

## APPENDIX J—APPARATUS FOR EVACUATION SLIDE RADIANT HEAT TEST

### J.1. SCOPE

#### J.1.1 APPLICABILITY

This test apparatus is intended for use in determining the ability of a material to resist heat and maintain pressure when subjected to a radiant heat source that simulates a large jet fuel fire.

### J.2. DEFINITIONS

#### J.2.1 RADIANT HEAT SOURCE

The radiant heat source is a 3-inch diameter circular electric furnace with a spiral tubular heating element.

#### J.2.2 TIME TO FAILURE

The time to failure is the time between first application of heat to the sample and the first decrease in pressure below the maximum pressure attained in the test cylinder during the test.

#### J.2.3 TEST SAMPLE

A test sample is a flat, 7-inch diameter circle that must replicate a material installed on an aircraft.

### J.3. TEST APPARATUS

#### J.3.1 PRESSURE CYLINDER SAMPLE HOLDER

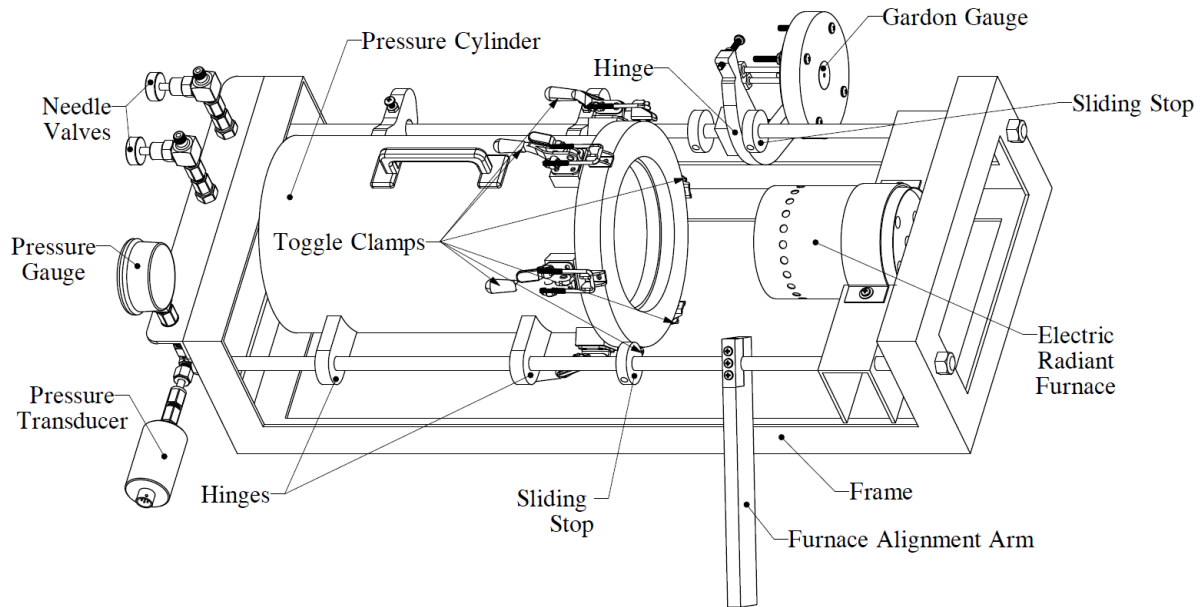
The pressure cylinder consists of a 12.375-inch-long (314 mm) aluminum cylinder with a 7-inch (178 mm) outside diameter (OD) and a 6.5-inch (165 mm) inside diameter (ID), as shown in figure J-1 and figure J-2.

J.3.1.1 An aluminum plate 0.5-inches (13 mm) thick must be welded to one end of the cylinder and must be drilled and tapped near its upper edge for a 0.25-inch (6.4-mm) National Pipe Thread (NPT) pipe to facilitate the installation of air pressure and pressure recording equipment.

