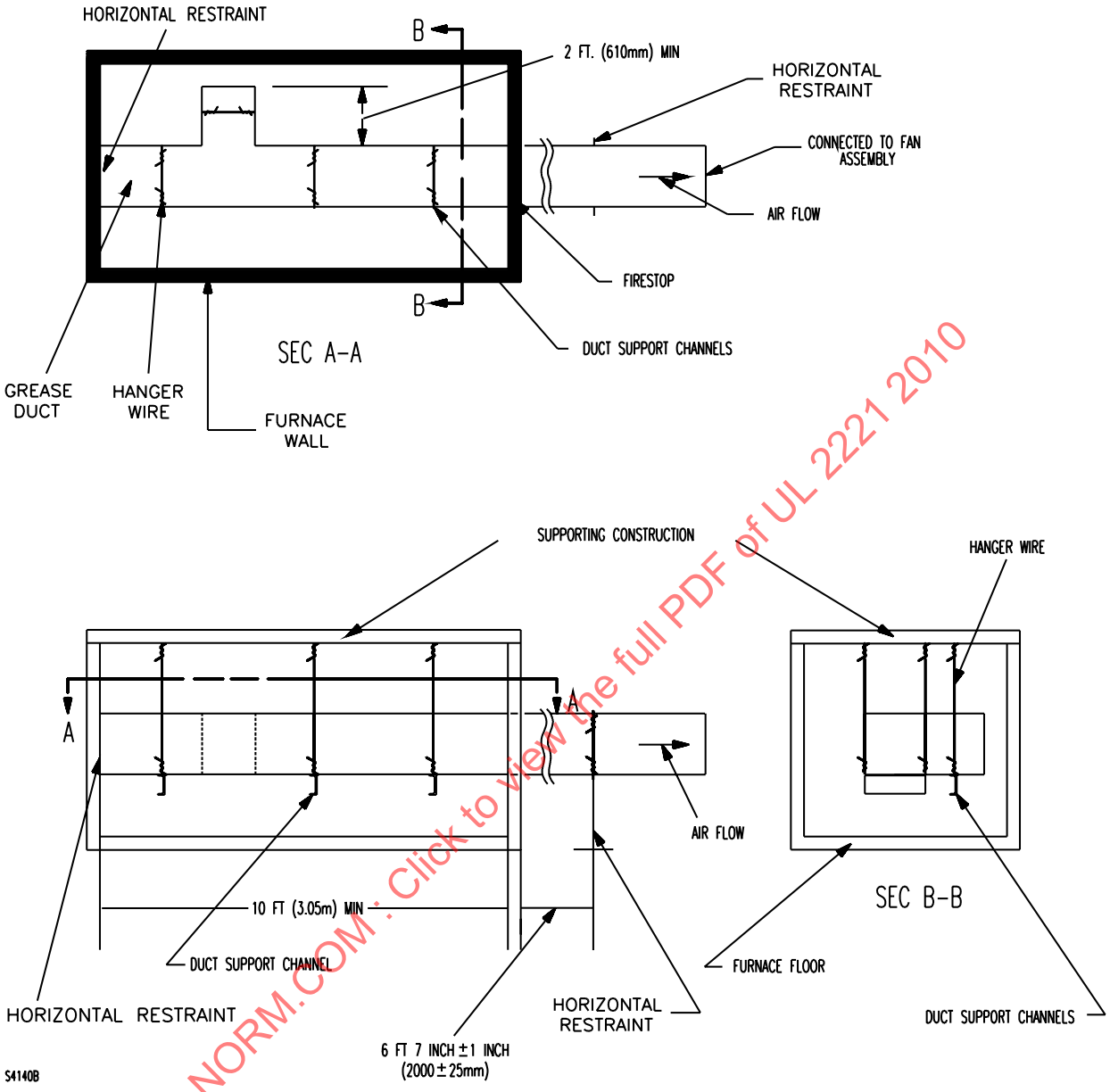


Figure 10.2
Location of test assembly in furnace



10.1.4 There is to be a clearance of 20 ±2 inches (508 ±50 mm) between the top of the test specimen and the supporting construction. There is to be a minimum clearance of 20 inches (508 mm) between the bottom of the test specimen and the floor of the furnace and a minimum clearance of 20 inches (508 mm) between the sides of the test specimen and the furnace walls and between adjacent test specimens.

10.2 Duct pressure

10.2.1 Prior to the start of the fire test, the pressure inside the grease duct assembly is to be 1.2 ±0.04 inch H_2O (300 ±10 Pa) below the ambient (laboratory) pressure. The fan setting required to obtain this pressure is not to be altered during the fire test.

10.3 Conduct of fire test

10.3.1 The fire test is to be conducted in accordance with External Fire Tests, General, Section 9, for a time period at least equal to the rating period.

10.3.2 The fan is to be stopped for a 5-minute period 10 minutes before the completion of every 30-minute period of the test.

10.4 Acceptance criteria

10.4.1 Stability failure shall be deemed to have occurred when the duct collapses at any place in excess of 25% of the cross-sectional area of that place, an opening develops in the grease duct, or the grease duct falls from the supporting construction.

10.4.2 Integrity failure shall be deemed to have occurred when conditions on the unexposed surface results in the ignition of the cotton waste or when flames are observed emitting from the unexposed surface.

11 External Fire Test, Firestop

11.1 Sample

11.1.1 The test sample shall comply with the requirements of Figure 10.1 or 11.1.2, 11.1.3, 11.1.4, and 11.1.5. The firestop test is to be conducted either at the same time as the fire engulfment test, by test in accordance with 11.1.2 through 11.1.5, or by test in accordance with the Standard for Fire Tests of Through-Penetration Firestops, UL 1479 (Standard Test Method for Fire Tests of Through-Penetration Firestops, ASTM E814).

