CS-25 AMENDMENT 6 - CHANGE INFORMATION

The Agency publishes amendments to Certification Specifications as consolidated documents. These documents are used for establishing the certification basis for applications made after the date of entry into force of the amendment.

Consequently, except for a note "Amdt. No.:25/6" under the amended paragraph, the consolidated text of CS-25 does not allow readers to see the detailed changes introduced by the new amendment. To allow readers to also see these detailed changes this document has been created. The same format as for publication of Notices of Proposed Amendments has been used to show the changes:

1. text not affected by the new amendment remains the same: unchanged
2. deleted text is shown with a strike through: ~~deleted~~
3. new text is highlighted with grey shading: new
4. ....
   Indicates that remaining text is unchanged in front of or following the reflected amendment.
   ....

Book 1

1. Revise CS 25.21 to read:

SUBPART B – FLIGHT

CS 25.21 Proof of compliance

….

(g) The requirements of this subpart associated with icing conditions apply only if the applicant is seeking certification for flight in icing conditions.

(1) Each requirement of this subpart, except CS 25.121(a), 25.123(c), 25.143(b)(1) and (b)(2), 25.149, 25.201(c)(2), ~~25.207(c) and (d),~~ and 25.251(b) through (e), must be met in icing conditions. CS 25.207(c) and (d) must be met in the landing configuration in icing conditions but need not be met for other configurations. Compliance must be shown using the ice accretions defined in Appendix C, assuming normal operation of the aeroplane and its ice protection system in accordance with the operating limitations and operating procedures established by the applicant and provided in the Aeroplane Flight Manual.

(2) ….

2. Revise CS 25.807 to read as follow:

SUBPART D - DESIGN AND CONSTRUCTION

….

CS 25.807 (h) (3)

….

"any other ventral or tail ~~passenger~~ cone passenger exit."

…

3. Add new CS 25.856:

SUBPART D - DESIGN AND CONSTRUCTION

….

CS 25.856 Thermal/acoustic insulation materials
(See AMC 25.856 (a) and AMC 25.856 (b))

(a) Thermal/acoustic insulation material installed in the fuselage must meet the flame propagation test requirements of Part VI of Appendix F to CS-25, or other approved equivalent test requirements. This requirement does not apply to "small parts", as defined in Part I of Appendix F to CS-25.

(b) For aeroplanes with a passenger capacity of 20 or greater, thermal/acoustic insulation materials (including the means of fastening the materials to the fuselage) installed in the lower half of the aeroplane fuselage must meet the flame penetration resistance test requirements of Part VII of Appendix F to CS-25, or other approved equivalent test requirements. This requirement does not apply to thermal/acoustic insulation installations that the Agency finds would not contribute to fire penetration resistance.

SUBPART E – POWERPLANT

4. Replace paragraph 25.981 (b) "Reserved" by:

(b) Fuel tank flammability

(1) To the extent practicable, design precautions must be taken to prevent the likelihood of flammable vapours within the fuel tanks by limiting heat and energy transfer (See AMC 25.981(b)(1)).

(2) Except as provided in sub-paragraph (4) of this paragraph, no fuel tank Fleet Average Flammability Exposure level may exceed the greater of:

(i) three percent, or

(ii) the exposure achieved in a fuel tank within the wing of the aeroplane model being evaluated. If the wing is not a conventional unheated aluminium wing, the analysis must be based on an assumed Equivalent Conventional Unheated Aluminium Wing (see AMC 25.981(b)(2)).

The Fleet Average Flammability Exposure is determined in accordance with appendix N of CS-25.

(3) Any active Flammability Reduction means introduced to allow compliance with sub-paragraph (2) must meet appendix M of CS-25.

(4) Sub-Paragraph (2) does not apply to a fuel tank if following an ignition of fuel vapours within that fuel tank the aeroplane remains capable of continued safe flight and landing.

5. Delete current paragraph 25.981 (c) as follow:

~~(c) Design precautions must be taken to achieve conditions within the fuel tanks which reduce the likelihood of flammable vapours. (See AMC 25.981(c)).~~

6. Amend paragraph (a)(1)(ii) in Part I of Appendix F to CS-25 as follows:

Appendix F

Part I – Test Criteria and Procedures for Showing Compliance with CS 25.853, 25.855 or 25.869

(a) *Material test criteria–*

(1) *Interior compartments occupied by crew or passengers.*

(i) ….

(ii) Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and non-decorative coated fabrics, leather, trays and galley furnishings, electrical conduit, ~~thermal and acoustical insulation and insulation covering,~~ air ducting, joint and edge covering, liners of Class B and E cargo or baggage compartments, floor panels of Class B, C, D, or E cargo or baggage compartments, ~~insulation blankets,~~ cargo covers and transparencies, moulded and thermoformed parts, air ducting joints, and trim strips (decorative and chafing), that are constructed of materials not covered in sub-paragraph (iv) below, must be self-extinguishing when tested vertically in accordance with the applicable portions of Part I of this Appendix or other approved equivalent means. The average burn length may not exceed 20 cm (8 inches), and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.

7. Remove and reserve paragraph (a)(2)(i) in Part I of Appendix F to CS-25 as follows:

(2) *Cargo and baggage compartments not occupied by crew or passengers.*

(i) *Reserved.* ~~Thermal and acoustic insulation (including coverings) used in each cargo and baggage compartment must be constructed of materials that meet the requirements set forth in sub-paragraph (a)(1)(ii) of Part I of this Appendix.~~

….

8. Revise CS 25.1309 to read as follow:

SUBPART F - EQUIPMENT

….

CS 25.1309 Equipment, systems and installations

...

"[…] The failure effects covered by CS 25.810(a)(1)(v) and CS~~CS~~ 25.812 are excepted from the requirements"

...

9. Add a new Part VI into Appendix F to CS-25 to read as follows:

Part VI - Test Method To Determine the Flammability and Flame Propagation Characteristics of Thermal/Acoustic Insulation Materials

Use this test method to evaluate the flammability and flame propagation characteristics of thermal/acoustic insulation when exposed to both a radiant heat source and a flame.

(a) *Definitions.*

''Flame propagation'' means the furthest distance of the propagation of visible flame towards the far end of the test specimen, measured from the midpoint of the ignition source flame. Measure this distance after initially applying the ignition source and before all flame on the test specimen is extinguished. The measurement is not a determination of burn length made after the test.

''Radiant heat source'' means an electric or air propane panel.

''Thermal/acoustic insulation'' means a material or system of materials used to provide thermal and/or acoustic protection. Examples include fibreglass or other batting material encapsulated by a film covering and foams.

''Zero point'' means the point of application of the pilot burner to the test specimen.

(b) *Test apparatus.*

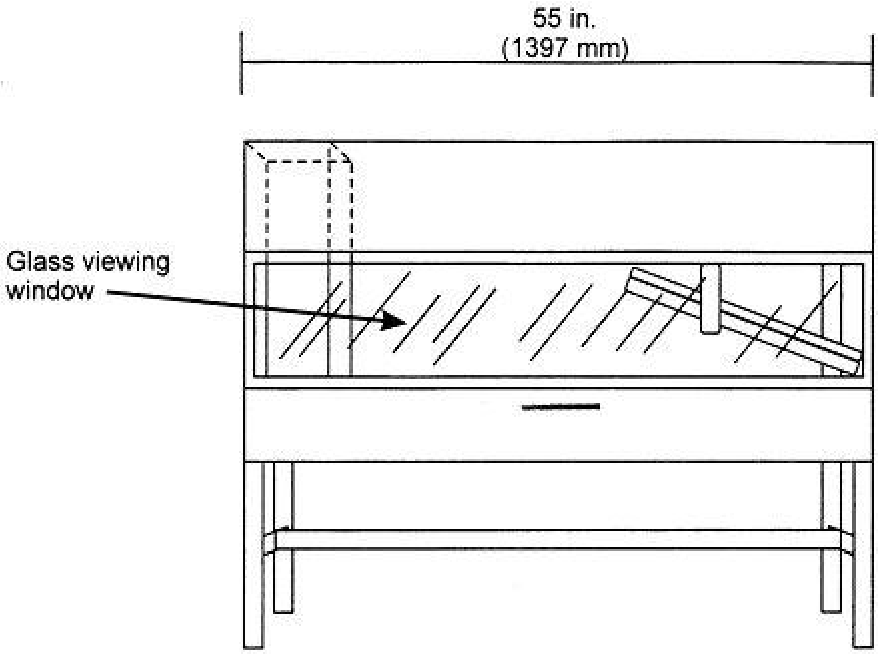

Figure 1 - Radiant Panel Test Chamber

(1) *Radiant panel test chamber.* Conduct tests in a radiant panel test chamber (see figure 1 above). Place the test chamber under an exhaust hood to facilitate clearing the chamber of smoke after each test. The radiant panel test chamber must be an enclosure 1397 mm (55 inches) long by 495 mm (19.5 inches) deep by 710 mm (28 inches) to 762 mm (maximum) (30 inches) above the test specimen. Insulate the sides, ends, and top with a fibrous ceramic insulation, such as Kaowool M^{TM} board. On the front side, provide a 52 by 12-inch (1321 by 305 mm) draft-free, high-temperature, glass window for viewing the sample during testing. Place a door below the window to provide access to the movable specimen platform holder. The bottom of the test chamber must be a sliding steel platform that has provision for securing the test specimen holder in a fixed and level position. The chamber must have an internal chimney with exterior dimensions of 129 mm (5.1 inches) wide, by 411 mm (16.2 inches) deep by 330 mm (13 inches) high at the opposite end of the chamber from the radiant energy source. The interior dimensions must be 114 mm (4.5 inches) wide by 395 mm (15.6 inches) deep. The chimney must extend to the top of the chamber (see figure 2).

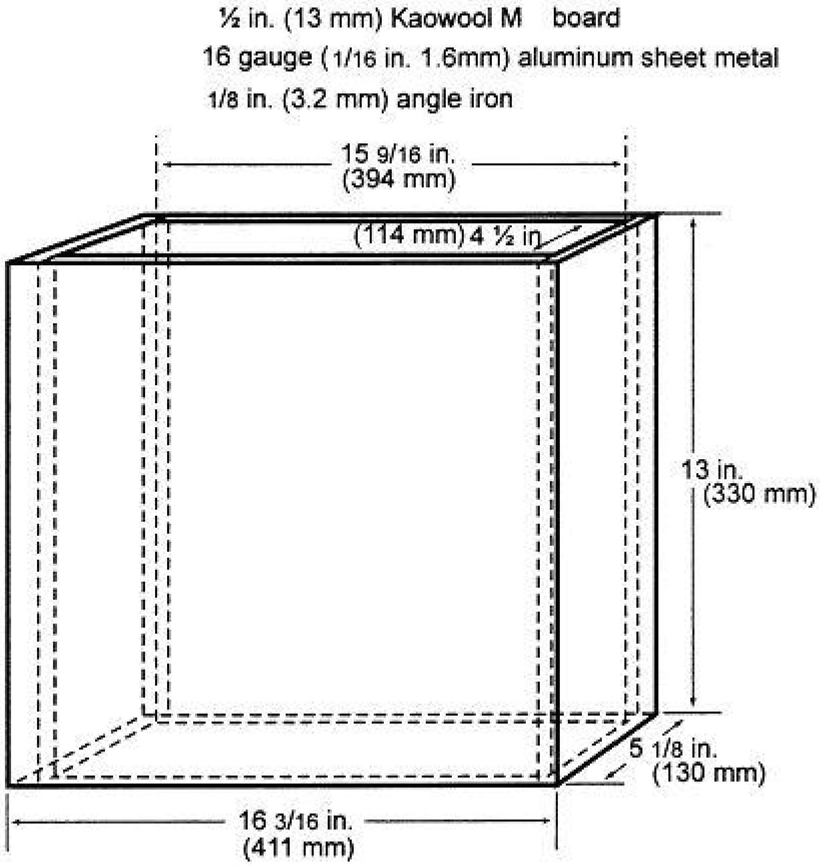

Figure 2 - Internal Chimney

(2) *Radiant heat source.* Mount the radiant heat energy source in a cast iron frame or equivalent. An electric panel must have six, 76 mm (3-inch) wide emitter strips. The emitter strips must be perpendicular to the length of the panel. The panel must have a radiation surface of 327 by 470 mm (12⅞ by 18½ inches). The panel must be capable of operating at temperatures up to 704°C (1300°F). An air propane panel must be made of a porous refractory material and have a radiation surface of 305 by 457 mm (12 by 18 inches). The panel must be capable of operating at temperatures up to 816°C (1500°F). See figures 3a and 3b.