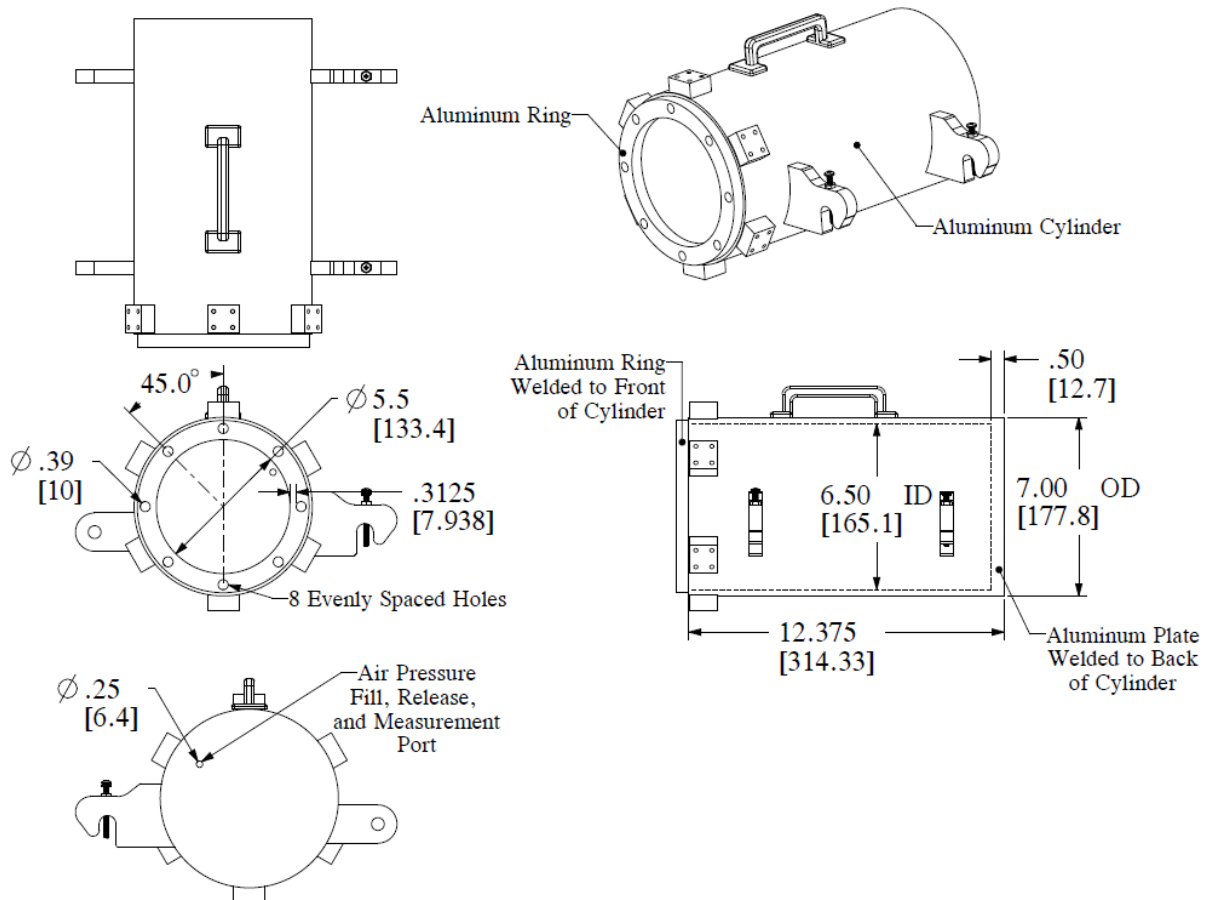
J.3.1.2 An aluminum ring 7 inches (178 mm) OD, 5.5 inches (140 mm) ID, and 0.5 inch (13 mm) thick must be welded to the other end of the cylinder. The ring must have eight evenly spaced 10-32 bolt holes on the circle, 0.3125 inch (8 mm) from the ring's inner edge. The diameter of this circle is 6.125 inches (156 mm) and the adjacent bolt holes are 2.3125 inches (59 mm) apart (see figure J-2 for detail dimensions). A 10-32 steel bolt 0.875 inches (22 mm) long will be placed into each of the holes.

