

FIRE TESTING FOR INSULATION

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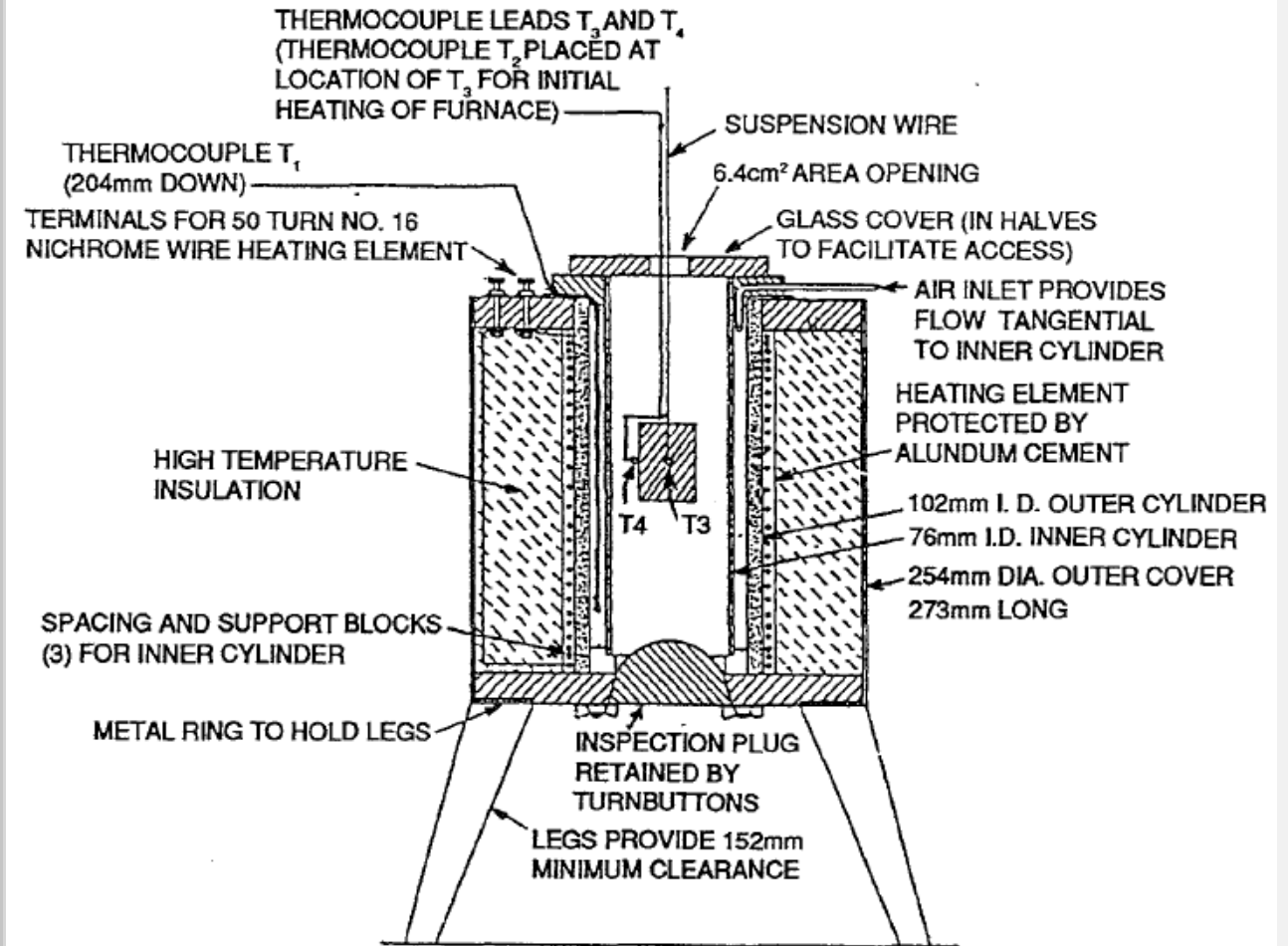
OVERVIEW

- Non-Combustibility
- Surface Burning Characteristics
- Wall and Ceiling Finishes—Room Corner Test
- Fire Resistance Test Methods—Standard Time-Temperature Exposure
- Exterior Flame Propagation
- Fire Resistance—Rapid Temperature Rise (Hydrocarbon Fires)
- Jet Fire