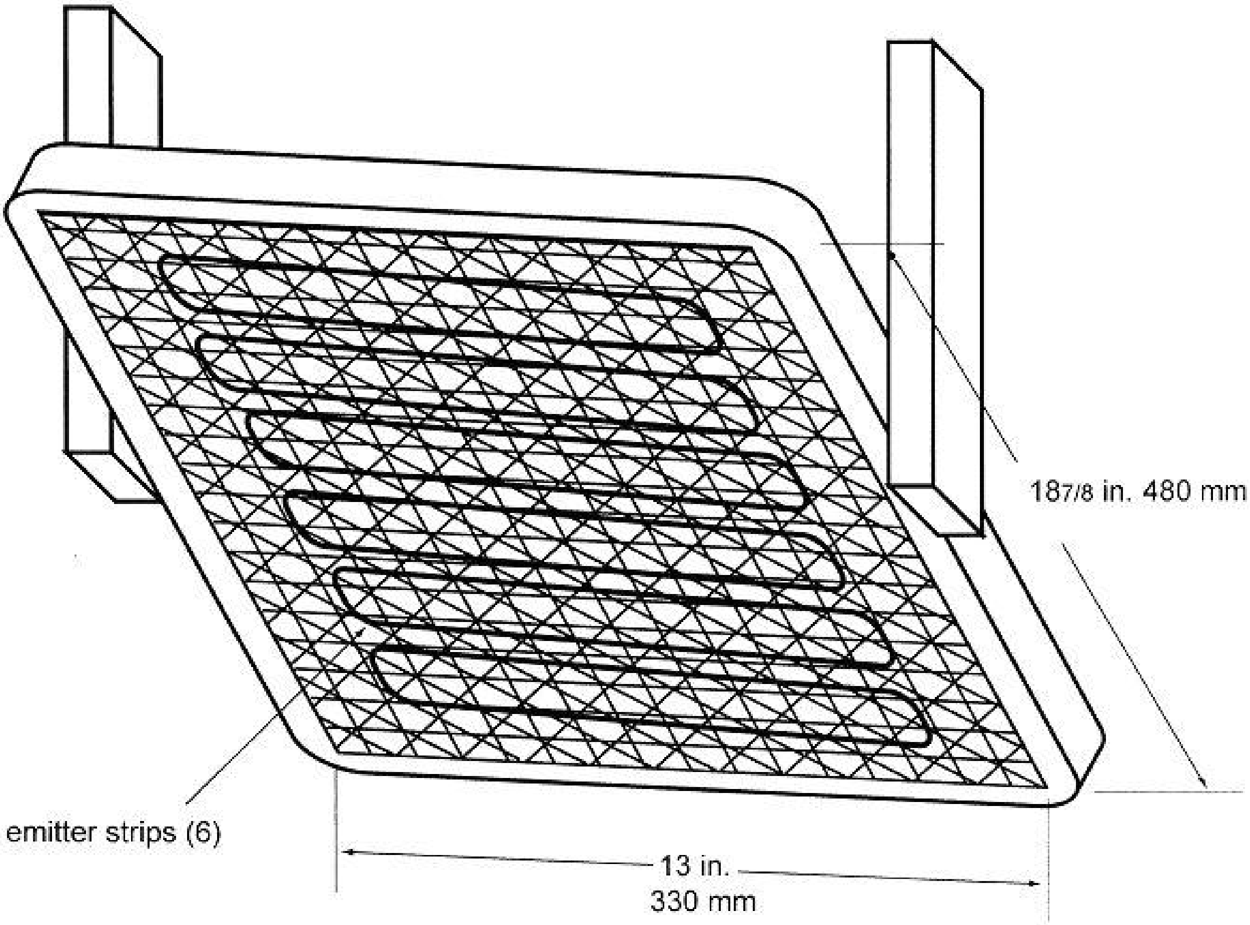

Figure 3a – Electric Panel

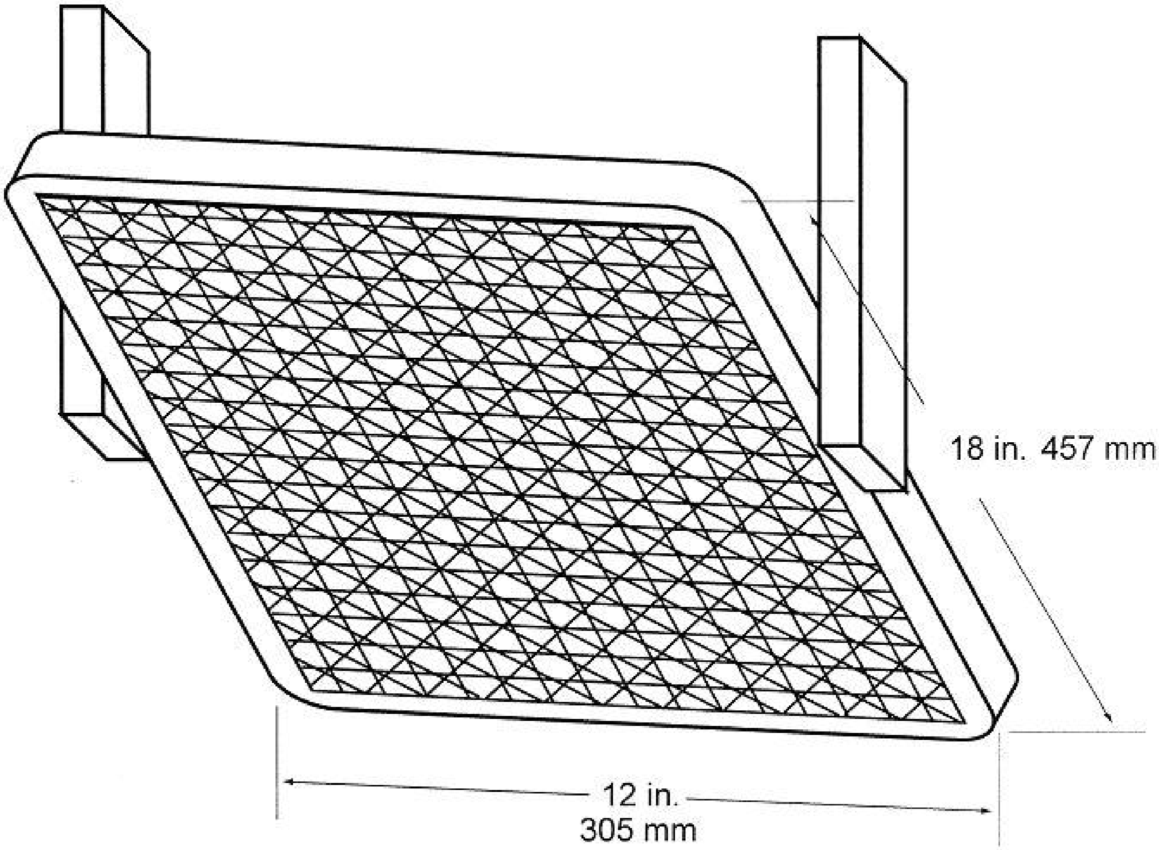

Figure 3b – Air Propane Radiant Panel

(i) *Electric radiant panel.* The radiant panel must be 3-phase and operate at 208 volts. A single-phase, 240 volt panel is also acceptable. Use a solid-state power controller and microprocessor-based controller to set the electric panel operating parameters.

(ii) *Gas radiant panel.* Use propane (liquid petroleum gas—2.1 UN 1075) for the radiant panel fuel. The panel fuel system must consist of a venturi-type aspirator for mixing gas and air at approximately atmospheric pressure. Provide suitable instrumentation for monitoring and controlling the flow of fuel and air to the panel. Include an air flow gauge, an air flow regulator, and a gas pressure gauge.

(iii) *Radiant panel placement.* Mount the panel in the chamber at 30° to the horizontal specimen plane, and 19 cm (7 ½ inches) above the zero point of the specimen.

(3) *Specimen holding system.*

(i) The sliding platform serves as the housing for test specimen placement. Brackets may be attached (via wing nuts) to the top lip of the platform in order to accommodate various thicknesses of test specimens. Place the test specimens on a sheet of Kaowool M™ board or 1260 Standard Board (manufactured by Thermal Ceramics and available in Europe), or equivalent, either resting on the bottom lip of the sliding platform or on the base of the brackets. It may be necessary to use multiple sheets of material based on the thickness of the test specimen (to meet the sample height requirement).

Typically, these non-combustible sheets of material are available in 6 mm (¼ inch) thicknesses. See figure 4. A sliding platform that is deeper than the 50.8 mm (2-inch) platform shown in figure 4 is also acceptable as long as the sample height requirement is met.

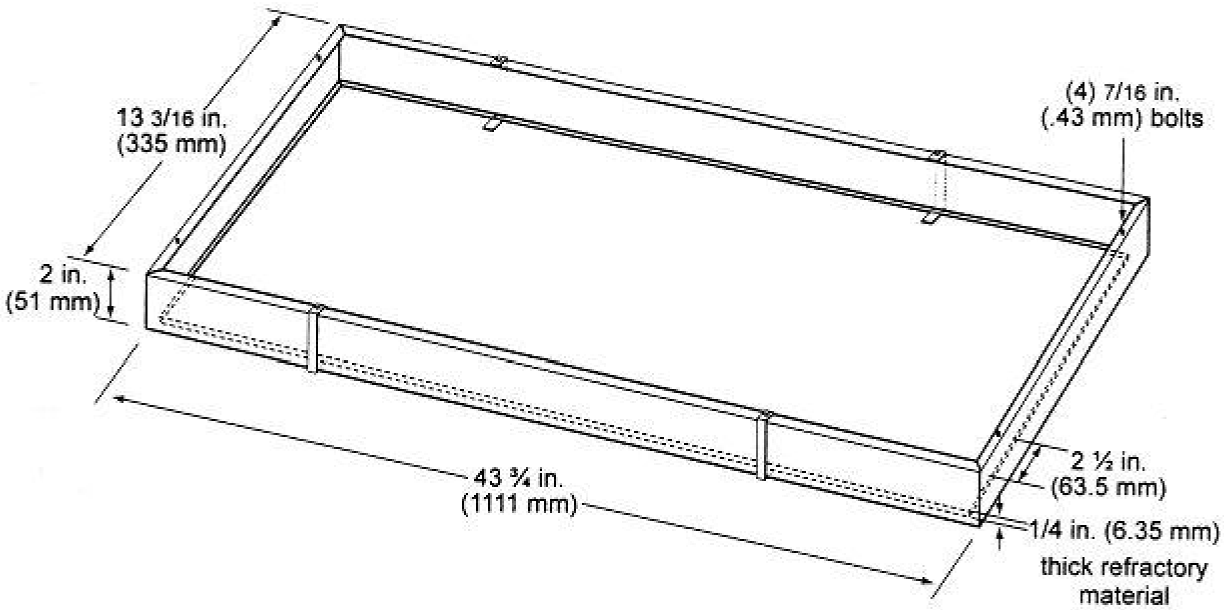

Figure 4 - Sliding Platform

(ii) Attach a 13 mm (½ inch) piece of Kaowool M™ board or other high temperature material measuring 1054 by 210 mm (41½ by 8¼ inches) to the back of the platform. This board serves as a heat retainer and protects the test specimen from excessive preheating. The height of this board must not impede the sliding platform movement (in and out of the test chamber). If the platform has been fabricated such that the back side of the platform is high enough to prevent excess preheating of the specimen when the sliding platform is out, a retainer board is not necessary.

(iii) Place the test specimen horizontally on the non-combustible board(s). Place a steel retaining/securing frame fabricated of mild steel, having a thickness of 3.2 mm (⅛ inch) and overall dimensions of 584 by 333 mm (23 by 13⅛ inches) with a specimen opening of 483 by 273 mm (19 by 10¾ inches) over the test specimen. The front, back, and right portions of the top flange of the frame must rest on the top of the sliding platform, and the bottom flanges must pinch all 4 sides of the test specimen. The right bottom flange must be flush with the sliding platform. See figure 5.

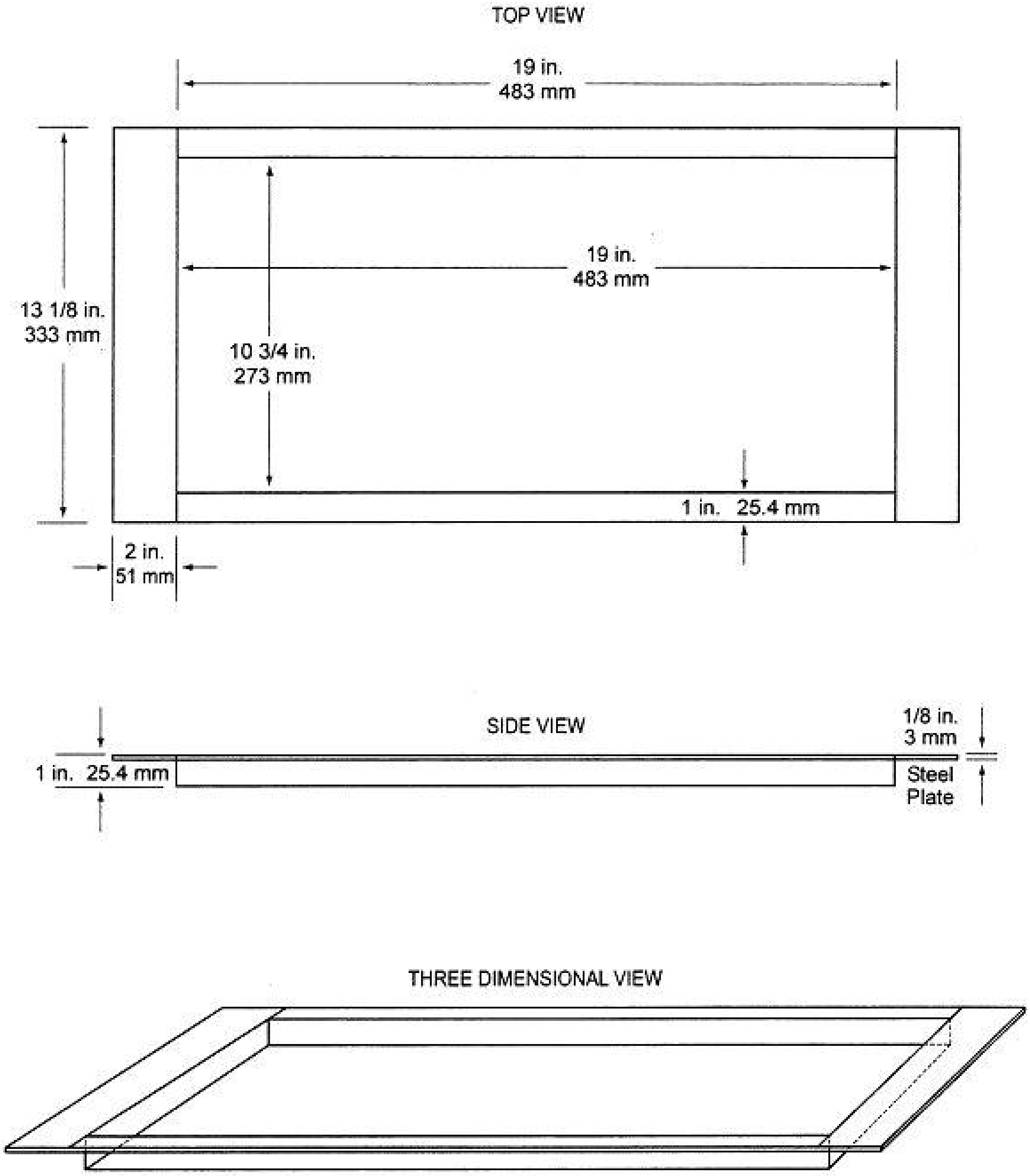

Figure 5: 3 views

(4) *Pilot Burner*. The pilot burner used to ignite the specimen must be a Bernzomatic™ (or equivalent) commercial propane venturi torch with an axially symmetric burner tip and a propane supply tube with an orifice diameter of 0.15 mm (0.006 inches). The length of the burner tube must be 71 mm (2⅞ inches). The propane flow must be adjusted via gas pressure through an in-line regulator to produce a blue inner cone length of 19 mm (¾ inch). A 19 mm (¾ inch) guide (such as a thin strip of metal) may be soldered to the top of the burner to aid in setting the flame height. The overall flame length must be approximately 127 mm (5 inches) long. Provide a way to move the burner out of the ignition position so that the flame is horizontal and at least 50 mm (2 inches) above the specimen plane. See figure 6.

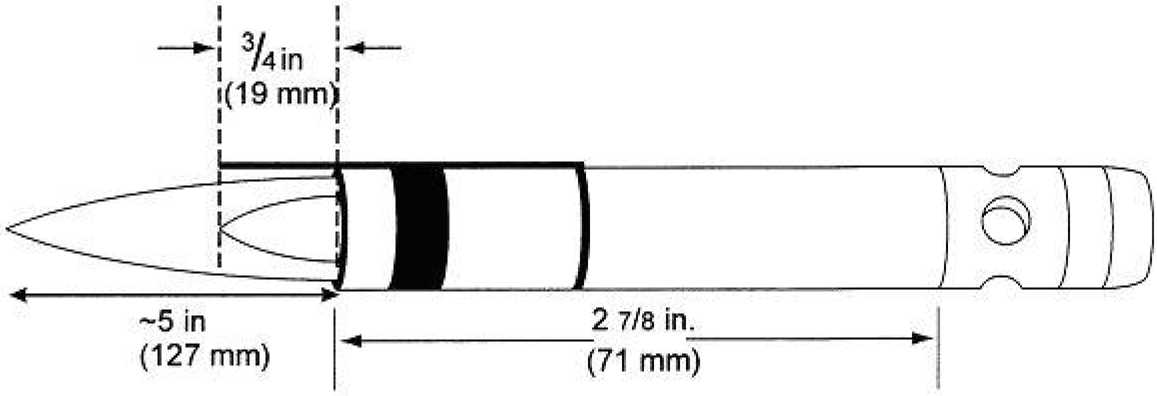

Figure 6 – Propane Pilot Burner

(5) *Thermocouples.* Install a 24 American Wire Gauge (AWG) Type K (Chromel-Alumel) thermocouple in the test chamber for temperature monitoring. Insert it into the chamber through a small hole drilled through the back of the chamber. Place the thermocouple so that it extends 279 mm (11 inches) out from the back of the chamber wall, 292 mm (11½ inches) from the right side of the chamber wall, and is 51 mm (2 inches) below the radiant panel. The use of other thermocouples is optional.