11.1.2 The grease duct is to be representative of the largest cross-sectional area and the maximum width-to-height ratio to be used. Insulation systems are to be installed in accordance with the manufacturer's installation instructions.

11.1.3 The grease duct is to extend 12 ±1 inches (300 ±25 mm) from the exposed side of the supporting construction and 36 ±1 inches (910 ±25 mm) from the unexposed side of the supporting construction. The extended portions of the grease duct assembly on the unexposed side are to be supported by methods intended to be employed in the field installation.

11.1.4 The end of the grease duct in the furnace chamber is to be sealed and covered with the grease duct enclosure materials. The end of the grease duct outside of the furnace chamber is to be connected to a fan assembly.

11.1.5 The periphery of the test specimen is to be not closer than 1-1/2 times the thickness of the supporting construction or a minimum of 12 inches (300 mm) to the furnace edge, whichever is greater. The distance between the test specimen periphery and the furnace edge is capable of being reduced when it is demonstrated that the edge effects do not affect the tests results.

11.2 Duct pressure

11.2.1 Prior to the start of the fire test, the pressure inside the grease duct assembly is to be 1.2 ±0.04 inch H_2O (300 ±10 Pa) below the ambient (laboratory) pressure. The fan setting required to obtain this pressure is not to be altered during the fire test.

11.3 Temperature measurements on test assembly

11.3.1 The temperatures on the unexposed surface of the test assembly shall be measured with thermocouples located as shown in Figure 11.1.

a) At points on the surface of the firestop, 1 inch (25.4 mm) from each side of the test specimen,

b) At the periphery of the opening on each side of the test specimen,

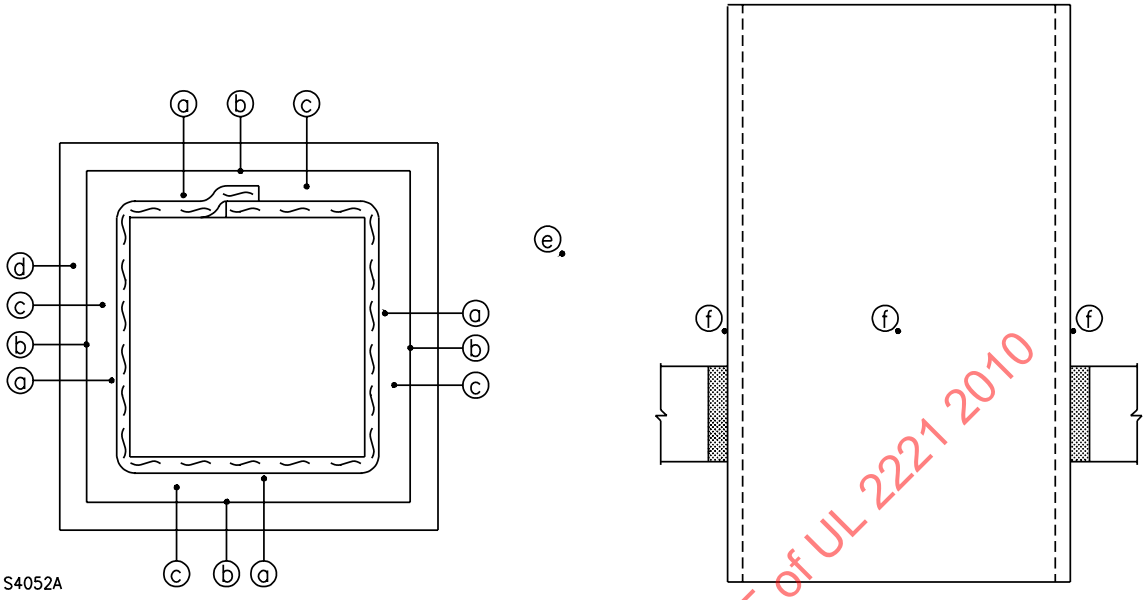
c) At points on the surface of the firestop, equidistant from each side of the test specimen and the periphery of the opening,

d) At a point on any frame installed around the periphery of the opening,

e) At a point on the unexposed surface of the supporting construction at least 12 inches (300 mm) from the periphery of the opening, and

f) At points on each side of the grease duct, 1 inch (25.4 mm) from the unexposed surface of the supporting construction. The thermocouples are to be located on the exterior surface of the insulation. When the insulation does not extend the full length of the grease duct assembly on the unexposed side, additional thermocouples are to be installed on the grease duct 1 inch (25.4 mm) beyond the termination of the insulation.

Figure 11.1
Temperature measurement locations



See 11.3.1 for a description of the lettered symbols.

11.3.2 Temperature measurements are to be made at locations in addition to those described in 11.3.1 when it is determined they are required for the purpose of evaluating the performance of the firestop.

11.4 Conduct of fire test

11.4.1 The fire test is to be conducted in accordance with External Fire Tests, General, Section 9, for a time period at least equal to the rating period.

11.5 Acceptance criteria

11.5.1 Insulation failure of the firestop system shall be deemed to have occurred when the temperature rise recorded by any thermocouple on the unexposed surface exceeds 325°F (181°C) above the initial starting temperature.

11.5.2 Integrity failure of the firestop system shall be deemed to have occurred when conditions on the unexposed surface results in the ignition of the cotton waste or when flames are observed emitting from the unexposed surface.