NON-COMBUSTIBILITY

ASTM E136—Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C

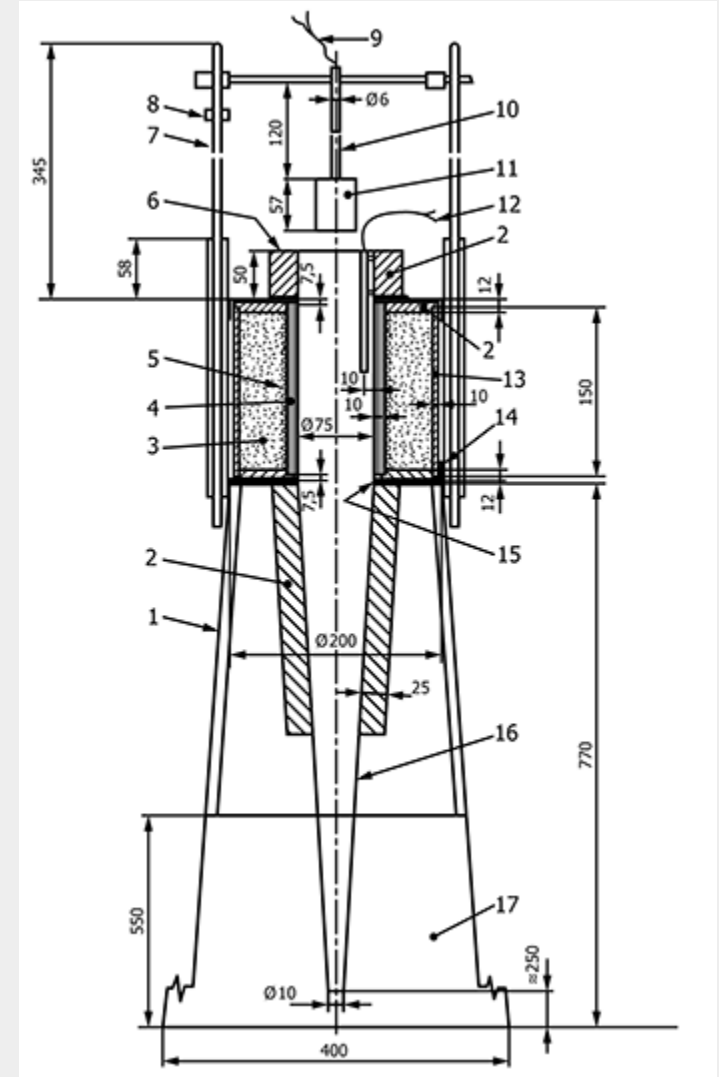
- Code References in IBC, IRC, and IMC



Option A

NON-COMBUSTIBILITY

- 30-minute test (usually) per test run
- Four test runs required
 - Three of the four specimens required to meet the individual test specimen criteria below
- Weight Loss Criteria
- Temperature Rise Criteria
 - $\leq 30^{\circ}\text{C}$ if weight loss $\leq 50\%$
 - None if weight loss $> 50\%$
- Flaming Criteria
 - None after 30s if weight loss $\leq 50\%$
 - No flaming if weight loss $> 50\%$

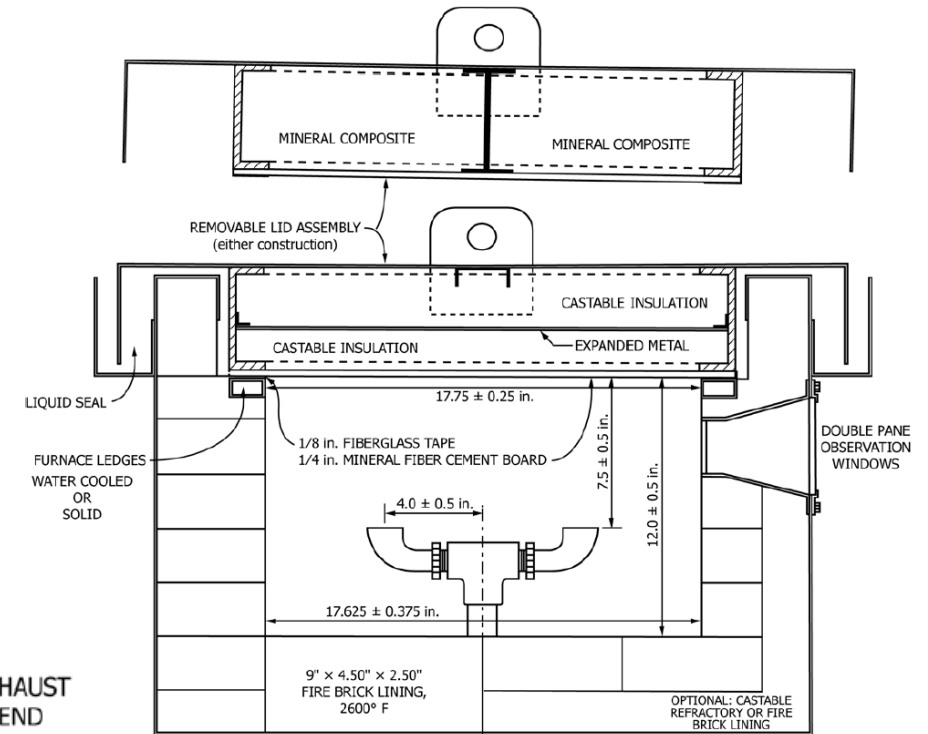
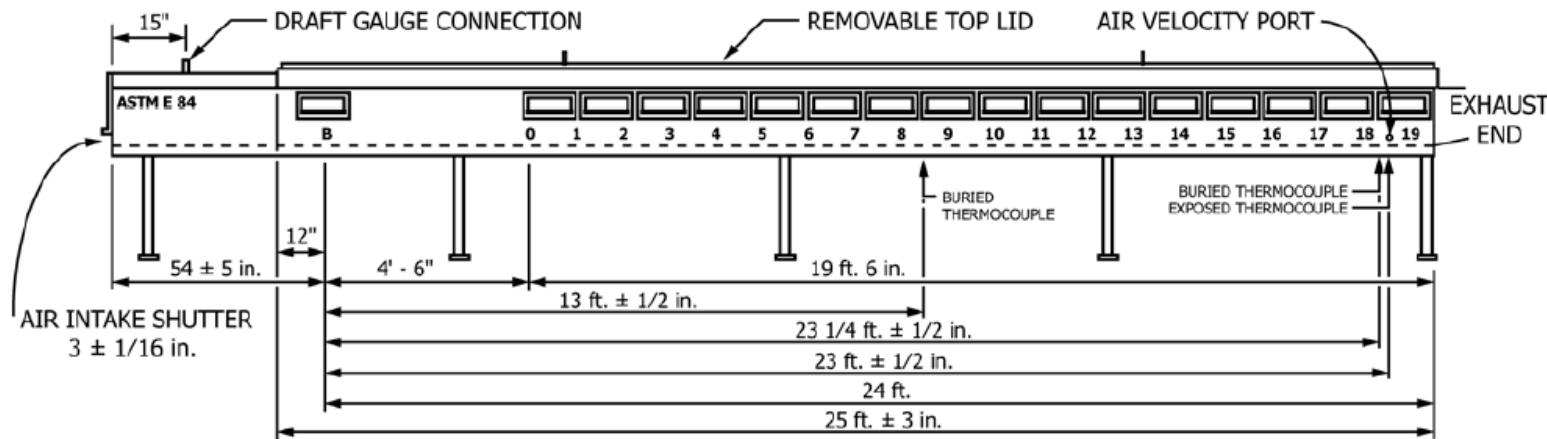