(6) *Calorimeter.* The calorimeter must be a one-inch cylindrical water-cooled, total heat flux density, foil type Gardon Gage that has a range of 0 to 5.7 Watts/cm^2 (0 to 5 BTU/ft^2 sec).

(7) *Calorimeter calibration specification and procedure.*

(i) *Calorimeter specification.*

(A) Foil diameter must be 6.35 ± 0.13 mm (0.25 ± 0.005 inches).

(B) Foil thickness must be 0.013 ± 0.0025 mm (0.0005 ± 0.0001 inches).

(C) Foil material must be thermocouple grade Constantan.

(D) Temperature measurement must be a Copper Constantan thermocouple.

(E) The copper center wire diameter must be 0.013 mm (0.0005 inches).

(F) The entire face of the calorimeter must be lightly coated with ‘‘Black Velvet’’ paint having an emissivity of 96 or greater.

(ii) *Calorimeter calibration.*

(A) The calibration method must be by comparison to a like standardized transducer.

(B) The standardized transducer must meet the specifications given in paragraph (b)(6) of Part VI of this Appendix.

(C) Calibrate the standard transducer against a primary standard traceable to the National Institute of Standards and Technology (NIST).

(D) The method of transfer must be a heated graphite plate.

(E) The graphite plate must be electrically heated, have a clear surface area on each side of the plate of at least 51 by 51 mm (2 by 2 inches), and be 3.2 ± 1.6 mm (⅛± 1⁄16 inch) thick.

(F) Center the 2 transducers on opposite sides of the plates at equal distances from the plate.

(G) The distance of the calorimeter to the plate must be no less than 1.6 mm (0.0625 inches), nor greater than 9.5 mm (0.375 inches).

(H) The range used in calibration must be at least 0–3.9 Watts/cm^2 (0–3.5 BTUs/ft^2 sec) and no greater than 0–6.4 Watts/cm^2 (0–5.7 BTUs/ft^2 sec).

(I) The recording device used must record the 2 transducers simultaneously or at least within 1⁄10 of each other.

(8) *Calorimeter fixture.* With the sliding platform pulled out of the chamber, install the calorimeter holding frame and place a sheet of non-combustible material in the bottom of the sliding platform adjacent to the holding frame. This will prevent heat losses during calibration. The frame must be 333 mm (13⅛ inches) deep (front to back) by 203 mm (8 inches) wide and must rest on the top of the sliding platform. It must be fabricated of 3.2 mm (⅛ inch) flat stock steel and have an opening that accommodates a 12.7 mm (½ inch) thick piece of refractory board, which is level with the top of the sliding platform. The board must have three 25.4 mm (1 inch) diameter holes drilled through the board for calorimeter insertion. The distance to the radiant panel surface from the centreline of the first hole (''zero'' position) must be 191 ± 3 mm (7½ ± ⅛ inches). The distance between the centreline of the first hole to the centreline of the second hole must be 51 mm (2 inches). It must also be the same distance from the centreline of the second hole to the centreline of the third hole. *See* figure 7. A calorimeter holding frame that differs in construction is acceptable as long as the height from the centreline of the first hole to the radiant panel and the distance between holes is the same as described in this paragraph.

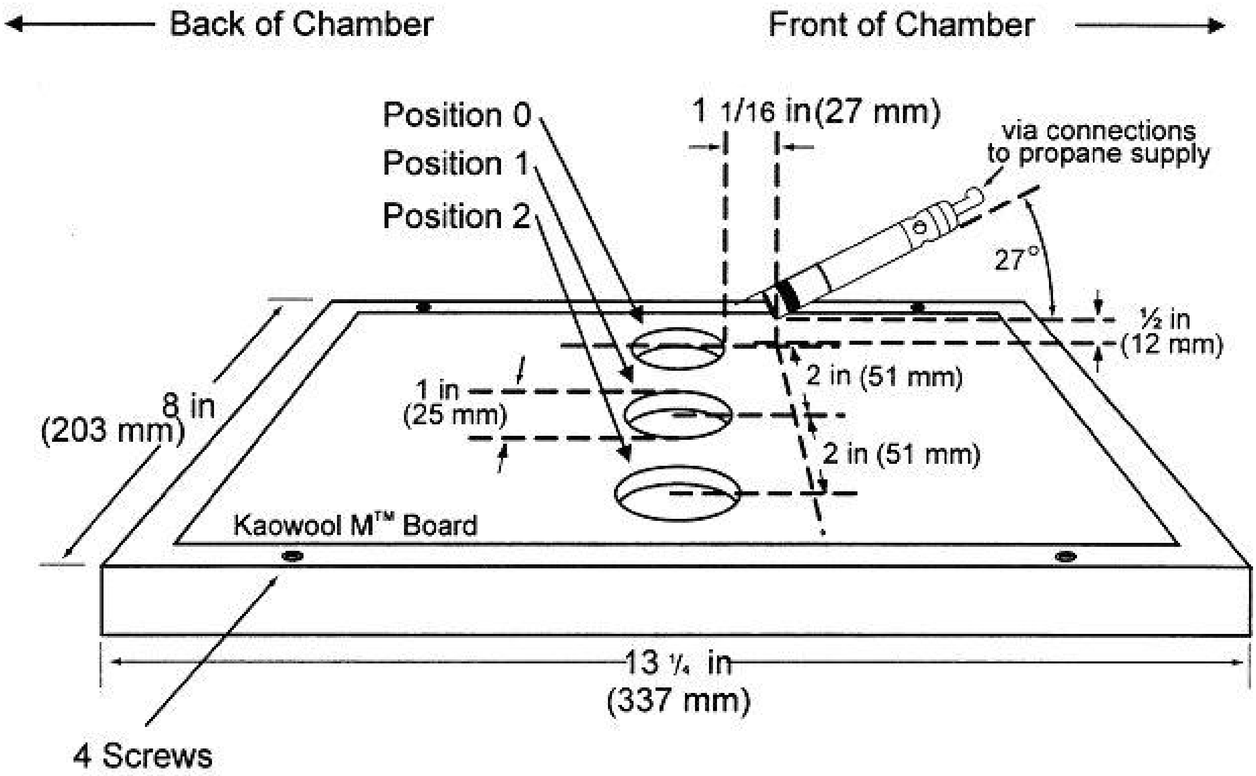

Figure 7 - Calorimeter Holding Frame

(9) *Instrumentation.* Provide a calibrated recording device with an appropriate range or a computerized data acquisition system to measure and record the outputs of the calorimeter and the thermocouple. The data acquisition system must be capable of recording the calorimeter output every second during calibration.

(10) *Timing device.* Provide a stopwatch or other device, accurate to ± 1 second/hour, to measure the time of application of the pilot burner flame.

(c*) Test specimens.*

(1) *Specimen preparation.* Prepare and test a minimum of three test specimens. If an oriented film cover material is used, prepare and test both the warp and fill directions.

(2) *Construction.* Test specimens must include all materials used in construction of the insulation (including batting, film, scrim, tape etc.). Cut a piece of core material such as foam or fiberglass, and cut a piece of film cover material (if used) large enough to cover the core material. Heat sealing is the preferred method of preparing fiberglass samples, since they can be made without compressing the fiberglass (‘‘box sample’’). Cover materials that are not heat sealable may be stapled, sewn, or taped as long as the cover material is over-cut enough to be drawn down the sides without compressing the core material. The fastening means should be as continuous as possible along the length of the seams. The specimen thickness must be of the same thickness as installed in the airplane.

(3) *Specimen Dimensions.* To facilitate proper placement of specimens in the sliding platform housing, cut non-rigid core materials, such as fibreglass, 318 mm (12½ inches) wide by 584 mm (23 inches) long. Cut rigid materials, such as foam, 292 ± 6 mm (11½ ± ¼ inches) wide by 584 mm (23 inches) long in order to fit properly in the sliding platform housing and provide a flat, exposed surface equal to the opening in the housing.

(d) *Specimen conditioning.* Condition the test specimens at 21 ± 2°C (70 ± 5°F) and 55% ± 10% relative humidity, for a minimum of 24 hours prior to testing.

(e) *Apparatus Calibration*.

(1) With the sliding platform out of the chamber, install the calorimeter holding frame. Push the platform back into the chamber and insert the calorimeter into the first hole (‘‘zero’’ position). *See* figure 7. Close the bottom door located below the sliding platform. The distance from the centerline of the calorimeter to the radiant panel surface at this point must be 191 ± 3 mm (7½ ± ⅛ inches). Prior to igniting the radiant panel, ensure that the calorimeter face is clean and that there is water running through the calorimeter.

(2) Ignite the panel. Adjust the fuel/air mixture to achieve 1.7 Watts/cm2 ± 5% (1.5 BTUs/ft2 sec ± 5%) at the ‘‘zero’’ position. If using an electric panel, set the power controller to achieve the proper heat flux. Allow the unit to reach steady state (this may take up to 1 hour). The pilot burner must be off and in the down position during this time.

(3) After steady-state conditions have been reached, move the calorimeter 51 mm (2 inches) from the ‘‘zero’’ position (first hole) to position 1 and record the heat flux. Move the calorimeter to position 2 and record the heat flux. Allow enough time at each position for the calorimeter to stabilize. Table 1 depicts typical calibration values at the three positions.

TABLE 1.—CALIBRATION TABLE

Position	BTU's/ft^2 sec	Watts/cm^2
''Zero'' Position.	1.5	1.7
Position 1	1.51–1.50–1.49	1.71–1.70–1.69
Position 2	1.43–1.44	1.62–1.63

(4) Open the bottom door. Remove the calorimeter and holder fixture. Use caution as the fixture is very hot.

(f) *Test Procedure.*

(1) Ignite the pilot burner. Ensure that it is at least 51 mm (2 inches) above the top of the platform. The burner must not contact the specimen until the test begins.

(2) Place the test specimen in the sliding platform holder. Ensure that the test sample surface is level with the top of the platform. At ''zero'' point, the specimen surface must be 191 ± 3 mm (7 ½ ± ⅛ inches) below the radiant panel.

(3) Place the retaining/securing frame over the test specimen. It may be necessary (due to compression) to adjust the sample (up or down) in order to maintain the distance from the sample to the radiant panel 191 ± 3 mm (7½ ± ⅛ inches) at ''zero'' position). With film/fiberglass assemblies, it is critical to make a slit in the film cover to purge any air inside. This allows the operator to maintain the proper test specimen position (level with the top of the platform) and to allow ventilation of gases during testing. A longitudinal slit, approximately 2 inches (51 mm) in length, must be centered 76 ± 13 mm (3 ± ½ inches) from the left flange of the securing frame. A utility knife is acceptable for slitting the film cover.

(4) Immediately push the sliding platform into the chamber and close the bottom door.

(5) Bring the pilot burner flame into contact with the center of the specimen at the ''zero'' point and simultaneously start the timer. The pilot burner must be at a 27° angle with the sample and be approximately ½ inch (12 mm) above the sample. See figure 7. A stop, as shown in figure 8, allows the operator to position the burner correctly each time.

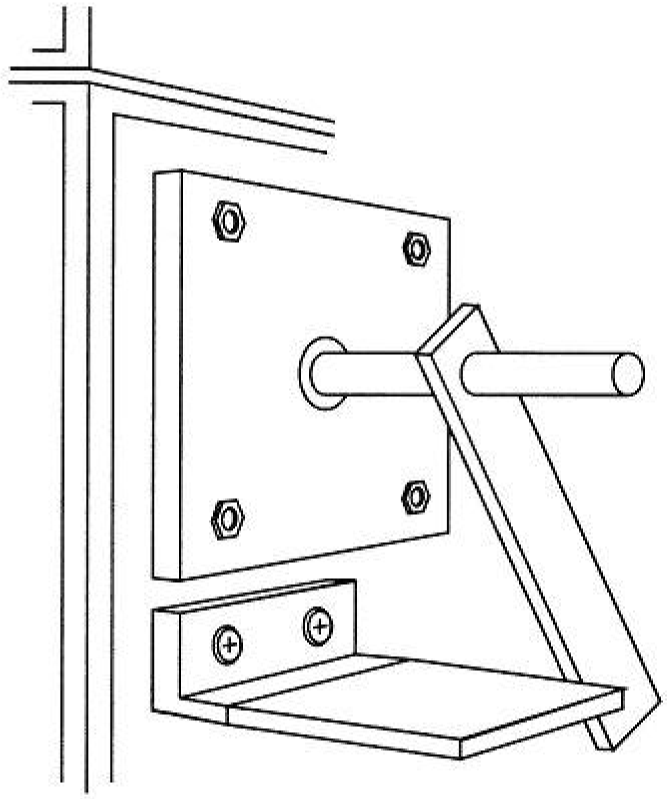

Figure 8 - Propane Burner Stop

(6) Leave the burner in position for 15 seconds and then remove to a position at least 51 mm (2 inches) above the specimen.

(g) *Report.*

(1) Identify and describe the test specimen.

(2) Report any shrinkage or melting of the test specimen.

(3) Report the flame propagation distance. If this distance is less than 51 mm (2 inches), report this as a pass (no measurement required).

(4) Report the after-flame time.

(h) *Requirements.*

(1) There must be no flame propagation beyond 51 mm (2 inches) to the left of the centerline of the pilot flame application.

(2) The flame time after removal of the pilot burner may not exceed 3 seconds on any specimen.

10. Add a new Part VII into Appendix F to CS-25 to read as follows:

Part VII - Test Method To Determine the Burnthrough Resistance of Thermal/Acoustic Insulation Materials

Use the following test method to evaluate the burnthrough resistance characteristics of aircraft thermal/acoustic insulation materials when exposed to a high intensity open flame.

(a) *Definitions.*

Burnthrough time means the time, in seconds, for the burner flame to penetrate the test specimen, and/or the time required for the heat flux to reach 2.27 W/cm^2 (2.0 Btu/ft^2 sec) on the inboard side, at a distance of 30.5 cm (12 inches) from the front surface of the insulation blanket test frame, whichever is sooner. The burnthrough time is measured at the inboard side of each of the insulation blanket specimens.

Insulation blanket specimen means one of two specimens positioned in either side of the test rig, at an angle of 30° with respect to vertical.

Specimen set means two insulation blanket specimens. Both specimens must represent the same production insulation blanket construction and materials, proportioned to correspond to the specimen size.

(b) *Apparatus.*

(1) The arrangement of the test apparatus is shown in figures 1 and 2 and must include the capability of swinging the burner away from the test specimen during warm-up.