Option B – ASTM E136 using
ASTM E2652 Apparatus

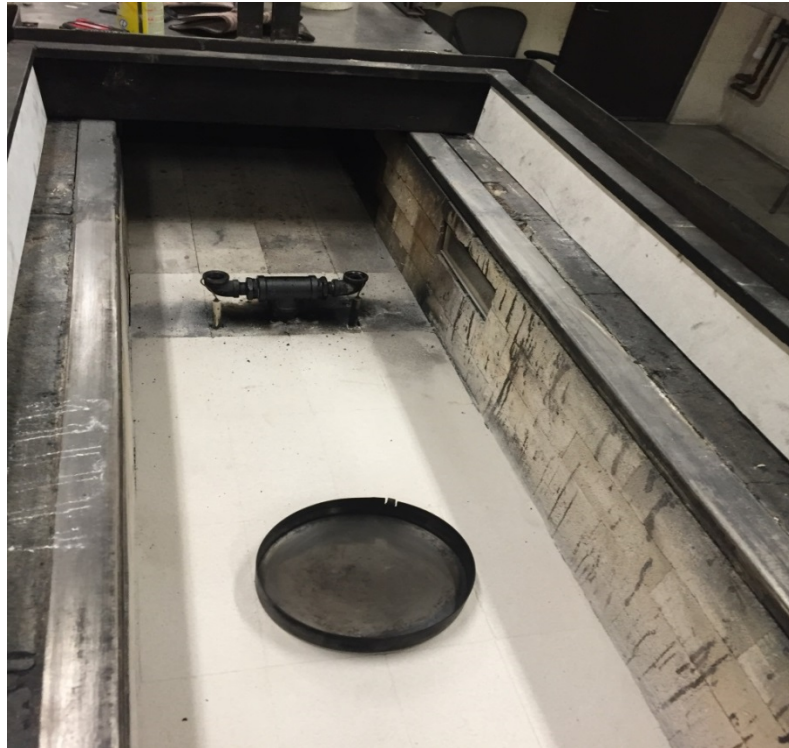
ASTM E84 STANDARD TEST METHOD FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS

- Code Requirement in the IBC, IRC, and IMC
- Flame Spread Index and Smoke Developed Index
 - Duct Insulation
 - Pipe Insulation
 - Foam Plastic Insulation
 - Material in Plenums
 - Etc.

ASTM E84 STANDARD TEST METHOD FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS



ASTM E84 (CONTINUED)



Heptane Pan for Smoke Calibration



Photometer System for
Smoke Measurement

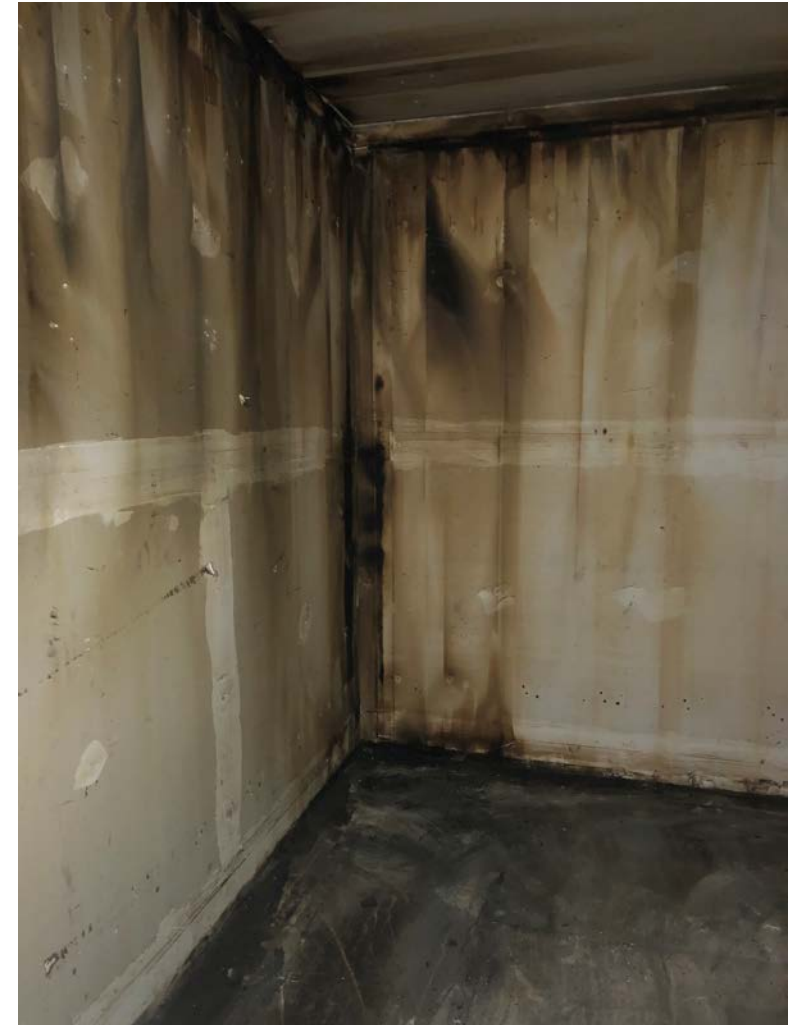
NFPA 286—ROOM CORNER TEST

- Room Size: 8 ft. tall x 8 ft. wide x 12 ft. deep
- Ignition source: Sand burner
 - 40 kW for 5 min. then 160 kW for 10 min.
- Flashover Conditions (when any two conditions below are met)
 - Heat release rate $> 1\text{ MW}$
 - Heat flux at floor $> 20\text{ kW/m}^2$
 - Avg upper layer temp. $> 600^\circ\text{C}$ (1112°F)
 - Flame exits doorway
 - Paper target on floor auto-ignites



NFPA 286 IBC CLASS A ALTERNATIVE METHOD AND FOAM PLASTIC INSULATION SPECIAL APPROVAL CRITERIA

- Class A Interior Finish Alternative and Foam Plastic Insulation Special Approval
 - During 40 kW exposure, flame shall not reach ceiling
 - Flame spread does not reach outer extremities of walls or ceiling
 - No Flashover per NFPA 286
 - Peak heat release rate ≤ 800 kW
 - Total smoke $\leq 1,000$ m²



FIRE RESISTANCE TEST METHODS— STANDARD TIME-TEMPERATURE EXPOSURE

- ASTM E119, Standard Test Methods for Fire Tests of Building Construction and Materials
- UL 263, Fire Tests of Building Construction and Materials

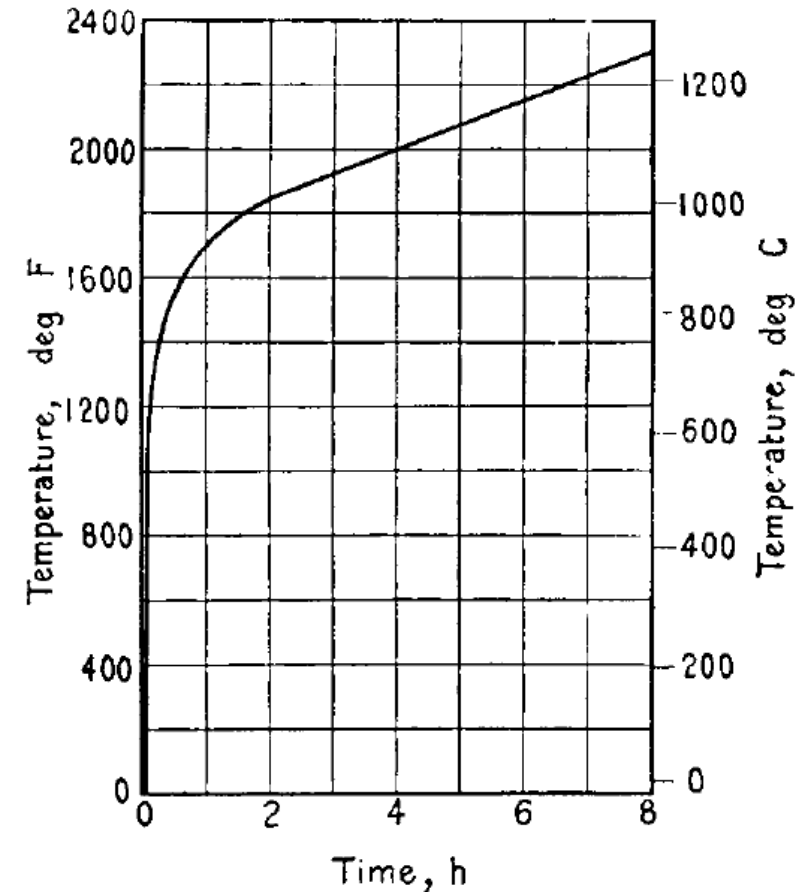


FIG. 1 Time-Temperature Curve

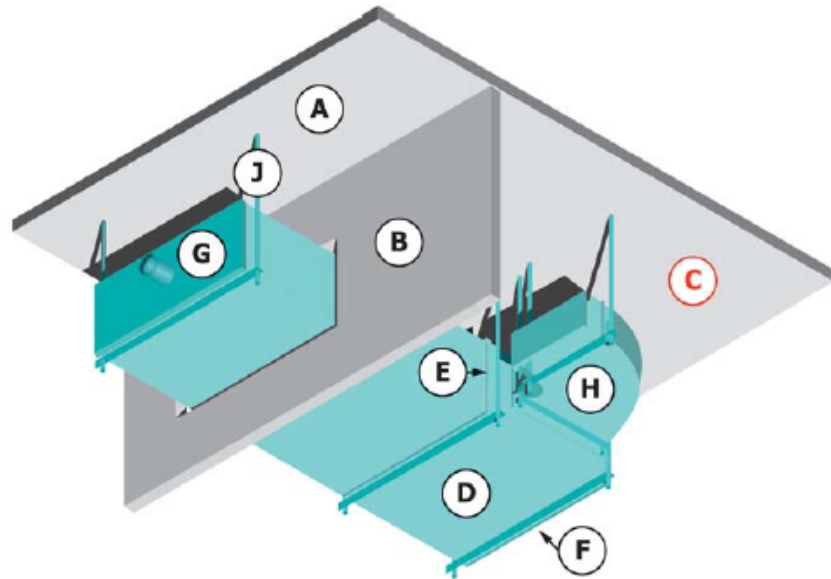
FIRE RESISTANCE TESTING— STANDARD TIME-TEMPERATURE EXPOSURE



FIRE RESISTANCE TESTING— STANDARD TIME-TEMPERATURE EXPOSURE

- Test Standards for Specific Applications
 - IMO 2010 FTP Code Part 3 (ISO 834-1 Exposure) International Marine Applications
 - ASTM E1725: Fire-Resistive Barrier Systems for Electrical System Components
 - ASTM E814/UL 1479: Through-Penetration Firestops
 - ASTM E1966/UL 2079: Fire Rated Joint Systems
 - ASTM E2816: Fire Resistive Metallic HVAC Duct Systems
 - ASTM E2336: Fire Resistive Grease Duct Enclosure Systems
 - UL 2221: Fire Resistive Grease Duct Enclosure Assemblies

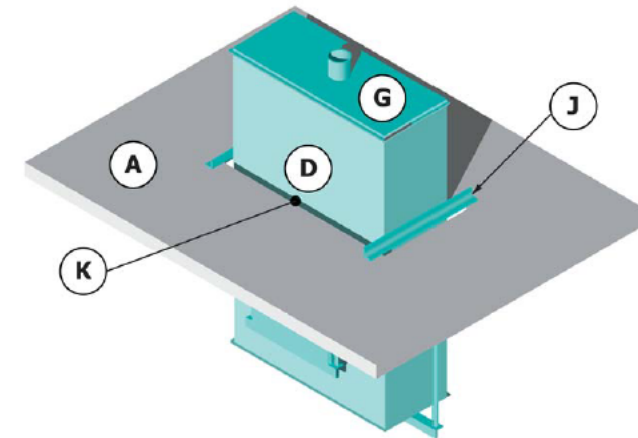
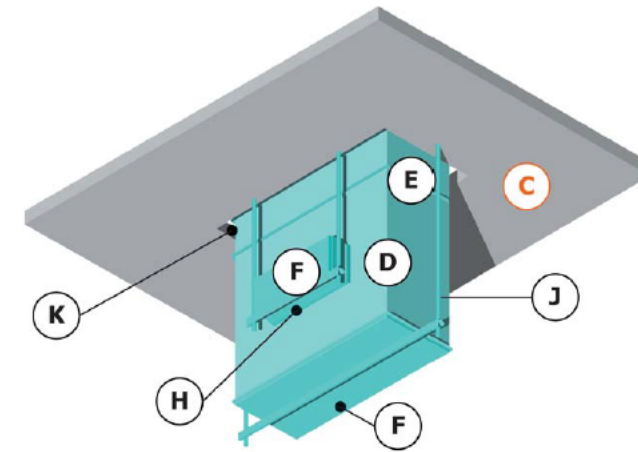
ASTM E2816 CONDITIONS



- A = Horizontal Fire-Separating Element
- B = Vertical Fire-Separating Element
- C = Fire Side of Fire-Separating Elements
- D = Straight HVAC Duct
- E = HVAC Duct Joints