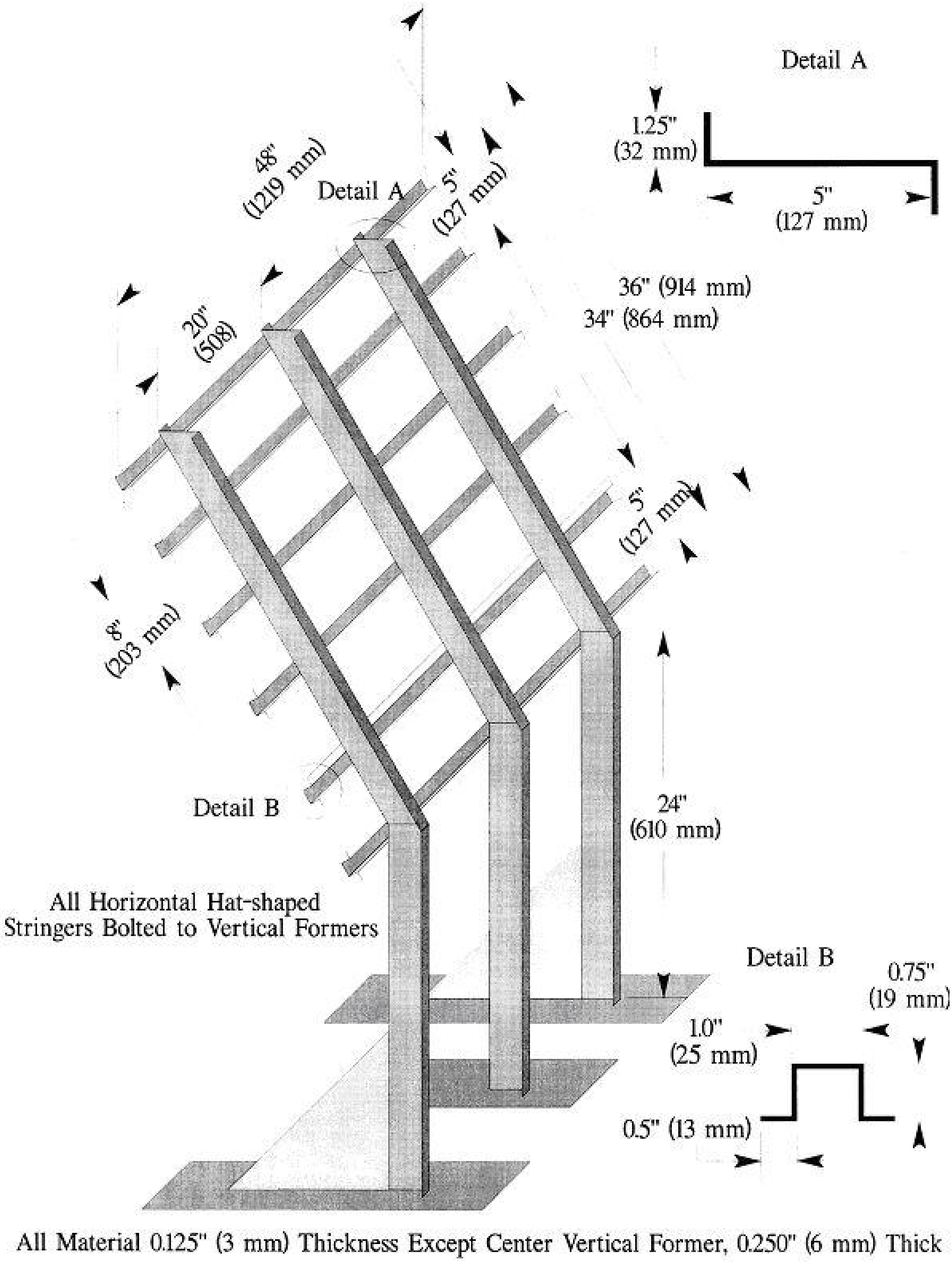

Figure 1 - Burnthrough Test Apparatus Specimen Holder

(2) *Test burner.* The test burner must be a modified gun-type such as the Park Model DPL 3400 or equivalent. Flame characteristics are highly dependent on actual burner setup. Parameters such as fuel pressure, nozzle depth, stator position, and intake airflow must be properly adjusted to achieve the correct flame output.

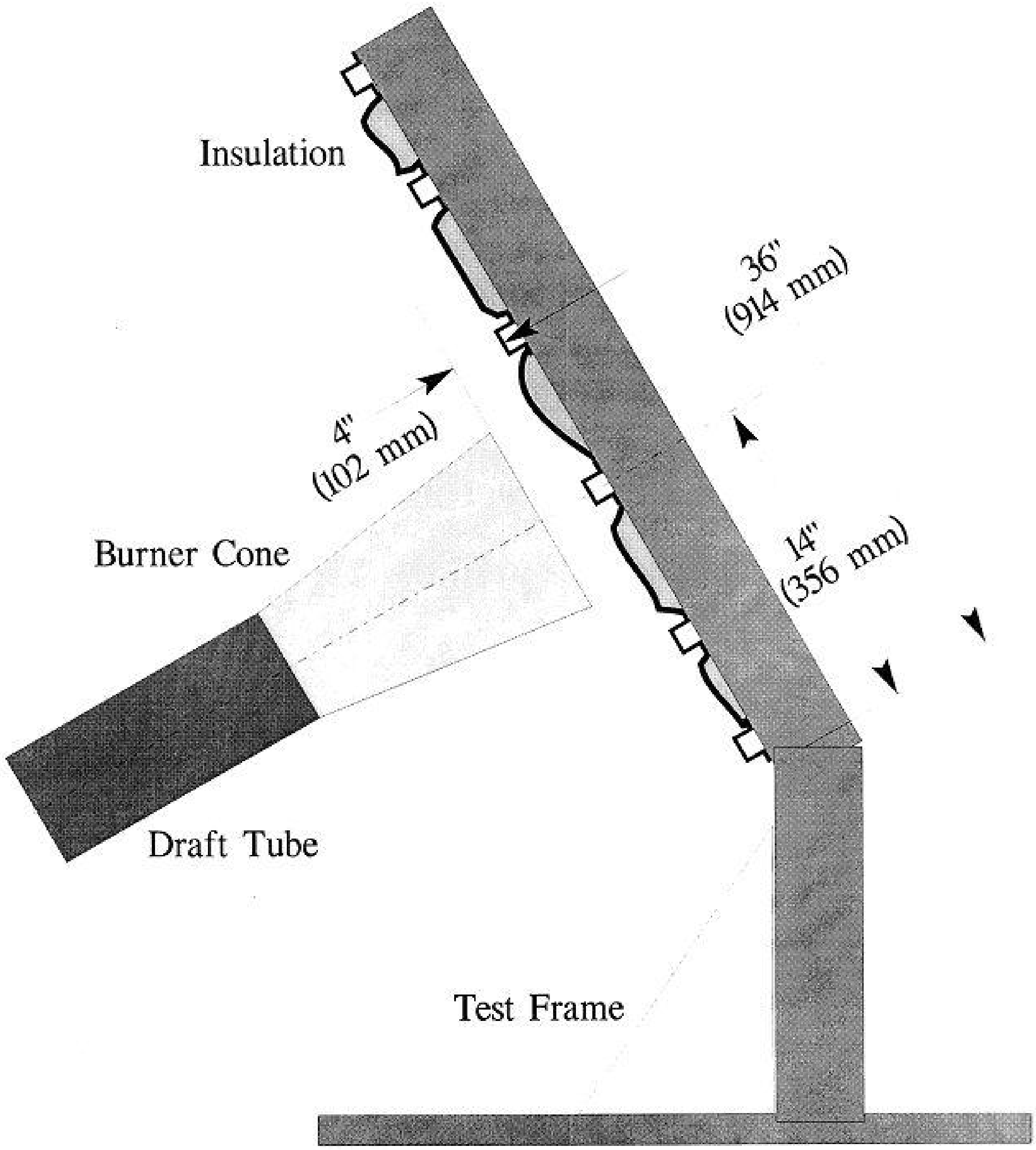

Figure 2 – Burnthrough Test Apparatus

(i) *Nozzle.* A nozzle must maintain the fuel pressure to yield a nominal 0.378 l/min (6.0 gal/hr) fuel flow. A Monarch-manufactured 80° PL (hollow cone) nozzle nominally rated at 6.0 gal/hr at 100 lb/in^2 (0.71 MPa) delivers a proper spray pattern.

(ii) *Fuel Rail.* The fuel rail must be adjusted to position the fuel nozzle at a depth of 8 mm (0.3125 inch) from the end plane of the exit stator, which must be mounted in the end of the draft tube.

(iii) *Internal Stator.* The internal stator, located in the middle of the draft tube, must be positioned at a depth of 95 mm (3.75 inches) from the tip of the fuel nozzle. The stator must also be positioned such that the integral igniters are located at an angle midway between the 10 and 11 o'clock position, when viewed looking into the draft tube. Minor deviations to the igniter angle are acceptable if the temperature and heat flux requirements conform to the requirements of paragraph (e) of Part VII of this Appendix.

(iv) *Blower Fan.* The cylindrical blower fan used to pump air through the burner must measure 133 mm (5.25 inches) in diameter by 89 mm (3.5 inches) in width.

(v) *Burner cone.* Install a 305 ± 3-mm (12 ± 0.125-inch) burner extension cone at the end of the draft tube. The cone must have an opening 152 ± 3 mm (6 ± 0.125 inches) high and 280 ± 3 mm (11 ± 0.125 inches) wide (see figure 3).

(vi) *Fuel.* Use JP–8, Jet A, or their international equivalent, at a flow rate of 0.378 ± 0.0126 l/min (6.0 ± 0.2 gal/hr). If this fuel is unavailable, ASTM K2 fuel (Number 2 grade kerosene) or ASTM D2 fuel (Number 2 grade fuel oil or Number 2 diesel fuel) are acceptable if the nominal fuel flow rate, temperature, and heat flux measurements conform to the requirements of paragraph (e) of Part VII of this Appendix.

(vii) *Fuel pressure regulator.* Provide a fuel pressure regulator, adjusted to deliver a nominal 0.378 l/min (6.0 gal/hr) flow rate. An operating fuel pressure of 0.71 MPa (100 lb/in^2) for a nominally rated 6.0 gal/hr 80° spray angle nozzle (such as a PL type) delivers 0.378 ± 0.0126 l/ min (6.0 ± 0.2 gal/hr).

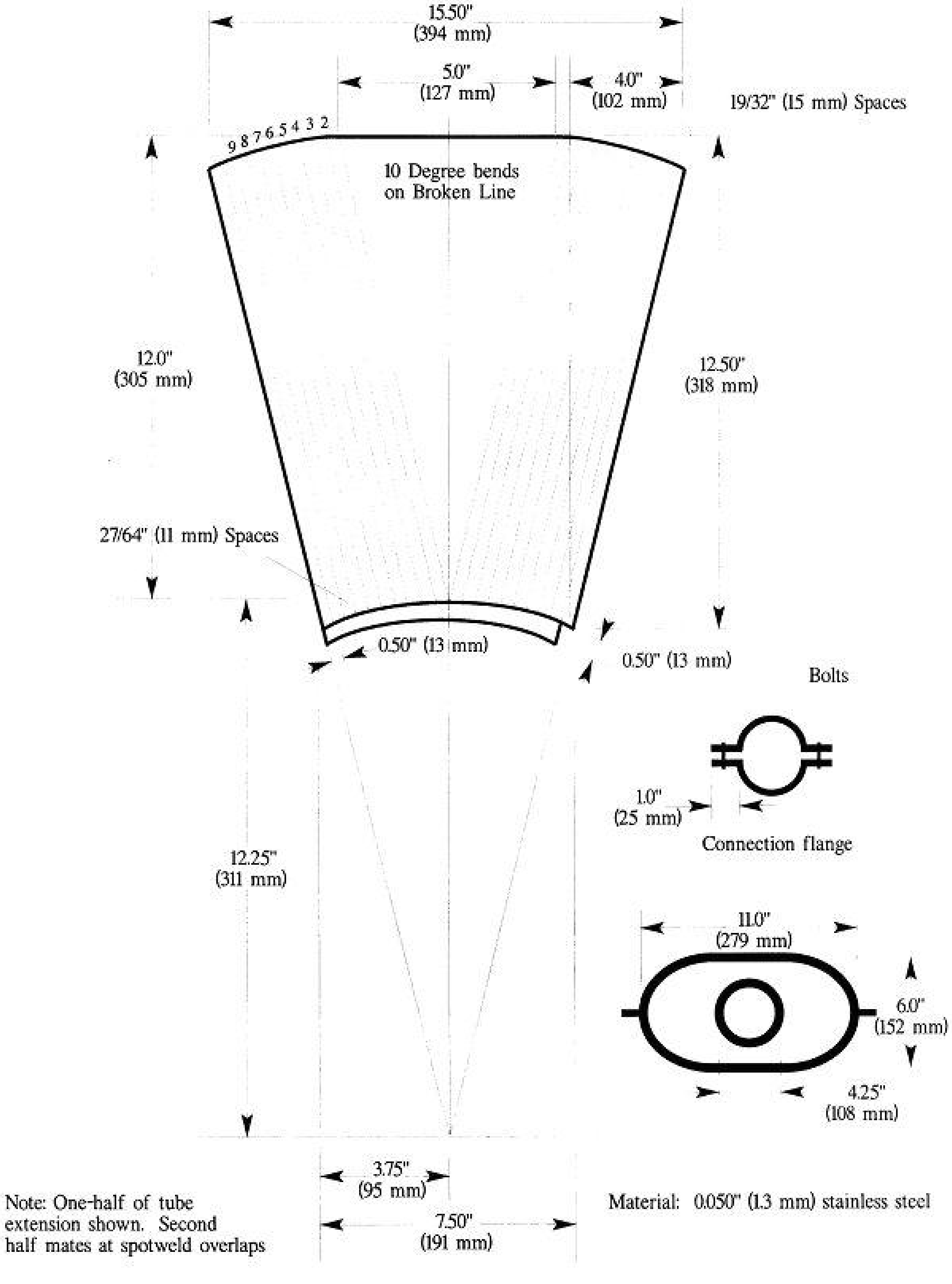

Figure 3 – Burner Draft Tube Extension Cone Diagram

(3) *Calibration rig and equipment*.

(i) Construct individual calibration rigs to incorporate a calorimeter and thermocouple rake for the measurement of heat flux and temperature. Position the calibration rigs to allow movement of the burner from the test rig position to either the heat flux or temperature position with minimal difficulty.

(ii) *Calorimeter.* The calorimeter must be a total heat flux, foil type Gardon Gage of an appropriate range such as 0–22.7 W/cm^2 (0–20 Btu/ft^2 sec), accurate to ± 3% of the indicated reading. The heat flux calibration method must be in accordance with paragraph (b)(7) of Part VI of this Appendix.

(iii) *Calorimeter mounting.* Mount the calorimeter in a 152 by 305 ± 3 mm (6 by 12 ± 0.125 inches) by 19 ± 3 mm (0.75 ± 0.125 inches) thick insulating block which is attached to the heat flux calibration rig during calibration (figure 4). Monitor the insulating block for deterioration and replace it when necessary. Adjust the mounting as necessary to ensure that the calorimeter face is parallel to the exit plane of the test burner cone.