- F = HVAC End Cap
- G = Test Cap with Fan Connection
- H = HVAC Duct 90° Elbow
- I = Optional HVAC Duct Internal Reinforcement – Not Shown
- J = Supports

FIG. 5 Isometric View of Test Assembly Condition A – Horizontal HVAC Duct without Openings



- A = Horizontal Fire-Separating Element
- B = No Vertical Fire-Separating Element
- C = Fire Side of Fire-Separating Elements
- D = Straight HVAC Duct
- E = HVAC Duct Joints

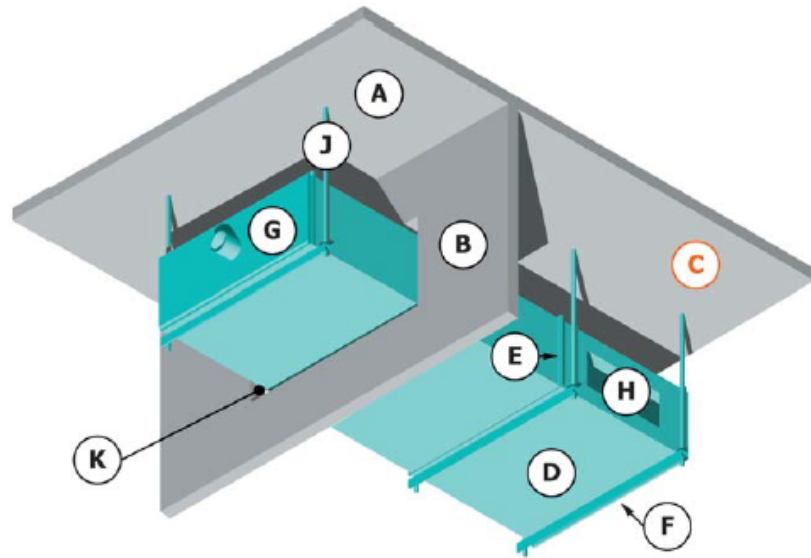
- G = Test Cap with Fan Connection
- H = "T" Connection

- F = HVAC End Cap

- I = Optional HVAC Duct Internal Reinforcement – Not Shown
- J = Supports
- K = Opening in Fire-Separating Element

FIG. 8 Isometric Views of Test Assembly Condition B – Vertical HVAC Duct without Openings

ASTM E2816 CONDITIONS



A = Horizontal Fire-Separating Element
 B = Vertical Fire-Separating Element
 C = Fire Side of Fire-Separating Elements

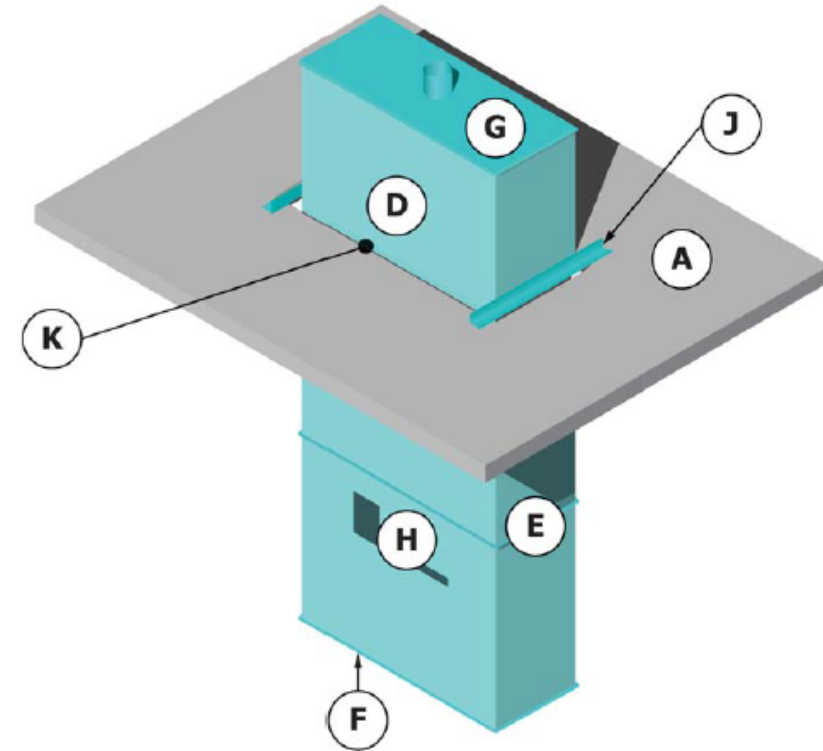
D = Straight HVAC Duct
 E = HVAC Duct Joints

F = HVAC End Cap

G = Test Cap with Fan Connection
 H = Unprotected Opening
 I = Optional HVAC Duct Internal Reinforcement – Not Shown

J = Supports
 K = Opening in Fire-Separating Element

FIG. 11 Isometric View of Test Assembly Condition C – Horizontal HVAC Duct with Openings



A = Horizontal Fire-Separating Element
 B = No Vertical Fire-Separating Element
 C = Fire Side of Fire-Separating Elements

D = Straight HVAC Duct
 E = HVAC Duct Joints

F = HVAC End Cap

G = Test Cap with Fan Connection
 H = Unprotected Opening

I = Optional HVAC Duct Internal Reinforcement – Not Shown
 J = Supports
 K = Opening in Fire-Separating Element

FIG. 14 Isometric View of Test Assembly Condition D – Vertical HVAC Duct with Openings

GREASE DUCT TESTING

- Internal Fire Test (500°F for 4 hours followed by 30 minutes at 2000°F)

- 1 hr. to 2 hr. Fire Engulfment Test (usually 2 hr.)

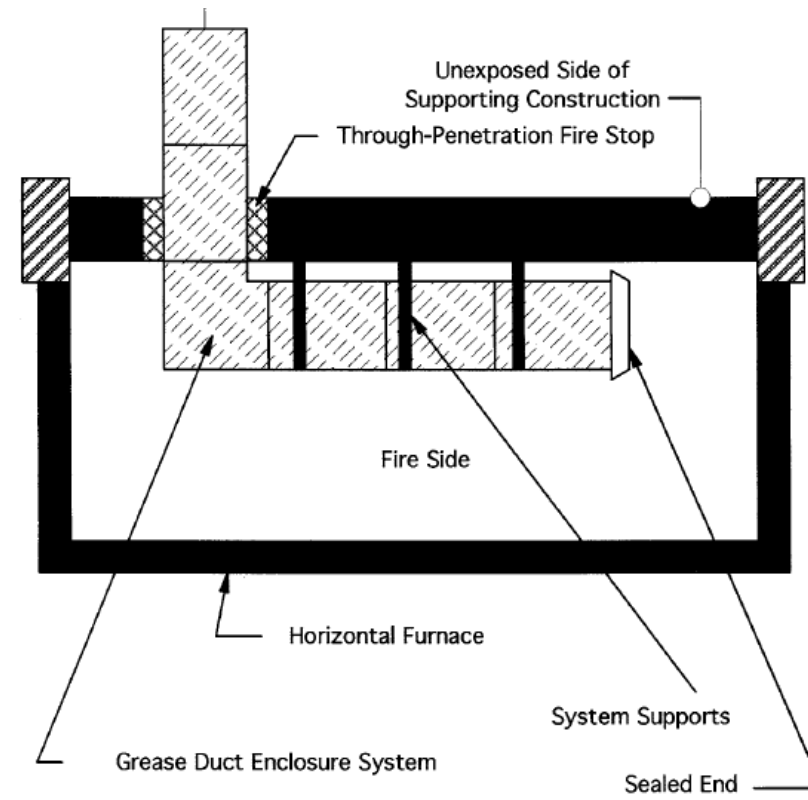
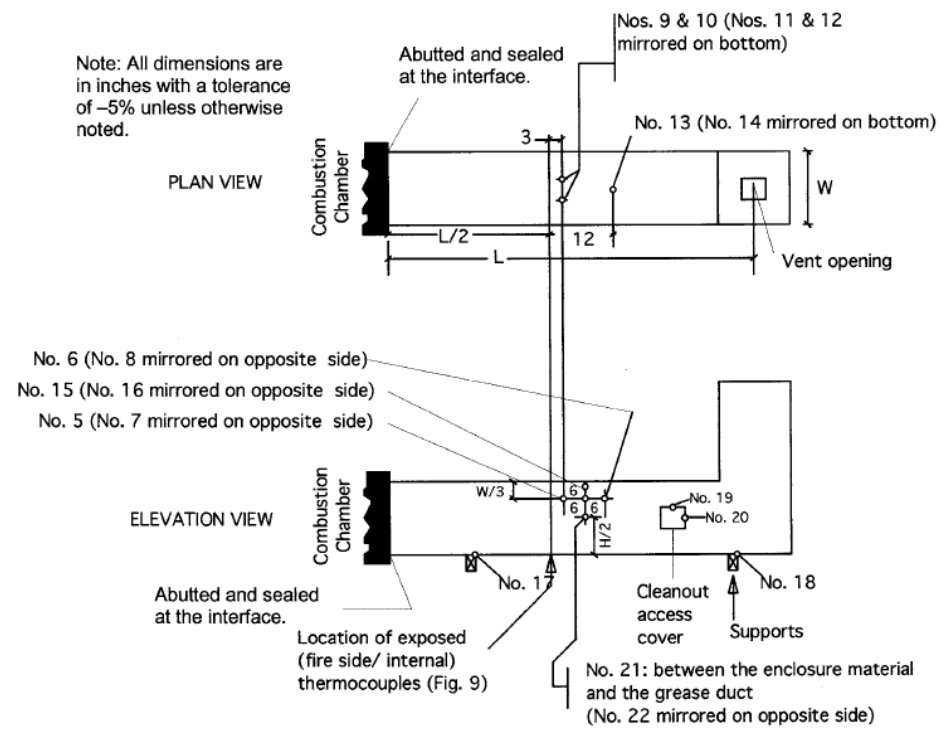
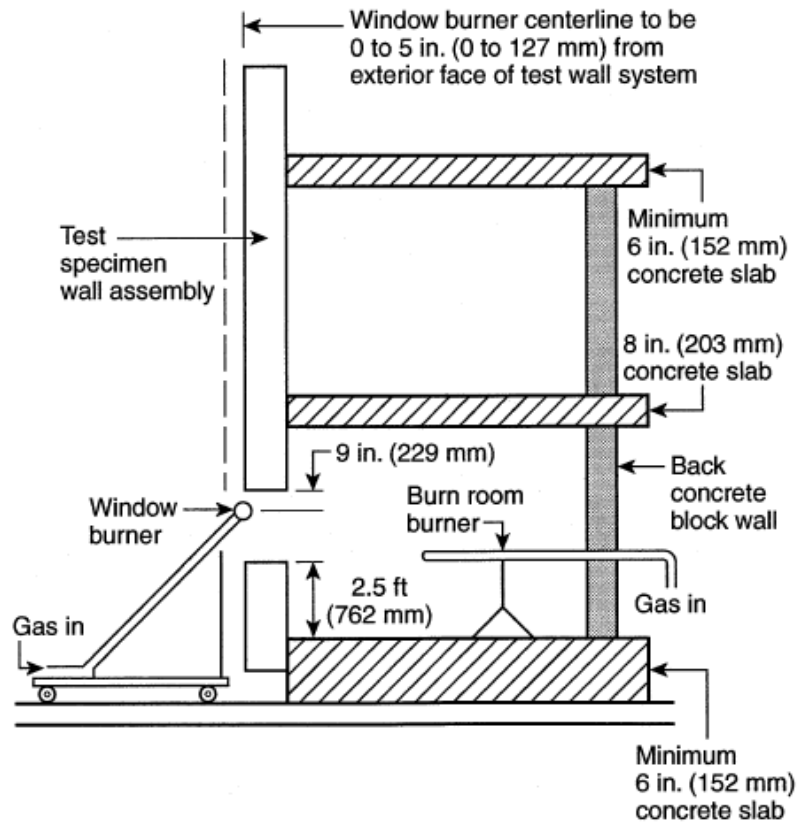
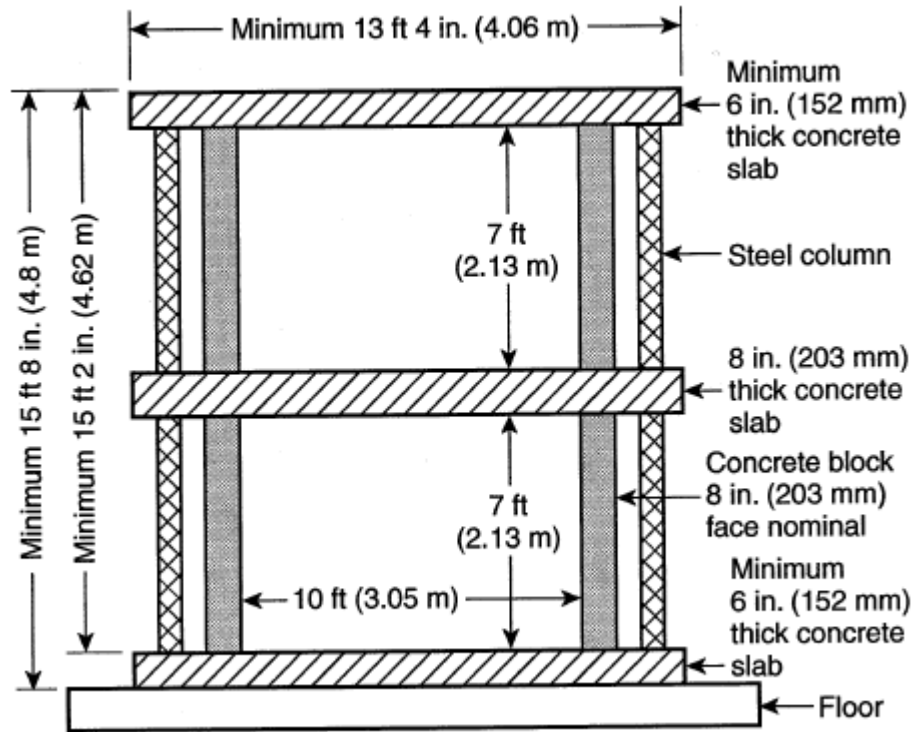