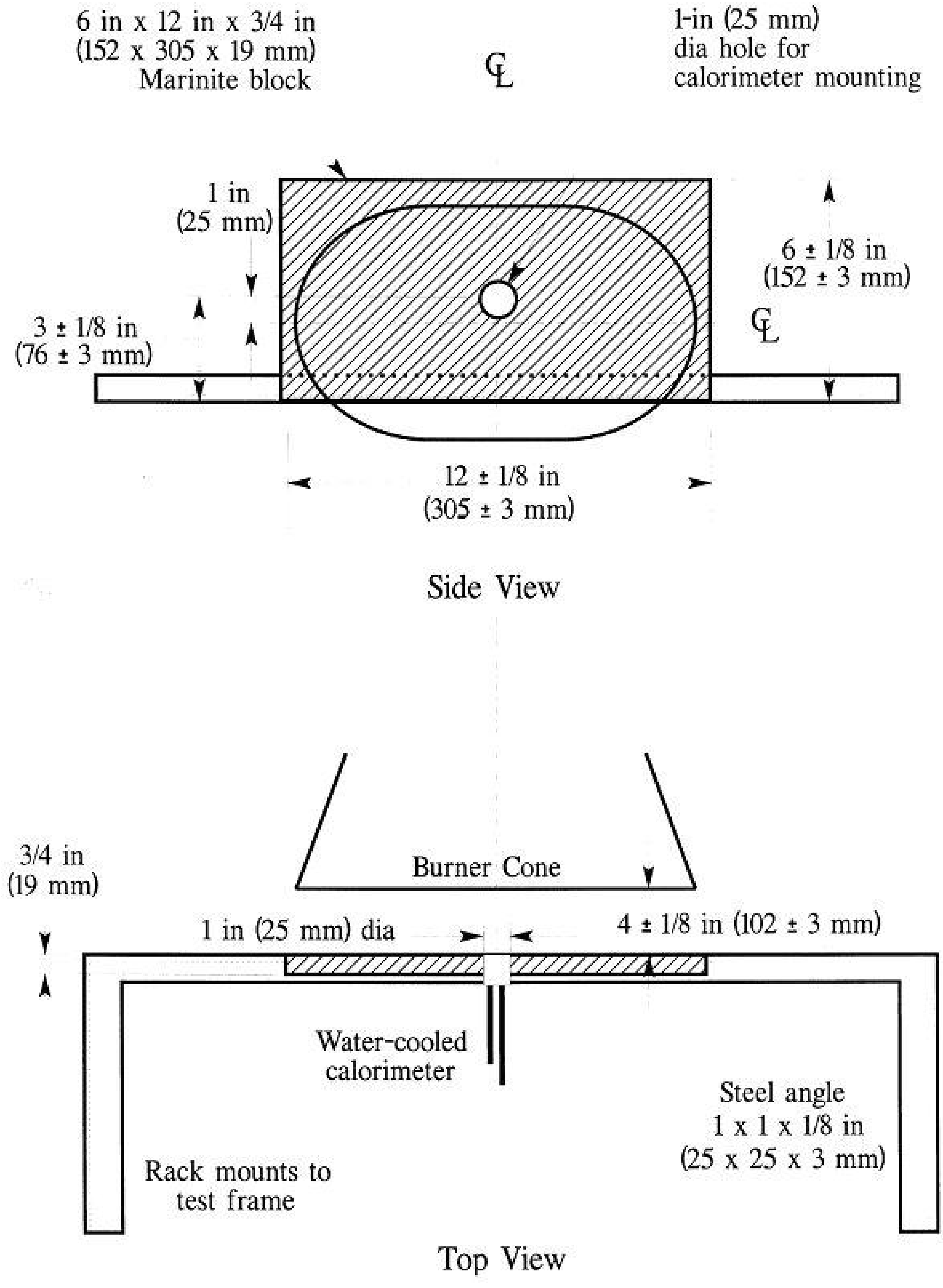

Figure 4 - Calorimeter Position Relative to Burner Cone

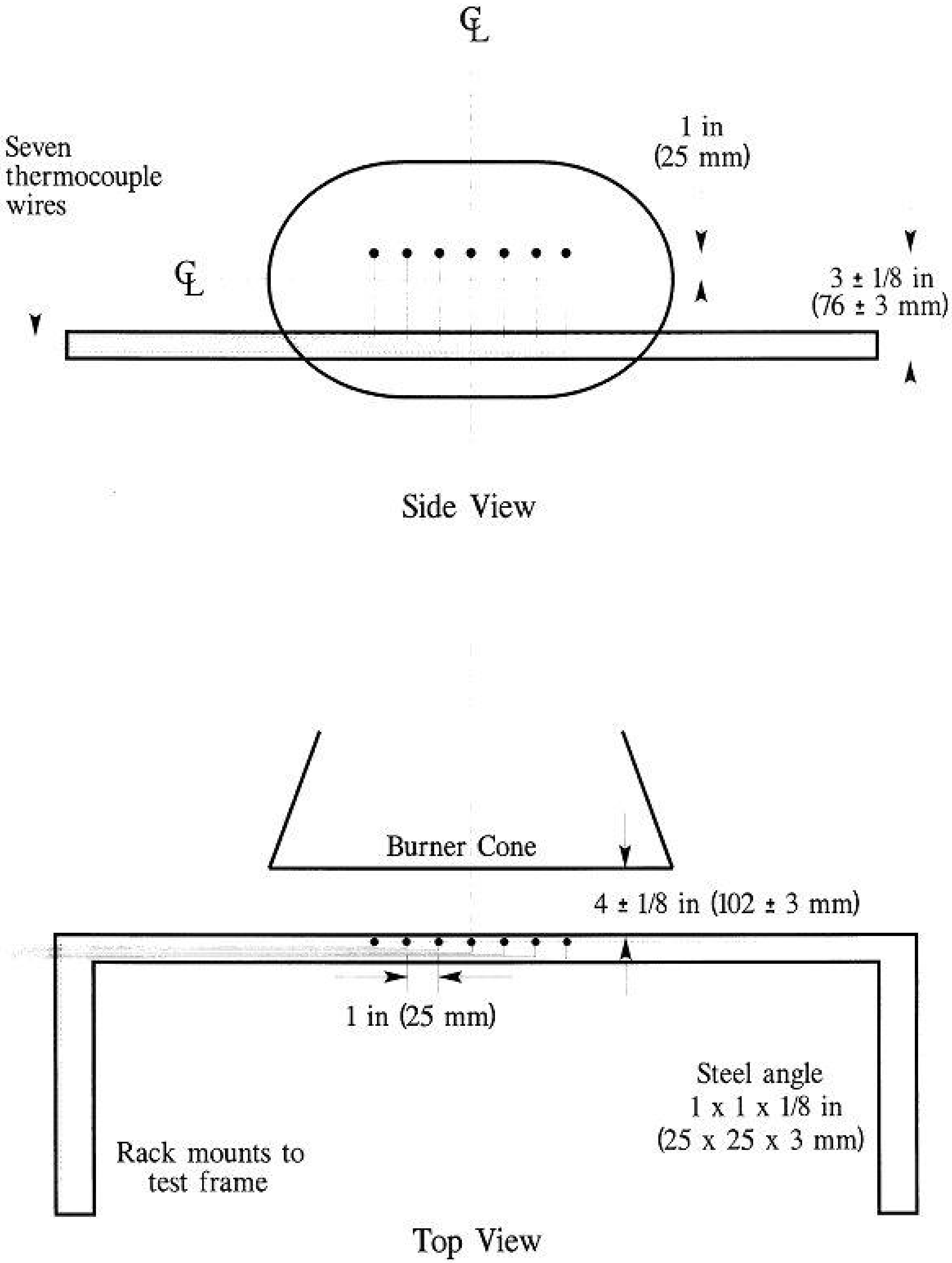

Figure 5 – Thermocouple Rake Position Relative to Burner Cone

(iv) *Thermocouples*. Provide seven 3.2 mm (⅛-inch) ceramic packed, metal sheathed, type K (Chromel-alumel), grounded junction thermocouples with a nominal 24 American Wire Gauge (AWG) size conductor for calibration. Attach the thermocouples to a steel angle bracket to form a thermocouple rake for placement in the calibration rig during burner calibration (figure 5).

(v) *Air velocity meter.* Use a vane-type air velocity meter to calibrate the velocity of air entering the burner. An Omega Engineering Model HH30A or equivalent is satisfactory. Use a suitable adapter to attach the measuring device to the inlet side of the burner to prevent air from entering the burner other than through the measuring device, which would produce erroneously low readings. Use a flexible duct, measuring 102 mm (4 inches) wide by 6.1 meters (20 feet) long, to supply fresh air to the burner intake to prevent damage to the air velocity meter from ingested soot. An optional airbox permanently mounted to the burner intake area can effectively house the air velocity meter and provide a mounting port for the flexible intake duct.

(4) *Test specimen mounting frame.* Make the mounting frame for the test specimens of 3.2 mm (⅛-inch) thick steel as shown in figure 1, except for the centre vertical former, which should be 6.4 mm (¼-inch) thick to minimize warpage. The specimen mounting frame stringers (horizontal) should be bolted to the test frame formers (vertical) such that the expansion of the stringers will not cause the entire structure to warp. Use the mounting frame for mounting the two insulation blanket test specimens as shown in figure 2.

(5) *Backface calorimeters.* Mount two total heat flux Gardon type calorimeters behind the insulation test specimens on the back side (cold) area of the test specimen mounting frame as shown in figure 6. Position the calorimeters along the same plane as the burner cone centreline, at a distance of 102 mm (4 inches) from the vertical centreline of the test frame.

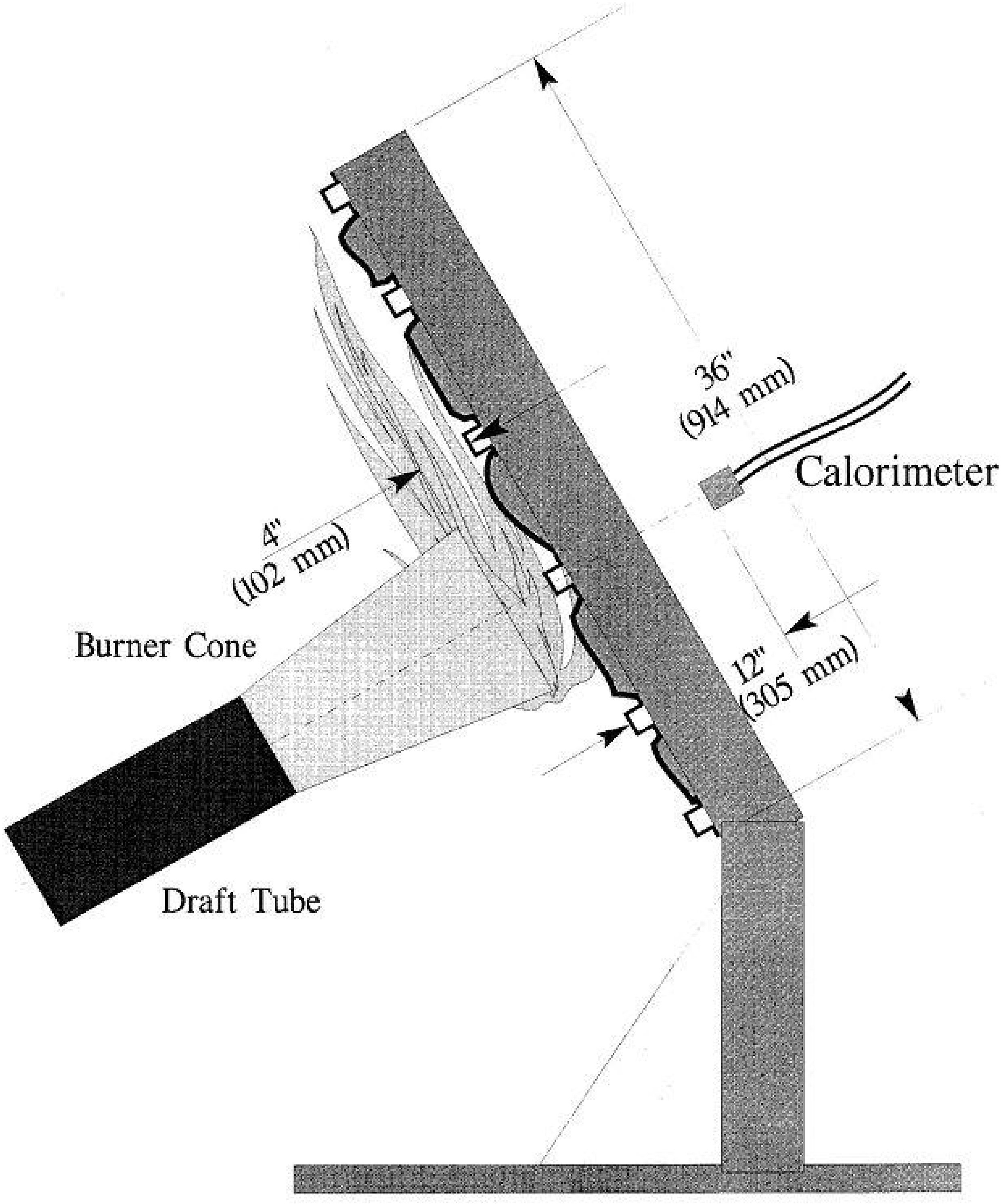

Figure 6 - . Position of Backface Calorimeters Relative to Test Specimen Frame

(i) The calorimeters must be a total heat flux, foil type Gardon Gage of an appropriate range such as 0–5.7 W/cm2 (0–5 Btu/ft^2 sec), accurate to ± 3% of the indicated reading. The heat flux calibration method must comply with paragraph (b)(7) of Part VI of this Appendix.

(6) *Instrumentation.* Provide a recording potentiometer or other suitable calibrated instrument with an appropriate range to measure and record the outputs of the calorimeter and the thermocouples.

(7) *Timing device.* Provide a stopwatch or other device, accurate to ± 1%, to measure the time of application of the burner flame and burnthrough time.

(8) *Test chamber.* Perform tests in a suitable chamber to reduce or eliminate the possibility of test fluctuation due to air movement. The chamber must have a minimum floor area of 305 by 305 cm (10 by 10 feet).

(i) *Ventilation hood.* Provide the test chamber with an exhaust system capable of removing the products of combustion expelled during tests.

(c) *Test Specimens.*

(1) *Specimen preparation.* Prepare a minimum of three specimen sets of the same construction and configuration for testing.

(2) *Insulation blanket test specimen*.

(i) For batt-type materials such as fibreglass, the constructed, finished blanket specimen assemblies must be 81.3 wide by 91.4 cm long (32 inches by 36 inches), exclusive of heat sealed film edges.

(ii) For rigid and other non-conforming types of insulation materials, the finished test specimens must fit into the test rig in such a manner as to replicate the actual in-service installation.

(3) *Construction.* Make each of the specimens tested using the principal components (i.e., insulation, fire barrier material if used, and moisture barrier film) and assembly processes (representative seams and closures).

(i) *Fire barrier material.* If the insulation blanket is constructed with a fire barrier material, place the fire barrier material in a manner reflective of the installed arrangement For example, if the material will be placed on the outboard side of the insulation material, inside the moisture film, place it the same way in the test specimen.

(ii) *Insulation material.* Blankets that utilize more than one variety of insulation (composition, density, etc.) must have specimen sets constructed that reflect the insulation combination used. If, however, several blanket types use similar insulation combinations, it is not necessary to test each combination if it is possible to bracket the various combinations.

(iii) *Moisture barrier film.* If a production blanket construction utilizes more than one type of moisture barrier film, perform separate tests on each combination. For example, if a polyimide film is used in conjunction with an insulation in order to enhance the burnthrough capabilities, also test the same insulation when used with a polyvinyl fluoride film.

(iv) *Installation on test frame.* Attach the blanket test specimens to the test frame using 12 steel spring type clamps as shown in figure 7. Use the clamps to hold the blankets in place in both of the outer vertical formers, as well as the centre vertical former (4 clamps per former). The clamp surfaces should measure 25.4 by 51 mm (1 inch by 2 inches). Place the top and bottom clamps 15.2 cm (6 inches) from the top and bottom of the test frame, respectively. Place the middle clamps 20.3 cm (8 inches) from the top and bottom clamps.

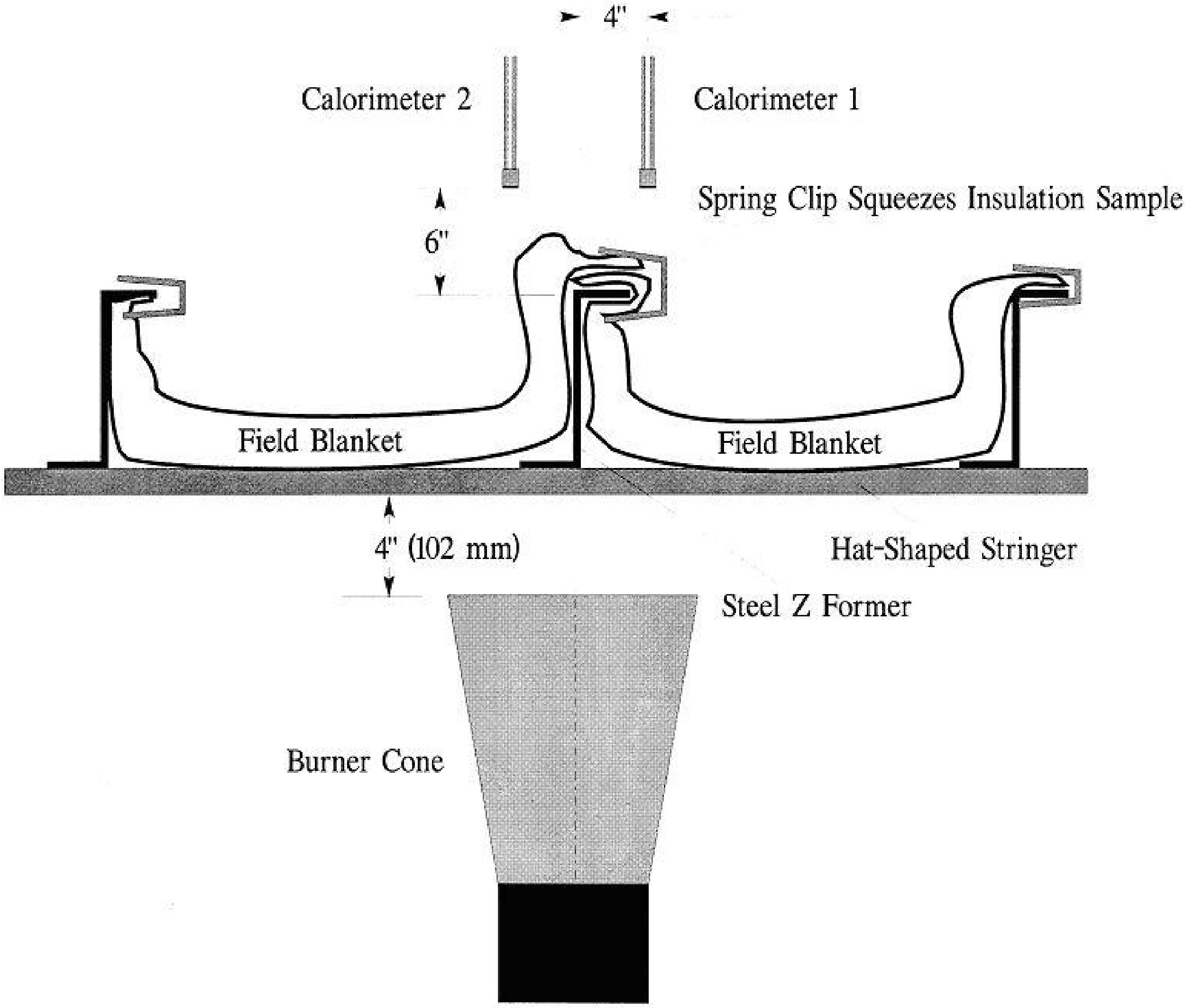

Figure 7 – Test Specimen Installation on Test Frame

(Note: For blanket materials that cannot be installed in accordance with figure 7 above, the blankets must be installed in a manner approved by the Agency.)

(v) *Conditioning.* Condition the specimens at 21° ± 2°C (70° ± 5°F) and 55% ± 10% relative humidity for a minimum of 24 hours prior to testing.

(d) Preparation of apparatus.

(1) Level and centre the frame assembly to ensure alignment of the calorimeter and/or thermocouple rake with the burner cone.

(2) Turn on the ventilation hood for the test chamber. Do not turn on the burner blower. Measure the airflow of the test chamber using a vane anemometer or equivalent measuring device. The vertical air velocity just behind the top of the upper insulation blanket test specimen must be 100 ± 50 ft/min (0.51±0.25 m/s). The horizontal air velocity at this point must be less than 50 ft/min (0.25 m/s).

(3) If a calibrated flow meter is not available, measure the fuel flow rate using a graduated cylinder of appropriate size. Turn on the burner motor/fuel pump, after insuring that the igniter system is turned off. Collect the fuel via a plastic or rubber tube into the graduated cylinder for a 2-minute period. Determine the flow rate in gallons per hour. The fuel flow rate must be 0.378 ± 0.0126 l/min (6.0 ± 0.2 gallons per hour).

(e) *Calibration.*

(1) Position the burner in front of the calorimeter so that it is centred and the vertical plane of the burner cone exit is 4 ± 0.125 inches (102 ± 3 mm) from the calorimeter face. Ensure that the horizontal centreline of the burner cone is offset 1 inch below the horizontal centreline of the calorimeter (figure 8). Without disturbing the calorimeter position, rotate the burner in front of the thermocouple rake, such that the middle thermocouple (number 4 of 7) is centred on the burner cone.

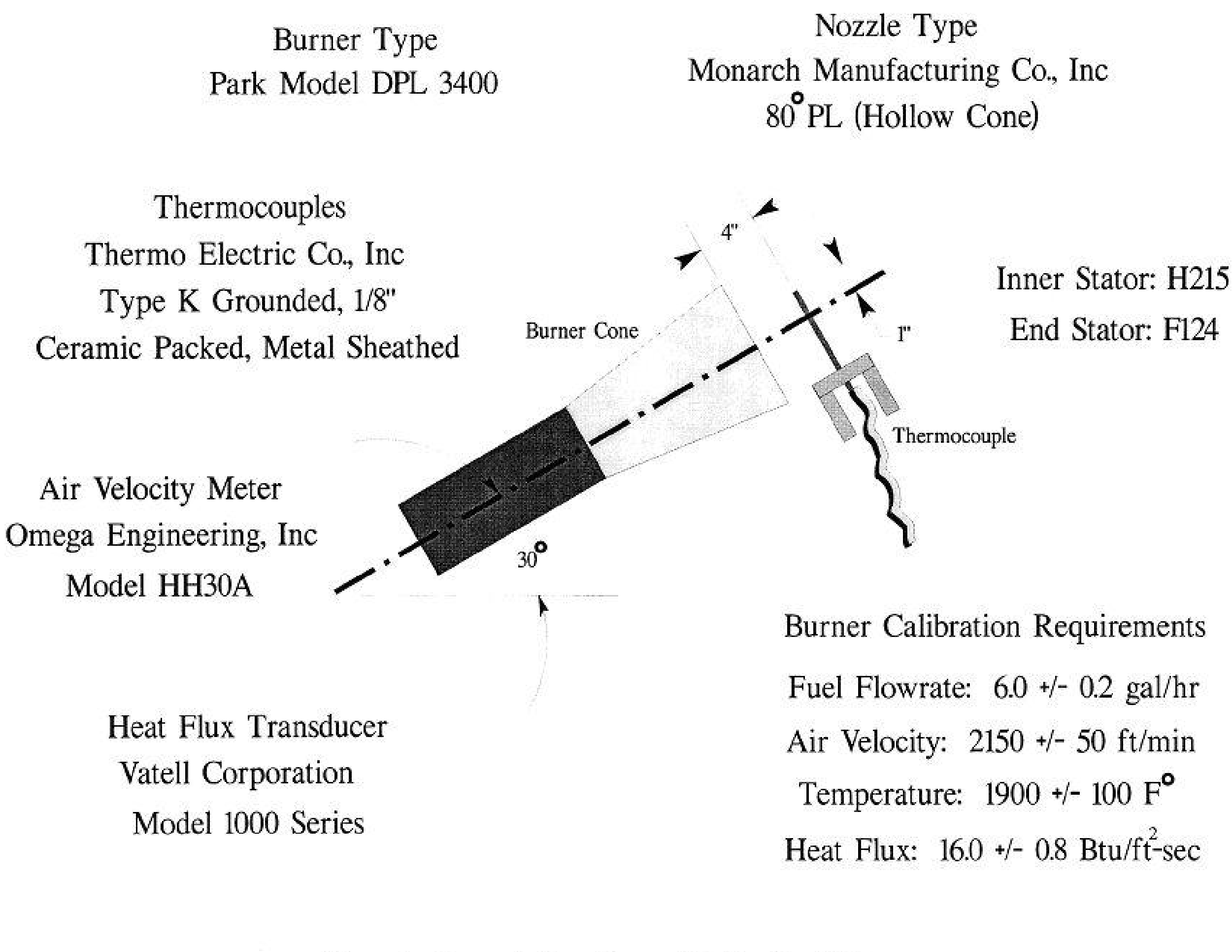

Figure 8 – Burner Information and Calibration Settings

Ensure that the horizontal centreline of the burner cone is also offset 25.4 mm (1 inch) below the horizontal centreline of the thermocouple tips. Re-check measurements by rotating the burner to each position to ensure proper alignment between the cone and the calorimeter and thermocouple rake. (Note: The test burner mounting system must incorporate ‘‘detents’’ that ensure proper centring of the burner cone with respect to both the calorimeter and the thermocouple rakes, so that rapid positioning of the burner can be achieved during the calibration procedure.)

(2) Position the air velocity meter in the adapter or airbox, making certain that no gaps exist where air could leak around the air velocity measuring device. Turn on the blower/motor while ensuring that the fuel solenoid and igniters are off. Adjust the air intake velocity to a level of 10.92 m/s, (2150 ft/min) then turn off the blower/motor. (Note: The Omega HH30 air velocity meter measures 66.7 mm (2.625 inches) in diameter. To calculate the intake airflow, multiply the cross-sectional area 0.0035 m^2 (0.03758 ft^2) by the air velocity 10.92 m/s (2150 ft/min) to obtain 2.29 m^3/min (80.80 ft^3/min). An air velocity meter other than the HH30 unit can be used, provided the calculated airflow of 2.29 m^3/min (80.80 ft^3/min) is equivalent.)

(3) Rotate the burner from the test position to the warm-up position. Prior to lighting the burner, ensure that the calorimeter face is clean of soot deposits, and there is water running through the calorimeter. Examine and clean the burner cone of any evidence of build-up of products of combustion, soot, *etc.* Soot build-up inside the burner cone may affect the flame characteristics and cause calibration difficulties. Since the burner cone may distort with time, dimensions should be checked periodically.

(4) While the burner is still rotated to the warm-up position, turn on the blower/motor, igniters and fuel flow, and light the burner. Allow it to warm up for a period of 2 minutes. Move the burner into the calibration position and allow 1 minute for calorimeter stabilization, then record the heat flux once every second for a period of 30 seconds. Turn off burner, rotate out of position, and allow to cool. Calculate the average heat flux over this 30-second duration. The average heat flux should be 18.2 ± 0.9 W/cm^2 (16.0 ± 0.8 Btu/ft^2 sec).

(5) Position the burner in front of the thermocouple rake. After checking for proper alignment, rotate the burner to the warm-up position, turn on the blower/motor, igniters and fuel flow, and light the burner. Allow it to warm up for a period of 2 minutes. Move the burner into the calibration position and allow 1 minute for thermocouple stabilization, then record the temperature of each of the 7 thermocouples once every second for a period of 30 seconds. Turn off burner, rotate out of position, and allow to cool. Calculate the average temperature of each thermocouple over this 30-second period and record. The average temperature of each of the 7 thermocouples should be 1038 ± 56°C (1900 ± 100°F).

(6) If either the heat flux or the temperatures are not within the specified range, adjust the burner intake air velocity and repeat the procedures of paragraphs (4) and (5) above to obtain the proper values. Ensure that the inlet air velocity is within the range of 10.92 ± 0.25 m/s (2150 ft/min ± 50 ft/min).

(7) Calibrate prior to each test until consistency has been demonstrated. After consistency has been confirmed, several tests may be conducted with calibration conducted before and after a series of tests.

(f) *Test procedure.*

(1) Secure the two insulation blanket test specimens to the test frame. The insulation blankets should be attached to the test rig centre vertical former using four spring clamps positioned as shown in figure 7 (according to the criteria of paragraph (c)(3)(iv) of Part VII of this Appendix).

(2) Ensure that the vertical plane of the burner cone is at a distance of 102 ± 3 mm (4 ± 0.125 inch) from the outer surface of the horizontal stringers of the test specimen frame, and that the burner and test frame are both situated at a 30° angle with respect to vertical.

(3) When ready to begin the test, direct the burner away from the test position to the warm-up position so that the flame will not impinge on the specimens prematurely. Turn on and light the burner and allow it to stabilize for 2 minutes.

(4) To begin the test, rotate the burner into the test position and simultaneously start the timing device.

(5) Expose the test specimens to the burner flame for 4 minutes and then turn off the burner. Immediately rotate the burner out of the test position.

(6) Determine (where applicable) the burnthrough time, or the point at which the heat flux exceeds 2.27 W/cm^2 (2.0 Btu/ft^2 sec).

(g) *Report.*

(1) Identify and describe the specimen being tested.

(2) Report the number of insulation blanket specimens tested.

(3) Report the burnthrough time (if any), and the maximum heat flux on the back face of the insulation blanket test specimen, and the time at which the maximum occurred.

(h) *Requirements.*

(1) Each of the two insulation blanket test specimens must not allow fire or flame penetration in less than 4 minutes.

(2) Each of the two insulation blanket test specimens must not allow more than 2.27 W/cm^2 (2.0 Btu/ft^2 sec) on the cold side of the insulation specimens at a point 30.5 cm (12 inches) from the face of the test rig.