FIG. 8 Fire-Engulfment Test Arrangement

NFPA 285—STANDARD FIRE TEST METHOD FOR EVALUATION OF FIRE PROPAGATION CHARACTERISTICS OF EXTERIOR WALL ASSEMBLIES CONTAINING COMBUSTIBLE COMPONENTS

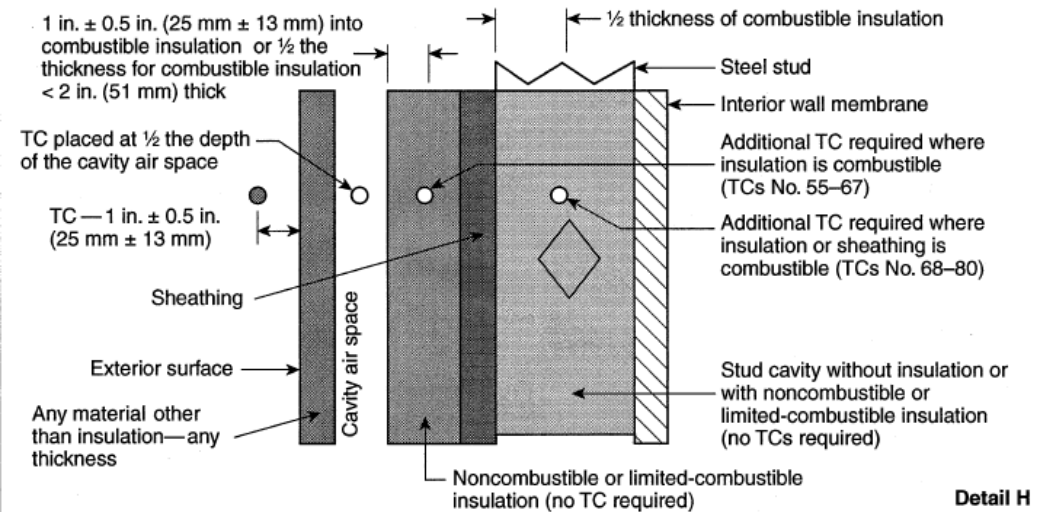


NFPA 285 (CONTINUED)



NFPA 285 (CONTINUED)

- Visual—10 ft. above top of window, laterally outside of burn room
- 1000°F on thermocouples located 10 ft. above top of window
- Combustible components (thermocouples inside wall)
- Assembly dependent
- Either 1000°F or 750°F



HYDROCARBON FIRE TESTS

- Pool Fires
- UL 1709
- H-Class
- MIL-STD-3020
- Transportation Tunnels
- Jet Fires

POOL FIRE TESTS

- Transportation Industry
 - 49 CFR 571.304—Compressed Natural Gas Fuel Container
 - 10 CFR 71.73—Nuclear Shipping Containers
- Fire Suppression Testing
- Very high heat flux
- ASTM E1529—*Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies*

POOL FIRE TESTS

- *ASTM E1529—Standard Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies*
 - *Uses same furnaces as ASTM E119 and UL 263*
 - *Furnace controlled to 158 kW/m² (1850 to 2150°F)*
 - *Accelerated Weathering and Aging*
 - *Method A—Columns*
 - *Loaded—Maintain Load*
 - *Unloaded—1000°F Limit on Average, 1200°F on Individual*
 - *Method B—Beams*
 - *Loaded—Maintain Load*
 - *Unloaded—1000°F Limit on Average, 1200°F on Individual*

POOL FIRE TESTS (ASTM E1529 CONTINUED)

- *Method C—Walls*
 - *Steel—(Bulkhead)*
 - *No Passage of Flame*
 - *250°F Rise for Average and 325°F Rise for Individual*

UL 1709—STANDARD FOR SAFETY RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL

- Uses same furnaces as ASTM E119 and UL 263
- Furnaces controlled to 204 kW/m² (~2000°F)
- Environmental Performance
 - *UL 2431*
 - *Material Classification Category 1-A: Outdoor, Heavy Industrial*
- 1000°F Limit on Average, 1200°F on Individual

UL 1709—STANDARD FOR SAFETY RAPID RISE FIRE TESTS OF PROTECTION MATERIALS FOR STRUCTURAL STEEL (CONTINUED)

- Supplemental Beam Test

- *Assesses materials performance with significant deflection in the beam*
- *Furnace temperature of 2000°F*
- *Test a loaded beam and an unloaded beam side by side*
- *Deflection limited to $(L^2)/(400d)$ total **AND** a rate of $(L^2)/(9000d)$*
- *Assessed temperature not specified by the standard*
 - *T for the average*
 - *1.2T for the individual*
- *Correction Factor calculated from the loaded and unloaded beam*