11. <u>Add a new appendix M to read:</u>

Appendix M – Fuel Tank Flammability Reduction Means (FRM)

M25.1 Fuel tank flammability exposure requirements

(a) The Fleet Average Flammability Exposure level of each fuel tank, as determined in accordance with Appendix N of CS-25, must not exceed 3 percent of the Flammability Exposure Evaluation Time (FEET), as defined in Appendix N of CS-25. If flammability reduction means (FRM) are used, neither time periods when any FRM is operational but the fuel tank is not inert, nor time periods when any FRM is inoperative may contribute more than 1.8 percent to the 3 percent average fleet flammability exposure of a tank.

(b) The Fleet Average Flammability Exposure, as defined in Appendix N of this part, of each fuel tank for ground, takeoff/climb phases of flight during warm days must not exceed 3 percent of FEET in each of these phases. The analysis must consider the following conditions.

(1) The analysis must use the subset of flights starting with a sea level ground ambient temperature of 26.7°C [80° F] (standard day plus 11.7°C (21° F) atmosphere) or more, from the flammability exposure analysis done for overall performance.

(2) For the ground, takeoff/climb phases of flight, the average flammability exposure must be

calculated by dividing the time during the specific flight phase the fuel tank is flammable by the total time of the specific flight phase.

(3) Compliance with this paragraph may be shown using only those flights for which the aeroplane is dispatched with the flammability reduction means operational.

M25.2 Showing compliance

(a) The applicant must provide data from analysis, ground testing, and flight testing, or any combination of these, that:

(1) validate the parameters used in the analysis required by paragraph M25.1;

(2) substantiate that the FRM is effective at limiting flammability exposure in all compartments of each tank for which the FRM is used to show compliance with paragraph M25.1; and

(3) describe the circumstances under which the FRM would not be operated during each phase of flight.

(4) identify critical features of the fuel tank system to prevent an auxiliary fuel tank installation from increasing the flammability exposure of main tanks above that permitted under paragraphs M25.1 (a) and (b) of this appendix and to prevent degradation of the performance and reliability of the FRM.

(b) The applicant must validate that the FRM meets the requirements of paragraph M25.1 of this appendix with any aeroplane or engine configuration affecting the performance of the FRM for which approval is sought.

(c) Any FRM failures or failures that could affect the FRM, with potential catastrophic consequences shall not result from a single failure or a combination of failures not shown to be extremely improbable.

(d) It must be shown that the fuel tank pressures will remain within limits during normal operating conditions and failure conditions.

(e) Oxygen-enriched air produced by the FRM must not create a hazard during normal operating conditions.

M25.3 Reliability indications and maintenance access

(a) Reliability indications must be provided to identify failures of the FRM that would otherwise be latent and whose identification is necessary to ensure the fuel tank with an FRM meets the fleet average flammability exposure listed in paragraph M25.1 of this appendix, including when the FRM is inoperative.

(b) Sufficient accessibility to FRM reliability indications must be provided for maintenance personnel or the flight crew.

(c) The accesses to the fuel tanks with FRMs (including any tanks that communicate with a tank via a vent system), and to any other confined spaces or enclosed areas that could contain hazardous atmosphere under normal conditions or failure conditions must be permanently stencilled, marked, or placarded to warn maintenance personnel of the possible presence of a potentially hazardous atmosphere. Those stencils, markings or placards must be installed such as to remain permanently visible during maintenance operations.

M25.4 Airworthiness limitations and procedures

The FRM shall be subject to analysis using conventional processes and methodology to ensure that the minimum scheduled maintenance tasks required for securing the continuing airworthiness of the system and installation are identified and published as part of the CS 25.1529 compliance. Maintenance tasks arising from either the Monte Carlo analysis or a CS 25.1309 safety assessment shall be dealt with in accordance with the principles laid down in AMC 25.1309.

(a) If FRM is used to comply with paragraph M25.1, Airworthiness Limitations must be identified for all maintenance or inspection tasks required to identify failures of components within the FRM that are needed to meet paragraph M25.1.

(b) Maintenance procedures must be developed to identify any hazards to be considered during maintenance of the fuel system and of the FRM. These procedures must be included in the instructions for continued airworthiness (ICA).

12. Add a new appendix N to read:

Appendix N – Fuel Tank Flammability Exposure

N25.1 General

(a) This appendix specifies the requirements for conducting fuel tank fleet average flammability exposure analyses required to meet CS 25.981(b) and Appendix M. This appendix defines parameters affecting fuel tank flammability that must be used in performing the analysis. These include parameters that affect all aeroplanes within the fleet, such as a statistical distribution of ambient temperature, fuel flash point, flight lengths, and aeroplane descent rate. Demonstration of compliance also requires application of factors specific to the aeroplane model being evaluated. Factors that need to be included are maximum range, cruise mach number, typical altitude where the aeroplane begins initial cruise phase of flight, fuel temperature during both ground and flight times, and the performance of an FRM if installed (See AMC to appendix N, N25.1(a)).

(b) For fuel tanks installed in aluminium wings, a qualitative assessment is sufficient if it substantiates that the tank is a conventional unheated aluminium wing tank (See AMC to Appendix N25.1(b)).

N25.2 Definitions

(a) Bulk Average Fuel Temperature means the average fuel temperature within the fuel tank or different sections of the tank if the tank is subdivided by baffles or compartments.

(b) Flammability Exposure Evaluation Time (FEET). The time from the start of preparing the aeroplane for flight, through the flight and landing, until all payload is unloaded, and all passengers and crew have disembarked. In the Monte Carlo program, the flight time is randomly selected from the Flight Length Distribution (Table 2), the pre-flight times are provided as a function of the flight time, and the post-flight time is a constant 30 minutes.

(c) Flammable. With respect to a fluid or gas, flammable means susceptible to igniting readily or to exploding (ref. CS-Definitions). A non-flammable ullage is one where the fuel-air vapour is too lean or too rich to burn or is inert as defined below. For the purposes of this appendix, a fuel tank that is not inert is considered flammable when the bulk average fuel temperature within the tank is within the flammable range for the fuel type being used. For any fuel tank that is subdivided into sections by baffles or compartments, the tank is considered flammable when the bulk average fuel temperature within any section of the tank, that is not inert, is within the flammable range for the fuel type being used.

(d) Flash Point. The flash point of a flammable fluid means the lowest temperature at which the application of a flame to a heated sample causes the vapour to ignite momentarily, or "flash." Table 1 of this appendix provides the flash point for the standard fuel to be used in the analysis.

(e) Fleet average flammability exposure is the percentage of the flammability exposure evaluation time (FEET) the fuel tank ullage is flammable for a fleet of an aeroplane type operating over the range of flight lengths in a world-wide range of environmental conditions and fuel properties as defined in this appendix.

(f) Gaussian Distribution is another name for the normal distribution, a symmetrical frequency distribution having a precise mathematical formula relating the mean and standard deviation of the samples. Gaussian distributions yield bell shaped frequency curves having a preponderance of values around the mean with progressively fewer observations as the curve extends outward.

(g) Hazardous atmosphere. An atmosphere that may expose maintenance personnel, passengers or flight crew to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a confined space), injury, or acute illness.

(h) Inert. For the purpose of this appendix, the tank is considered inert when the bulk average oxygen concentration within each compartment of the tank is 12 percent or less from sea level up to 10,000 feet altitude, then linearly increasing from 12 percent at 10,000 feet to 14.5 percent at 40,000 feet altitude, and extrapolated linearly above that altitude.

(i) Inerting. A process where a non-combustible gas is introduced into the ullage of a fuel tank so that the ullage becomes non-flammable.

(j) Monte Carlo Analysis. The analytical method that is specified in this appendix as the compliance means for assessing the fleet average flammability exposure time for a fuel tank.

(k) Oxygen evolution occurs when oxygen dissolved in the fuel is released into the ullage as the pressure and temperature in the fuel tank are reduced.

(l) Standard deviation is a statistical measure of the dispersion or variation in a distribution, equal to the square root of the arithmetic mean of the squares of the deviations from the arithmetic means.

(m) Transport Effects. For purposes of this appendix, transport effects are the change in fuel vapour concentration in a fuel tank caused by low fuel conditions and fuel condensation and vaporization.

(n) Ullage. The volume within the fuel tank not occupied by liquid fuel.

N25.3 Fuel tank flammability exposure analysis

(a) A flammability exposure analysis must be conducted for the fuel tank under evaluation to determine fleet average flammability exposure for the aeroplane and fuel types under evaluation. For fuel tanks that are subdivided by baffles or compartments, an analysis must be performed either for each section of the tank, or for the section of the tank having the highest flammability exposure. Consideration of transport effects is not allowed in the analysis.

(b) The following parameters are defined in the Monte Carlo analysis and provided in paragraph N25.4:

(1) Cruise Ambient Temperature – as defined in this appendix.

(2) Ground Temperature – as defined in this appendix.

(3) Fuel Flash Point – as defined in this appendix.

(4) Flight length Distribution –that must be used is defined in Table 2 of this appendix.

(c) Parameters that are specific to the particular aeroplane model under evaluation that must be provided as inputs to the Monte Carlo analysis are:

(1) Aeroplane Cruise Altitude

(2) Fuel Tank quantities. If fuel quantity affects fuel tank flammability, inputs to the Monte Carlo analysis must be provided that represent the actual fuel quantity within the fuel tank or compartment of the fuel tank throughout each of the flights being evaluated. Input values for this data must be obtained from ground and flight test data or the EASA approved fuel management procedures.

(3) Aeroplane cruise Mach Number.

(4) Aeroplane maximum Range

(5) Fuel Tank Thermal Characteristics. If fuel temperature affects fuel tank flammability, inputs to the Monte Carlo analysis must be provided that represent the actual bulk average fuel temperature within the fuel tank throughout each of the flights being evaluated. For fuel tanks that are subdivided by baffles or compartments, bulk average fuel temperature inputs must be provided either for each section of the tank or for the section of the tank having the highest flammability exposure. Input values for this data must be obtained from ground and flight test data or a thermal model of the tank that has been validated by ground and flight test data.

(6) Maximum aeroplane operating temperature limit as defined by any limitations in the Aeroplane Flight Manual.

(7) Aeroplane Utilization. The applicant must provide data supporting the number of flights per day and the number of hours per flight for the specific aeroplane model under evaluation. If there is no existing aeroplane fleet data to support the aeroplane being evaluated, the applicant must provide substantiation that the number of flights per day and the number of hours per flight for that aeroplane model is consistent with the existing fleet data they propose to use.

(8) Aeroplane climb & descent profiles in accordance with the aircraft performance data documented in the Aircraft Flight Manual.

(d) Fuel Tank FRM Model. If FRM is used, an Agency approved Monte Carlo program must be used to show compliance with the flammability requirements of CS 25.981 and Appendix M of this part. The program must determine the time periods during each flight phase when the fuel tank or compartment with the FRM would be flammable. The following factors must be considered in establishing these time periods:

(1) Any time periods throughout the flammability exposure evaluation time and under the full range of expected operating conditions, when the FRM is operating properly but fails to maintain a non-flammable fuel tank because of the effects of the fuel tank vent system or other causes,

(2) If dispatch with the system inoperative under the Master Minimum Equipment List (MMEL) is requested, the time period assumed in the reliability analysis shall be consistent with the proposed rectification interval, depending on aeroplane utilisation,

(3) Frequency and duration of time periods of FRM inoperability, substantiated by test or analysis, caused by latent or known failures, including aeroplane system shut-downs and failures that could cause the FRM to shut down or become inoperative,

(4) Effects of failures of the FRM that could increase the flammability exposure of the fuel tank,

(5) Oxygen Evolution: If an FRM is used that is affected by oxygen concentrations in the fuel tank, the time periods when oxygen evolution from the fuel results in the fuel tank or compartment exceeding the inert level. The applicant must include any times when oxygen evolution from the fuel in the tank or compartment under evaluation would result in a flammable fuel tank. The oxygen evolution rate that must be used is defined in the FAA document “Fuel Tank Flammability Assessment Method User's Manual”, dated May 2008 (or latest revision), document number DOT/FAA/AR–05/8.

(6) If an inerting system FRM is used, the effects of any air that may enter the fuel tank following the last flight of the day due to changes in ambient temperature, as defined in Table 4, during a 12-hour overnight period.

N25.4 Variables and data tables

The following data must be used when conducting a flammability exposure analysis to determine the fleet average flammability exposure. Variables used to calculate fleet flammability exposure must include atmospheric ambient temperatures, flight length, flammability exposure evaluation time, fuel flash point, thermal characteristics of the fuel tank, overnight temperature drop, and oxygen evolution from the fuel into the ullage.

(a) Atmospheric Ambient Temperatures and Fuel Properties.

(1) In order to predict flammability exposure during a given flight, the variation of ground ambient temperatures, cruise ambient temperatures, and a method to compute the transition from ground to cruise and back again must be used. The variation of the ground and cruise ambient temperatures and the flash point of the fuel is defined by a Gaussian curve, given

by the 50 percent value and a ± 1-standard deviation value.

(2) Ambient Temperature: Under the program, the ground and cruise ambient temperatures are linked by a set of assumptions on the atmosphere. The temperature varies with altitude following the International Standard Atmosphere (ISA) rate of change from the ground ambient temperature until the cruise temperature for the flight is reached. Above this altitude, the ambient temperature is fixed at the cruise ambient temperature. This results in a variation in the upper atmospheric temperature. For cold days, an inversion is applied up to 10,000 feet, and then the ISA rate of change is used.

(3) Fuel properties:

(i) For Jet A and Jet A-1 fuel, the variation of flash point of the fuel is defined by a Gaussian curve, given by the 50 percent value and a ± 1-standard deviation, as shown in Table 1.

ii) The flammability envelope of the fuel that must be used for the flammability exposure analysis is a function of the flash point of the fuel selected by the Monte Carlo for a given flight. The flammability envelope for the fuel is defined by the upper flammability limit (UFL) and lower flammability limit (LFL) as follows:

(A) LFL at sea level = flash point temperature of the fuel at sea level minus 5.5°C (10°F). LFL decreases from sea level value with increasing altitude at a rate of 0.55 °C (1ºF) per 808 feet.

(B) UFL at sea level = flash point temperature of the fuel at sea level plus 19.5°C (63.5ºF). UFL decreases from the sea level value with increasing altitude at a rate of 0.55°C (1ºF) per 512 feet.

(4) For each flight analyzed, a separate random number must be generated for each of the three parameters (ground ambient temperature, cruise ambient temperature, and fuel flash point) using the Gaussian distribution defined in Table 1.

Table 1. Gaussian Distribution for Ground Ambient Temperature, Cruise Ambient Temperature, and Fuel Flash Point

	Temperature in Deg C/Deg F		
Parameter	Ground Ambient Temperature.	Cruise ambient Temperature.	Fuel Flash Point (FP)
Mean Temp	15.53/59.95	_ -56.67/ -70	48.89/ 120
Neg 1 std dev	11.18/ 20.14	4.4/ 8	4.4/ 8
Pos 1 std dev	9.6/ 17.28	4.4/ 8	4.4/8

(b) The Flight Length Distribution defined in Table 2 must be used in the Monte Carlo analysis.

Table 2. Flight Length Distribution

	Aeroplane Maximum Range – Nautical Miles (NM)									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Flight Length (NM)	Distribution of flight lengths (Percentage of total)									

		Aeroplane Maximum Range – Nautical Miles (NM)									
		1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Flight Length (NM)		Distribution of flight lengths (Percentage of total)									
From	To										
0	200	11.7	7.5	6.2	5.5	4.7	4.0	3.4	3.0	2.6	2.3
200	400	27.3	19.9	17.0	15.2	13.2	11.4	9.7	8.5	7.5	6.7
400	600	46.3	40.0	35.7	32.6	28.5	24.9	21.2	18.7	16.4	14.8
600	800	10.3	11.6	11.0	10.2	9.1	8.0	6.9	6.1	5.4	4.8
800	1000	4.4	8.5	8.6	8.2	7.4	6.6	5.7	5.0	4.5	4.0
1000	1200	0.0	4.8	5.3	5.3	4.8	4.3	3.8	3.3	3.0	2.7
1200	1400	0.0	3.6	4.4	4.5	4.2	3.8	3.3	3.0	2.7	2.4
1400	1600	0.0	2.2	3.3	3.5	3.3	3.1	2.7	2.4	2.2	2.0
1600	1800	0.0	1.2	2.3	2.6	2.5	2.4	2.1	1.9	1.7	1.6
1800	2000	0.0	0.7	2.2	2.6	2.6	2.5	2.2	2.0	1.8	1.7
2000	2200	0.0	0.0	1.6	2.1	2.2	2.1	1.9	1.7	1.6	1.4
2200	2400	0.0	0.0	1.1	1.6	1.7	1.7	1.6	1.4	1.3	1.2
2400	2600	0.0	0.0	0.7	1.2	1.4	1.4	1.3	1.2	1.1	1.0
2600	2800	0.0	0.0	0.4	0.9	1.0	1.1	1.0	0.9	0.9	0.8
2800	3000	0.0	0.0	0.2	0.6	0.7	0.8	0.7	0.7	0.6	0.6
3000	3200	0.0	0.0	0.0	0.6	0.8	0.8	0.8	0.8	0.7	0.7
3200	3400	0.0	0.0	0.0	0.7	1.1	1.2	1.2	1.1	1.1	1.0
3400	3600	0.0	0.0	0.0	0.7	1.3	1.6	1.6	1.5	1.5	1.4
3600	3800	0.0	0.0	0.0	0.9	2.2	2.7	2.8	2.7	2.6	2.5
3800	4000	0.0	0.0	0.0	0.5	2.0	2.6	2.8	2.8	2.7	2.6
4000	4200	0.0	0.0	0.0	0.0	2.1	3.0	3.2	3.3	3.2	3.1
4200	4400	0.0	0.0	0.0	0.0	1.4	2.2	2.5	2.6	2.6	2.5
4400	4600	0.0	0.0	0.0	0.0	1.0	2.0	2.3	2.5	2.5	2.4
4600	4800	0.0	0.0	0.0	0.0	0.6	1.5	1.8	2.0	2.0	2.0
4800	5000	0.0	0.0	0.0	0.0	0.2	1.0	1.4	1.5	1.6	1.5
5000	5200	0.0	0.0	0.0	0.0	0.0	0.8	1.1	1.3	1.3	1.3
5200	5400	0.0	0.0	0.0	0.0	0.0	0.8	1.2	1.5	1.6	1.6
5400	5600	0.0	0.0	0.0	0.0	0.0	0.9	1.7	2.1	2.2	2.3
5600	5800	0.0	0.0	0.0	0.0	0.0	0.6	1.6	2.2	2.4	2.5
5800	6000	0.0	0.0	0.0	0.0	0.0	0.2	1.8	2.4	2.8	2.9
6000	6200	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.6	3.1	3.3
6200	6400	0.0	0.0	0.0	0.0	0.0	0.0	1.4	2.4	2.9	3.1
6400	6600	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.8	2.2	2.5
6600	6800	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	1.6	1.9
6800	7000	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8	1.1	1.3
7000	7200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.7	0.8
7200	7400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.7
7400	7600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.6
7600	7800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.7
7800	8000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	0.8
8000	8200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.8
8200	8400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0
8400	8600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.3
8600	8800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1
8800	9000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.8
9000	9200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
9200	9400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2

		Aeroplane Maximum Range – Nautical Miles (NM)									
		1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
Flight Length (NM)		Distribution of flight lengths (Percentage of total)									
9400	9600	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9600	9800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
9800	10000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

(c) Overnight Temperature Drop. For aeroplanes on which FRM is installed, the overnight temperature drop for this appendix is defined using:

(1) A temperature at the beginning of the overnight period that equals the landing temperature of the previous flight that is a random value based on a Gaussian distribution; and

(2) An overnight temperature drop that is a random value based on a Gaussian distribution.

(3) For any flight that will end with an overnight ground period (one flight per day out of an average of number of flights per day, depending on utilization of the particular aeroplane model being evaluated), the landing outside air temperature (OAT) is to be chosen as a random value from the following Gaussian curve:

Table 3. Landing Outside Air Temperature

Parameter	Landing Outside Air Temperature °C/ °F
Mean Temperature	14.82/ 58.68
negative 1 std dev	11.41/ 20.55
positive 1 std dev	7.34/ 13.21

(4) The outside ambient air temperature (OAT) overnight temperature drop is to be chosen as a random value from the following Gaussian curve:

Table 4. Outside Air Temperature (OAT) Drop

Parameter		OAT Drop Temperature °C/ °F
Mean Temp		-11.11/ 12.0
1 std dev		3.3/ 6.0

(d) Number of Simulated Flights Required in Analysis. In order for the Monte Carlo analysis to be valid for showing compliance with the fleet average and warm day flammability exposure requirements, the applicant must run the analysis for a minimum number of flights to ensure that the fleet average and warm day flammability exposure for the fuel tank under evaluation meets the applicable flammability limits defined in Table 5.

Table 5. Flammability Exposure Limit

Minimum Number of Flights in Monte Carlo Analysis	Maximum Acceptable Monte Carlo Average Fuel Tank Flammability Exposure (%) to meet 3% requirements	Maximum Acceptable Monte Carlo Average Fuel Tank Flammability Exposure (%) to meet 7% requirements
10,000	2.91	6.79
100,000	2.98	6.96
1,000,000	3.00	7.00

BOOK 2

13. Revise AMC 25.21 (g) to read:

AMC – SUBPART B

AMC 25.21(g)
Performance and Handling Characteristics in Icing Conditions Contained in Appendix C, of CS25

...

~~iii.~~d Conduct steady heading sideslips to full rudder authority, 801~~356~~ N. (180 lbf) rudder force or full lateral control authority (whichever comes first), with highest lift landing configuration, trim speed 1.23 VSR, and power or thrust for 3° flight path angle.

...

6.9.5.1 Where the ice protection system is activated as described in paragraph A1.2.3.~~3~~4.a of Appendix 1 of this AMC, paragraphs 6.9.1, 6.9.2 and 6.9.4 of this AMC are applicable with the ice accretion prior to normal system operation.

6.9.5.2 Where the ice protection system is activated as described in paragraphs A1.2.3.~~3~~4.b,c,d or e of Appendix 1 of this AMC, it is acceptable to demonstrate adequate controllability with the ice accretion prior to normal system operation, as follows:

...

6.18.3.1 Where the ice protection system is activated as described in paragraph A1.2.3.~~3~~4.a, of Appendix 1 of this AMC, paragraphs 6.18.1 and 6.18.2 of this AMC are applicable with the ice accretion prior to normal system operation.

6.18.3.2 Where the ice protection system is activated as described in paragraphs A1.2.3.~~3~~4.b,c,d or e of Appendix 1 of this AMC, it is acceptable to demonstrate adequate stall warning with the ice accretion prior to normal system operation, as follows:

...

14. Revise AMC 25.629 as follows:

AMC – SUBPART D

AMC 25.629 Aeroelastic stability requirements

…

"- CS 25.1329 ~~Automatic pilot~~ Flight Guidance system"

…

15. Revise AMC 25.783 as follows:

AMC – SUBPART D

AMC 25.783 Fuselage Doors

…

"As an alternative to providing the feature described above, reliance can be placed on trained cabin ~~attendants~~ crew or flight crew members to determine that certain doors are not fully closed. This alternative is applicable only to doors that are normally operated by these crew members, and where it is visually clearly evident from within the aircraft without detailed inspection under all operational lighting

conditions that the door is not fully closed."
…

16. Revise AMC 25.807 as follows:

AMC – SUBPART D
…
"AMC 25.807 Emergency ~~lighting~~ Exits
Relevant part of the FAA Advisory Circular 25-17 Transport Airplane Cabin Interiors Crashworthiness Handbook, dated 15/7/91 ~~and AC 25.812-2 Floor Proximity Emergency Escape Path Marking Systems Incorporating Photoluminescent Elements, dated 24/7/97 are~~ is accepted by the Agency as providing acceptable means of compliance with CS 25.~~812~~ 807.

Note: "relevant parts" means "the part of the AC 25-17 that addresses the applicable FAR/CS25 paragraph"."

17. Add new AMC 25.856(a) and AMC 25.856(b) as follows:

AMC – SUBPART D

….
AMC 25.856(a)

Thermal/acoustic insulation materials: Flame propagation resistance

FAA Advisory Circular 25.856-1 Thermal/Acoustic Insulation Flame Propagation Test Method Details, dated 24/06/2005, is accepted by the Agency as providing acceptable means of compliance with CS 25.856(a) and Part VI of Appendix F to CS-25.

AMC 25.856(b)

Thermal/acoustic insulation materials: Flame penetration (Burnthrough) resistance

FAA Advisory Circular 25.856-2A Installation of Thermal/Acoustic Insulation for Burnthrough Protection, dated 29/07/2008, is accepted by the Agency as providing acceptable means of compliance with CS 25.856(b) and Part VII of Appendix F to CS-25.

18. Add new AMC 25.981 (b) (1) to read:

AMC – SUBPART E
…

AMC 25.981(b)(1)
Fuel tank flammability design precautions

The intention of this requirement is to introduce design precautions, to avoid unnecessary increases in fuel tank flammability. These precautions should ensure:

(i) no large net heat sources going into the tank,

(ii) no unnecessary spraying, sloshing or creation of fuel mist,
(iii) minimization of any other energy transfer such as HIRF;

Applicants should limit the heat inputs to the maximum extent. Heat sources can be other systems, but also include environmental conditions such as solar radiation. The following design features have been found acceptable:

- heat insulation between a fuel tank and an adjacent heat source (typically ECS packs),
- forced ventilation around a fuel tank,
- fuel transfer logic leaving sufficient fuel in transfer tanks exposed to solar radiations on the ground in order to limit their effects
- heat rejecting paintings or solar energy reflecting paints to limit the heat input by solar radiation.

A critical parameter is the maximum temperature rise in any part of the tank under warm day conditions during a 4 hours ground operation. Any physical phenomenon, including environmental conditions such as solar radiation, should be taken into account. A temperature increase in the order of 20°C limit has been found acceptable for tanks not fitted with an active Flammability Reduction Means and therefore unable to meet the exposure criteria as defined in M25.1(b)(1).
Note 1: for tanks fitted with Flammability Reduction Means, applicants should limit heat and energy transfers to the maximum extent. No maximum temperature increase limit is defined; however the 20 °C limit is applicable in case of dispatch with the active Flammability Reduction Means inoperative.
Note 2: the maximum temperature increase under the conditions described above should be quantified whether or not the affected tank is fitted with a Flammability Reduction Means.

19. Add new AMC 25.981 (b) (2) to read:

AMC – SUBPART E

…

AMC 25.981(b)(2)
Fuel tank flammability definitions

Equivalent Conventional Unheated Aluminium Wing is an integral tank in an unheated semi-monocoque aluminium wing of a subsonic aeroplane that is equivalent in aerodynamic performance, structural capability, fuel tank capacity and tank configuration to the designed wing.

Fleet Average Flammability Exposure is defined in Appendix N and means the percentage of time the fuel tank ullage is flammable for a fleet of an aeroplane type operating over the range of flight lengths.

20. Deletion of current AMC 25.981 (c) as follow:

AMC – SUBPART E

…

~~AMC 25.981(c)~~
~~Flammability precautions~~
~~The intention of this requirement is to introduce design precautions, to avoid unnecessary increases in fuel tank flammability. These precautions should ensure:~~
~~(i) no large net heat sources going into the tank,~~
~~(ii) no unnecessary spraying, sloshing or creation of fuel mist.~~

21. Book 2 - Subpart H - Pages renumbering:

Change Pages: ~~1~~-H-20 to 1-H-29. 2-H-20 to 2-H-29

Change pages: 2-App ~~F-2~~ and 2-App ~~F-3~~ to 2-App H-1 and 2-App H-2

22. Add a new AMC to appendix N- Fuel Tank Flammability Exposure:

AMC to Appendix N, N25.1(a)
Fuel tank flammability assessment method

The Monte-Carlo program as well as the method and procedures set forth in FAA document, "Fuel Tank Flammability Assessment Method Users Manual" DOT/FAA/AR-05/8 dated May 2008 (or the latest existing revision on the condition that it is accepted by EASA), is an acceptable means of compliance to conduct the flammability assessment specified in Appendix N25.1(a). A copy may be obtained from the Office of the Federal Register, 800 North Capitol Street, N.W., Suite 700, Washington, D.C. The following definitions, input variables, and data tables that are used in the program to determine fleet average flammability exposure for a specific aeroplane model are the ones included into paragraph N25.2 Definitions and N25.4 Variables and data tables.

AMC to Appendix N, N25.1(b)
Qualitative fuel tank flammability assessment

(a) A conventional unheated aluminium wing tank is a conventional aluminium structure, integral tank of a subsonic transport aeroplane wing, with minimal heating from aeroplane systems or other fuel tanks and cooled by ambient airflow during flight. Heat sources that have the potential for significantly increasing the flammability exposure of a fuel tank would preclude the tank from being considered "unheated." Examples of such heat sources that may have this effect are heat exchangers, adjacent heated fuel tanks, transfer of fuel from a warmer tank, and adjacent air conditioning equipment. Thermal anti-ice systems and thermal anti-ice blankets typically do not significantly increase flammability of fuel tanks. For these tanks, a qualitative assessment showing equivalency to the unheated aluminium wing fuel tank may be acceptable when considered with the following:

1 A description of the aeroplane configuration, (including subsonic, wing construction, etc.),

2 A listing of any heat sources in or adjacent to the fuel tank,

3 The type of fuel approved for the aeroplane,

4 The tank operating pressure relative to ambient static pressure,

5 The tank is uninsulated and made of aluminium, and

6 The tank has a large aerodynamic surface area exposed to outside air to transfer heat from the tank.

(b) Fuel tanks with an aerodynamic surface area to volume ratio (surface area/volume) greater than 1.0 have been shown to meet these criteria. Fuel tanks with a ratio less than 1.0 are not considered conventional unheated aluminium wing tanks. The aerodynamic surface area includes the area of the integral aluminium wing fuel tank that is exposed to outside air. It does not include any portion of a fuel tank that is shielded from free stream airflow, such as the front and rear spar, or an area under a fairing or wing thermal blanket.