H-CLASS

- Variation of IMO Part 3—Test for “A,” “B,” and “F” Class Divisions
- Standardized Steel Bulkhead and Deck
- Insulation and Integrity Criteria
 - *No flaming*
 - *Limited to 250°F Rise on Average and 325°F Rise on Individual*
- Uses a Hydrocarbon Furnace Environment (2000°F by 5 min.)
 - *IMO Furnace Environment*
 - *1070°F at 5 min.*
 - *1250°F at 10 min.*
 - *1550°F at 30 min.*
 - *1730°F at 60 min.*

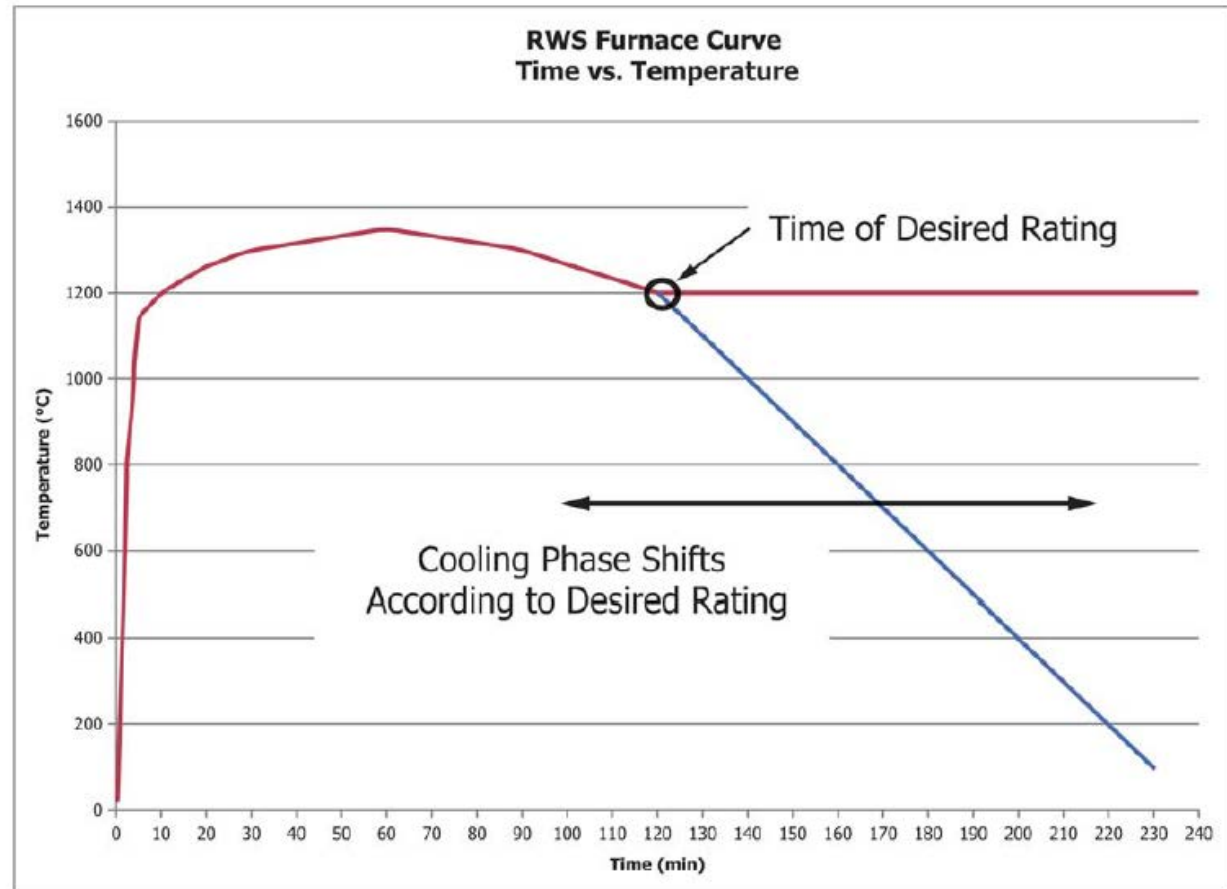
H-CLASS (CONTINUED)

- Can Extend Beyond 60 min.
- Applicable to Other Components
 - *Windows*
 - *Doors*
 - *Dampers*
 - *Penetrations*

ASTM E3134—STANDARD SPECIFICATION FOR TRANSPORTATION TUNNEL STRUCTURAL COMPONENTS AND PASSIVE FIRE PROTECTION SYSTEMS

TABLE 1 Tunnel Fire Test Time-Temperature Curve for Control of Fire Tests

| Time (min) | Temperature [°C (°F)] |
|------------|-----------------------|
| 0 | 20 (68) |
| 3 | 891 (1635) |
| 5 | 1141 (2085) |
| 10 | 1199 (2190) |
| 30 | 1299 (2370) |
| 60 | 1349 (2460) |
| 90 | 1299 (2370) |
| ≥120 | 1199 (2190) |



ASTM E3134 (CONTINUED)

- Flame Spread Limitations
- Environmental tests
- Spalling
- Limit temperatures of reinforcing steel to 482°F
- Insulation concrete interface limited to 716°F

MIL-STD-3020—FIRE RESISTANCE OF U.S. NAVAL SURFACE SHIPS

- Similar to H-Class
 - *Bulkhead and Deck Construction*
 - *Thermocouple Requirements*
- Furnace Controlled to 204 kW/m^2 ($\sim 2000^\circ \text{F}$)
- 30-min. Duration
- Criteria
 - *Integrity—No Flaming*
 - *Insulation—Limited to 250°F Rise on Average and 325°F Rise on Individual*
- Other Requirements
 - *Shock and Vibration*
 - *Smoke and Toxicity*

ISO 22899–DETERMINATION OF THE RESISTANCE TO JET FIRES OF PASSIVE FIRE PROTECTION MATERIALS

- Originally OTI 95-634
- Propane at 0.30 kg/s
- Heat Fluxes up to 350 kW/m²
- Recirculation Chamber and Back Box
- ~1.5 m x 1.5 m Test Area
- Panels, Tubular Sections, Structural Steel, Penetrations



QUESTIONS AND CONTACT INFORMATION

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