J.3.1.3 Another aluminum ring, 6.75 inches (171 mm) OD, 5.5 inches (140 mm) ID, and 0.5 inch (13 mm) thick, with two neoprene or comparable (e.g., silicone rubber) gaskets with similar clearance holes to fit over the bolts, must provide a means for clamping and sealing the test sample in place. Hinges and adjustable stops will be welded to the sides of the cylinder, as shown in figures J-1 and J-2.

*NOTE: It is acceptable to use toggle clamps instead of nuts and bolts (see figure J-1) as a method to secure the test sample in place between the aluminum ring holder and the pressure cylinder.*



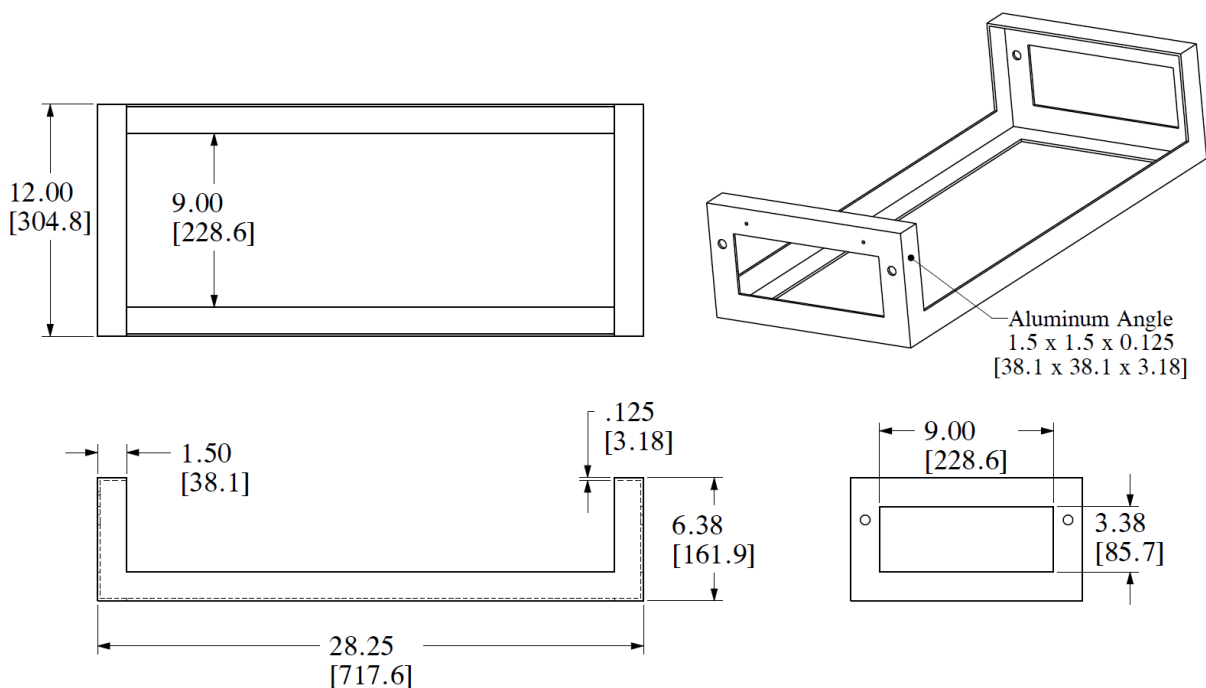
**Figure J-1. Overview of evacuation slide material test apparatus**



**Figure J-2. Dimensioned drawing of the pressure cylinder**

### J.3.2 TEST APPARATUS FRAME

The test apparatus frame must be able to support the electric furnace, pressure cylinder sample holder, and heat flux gauge. The furnace is fixed in place at one end whereas the pressure cylinder and heat flux gauge must be able to rotate into and out of test position and also translate toward and away from the furnace. The dimensions of the frame are not critical, but an example is shown in figure J-3.

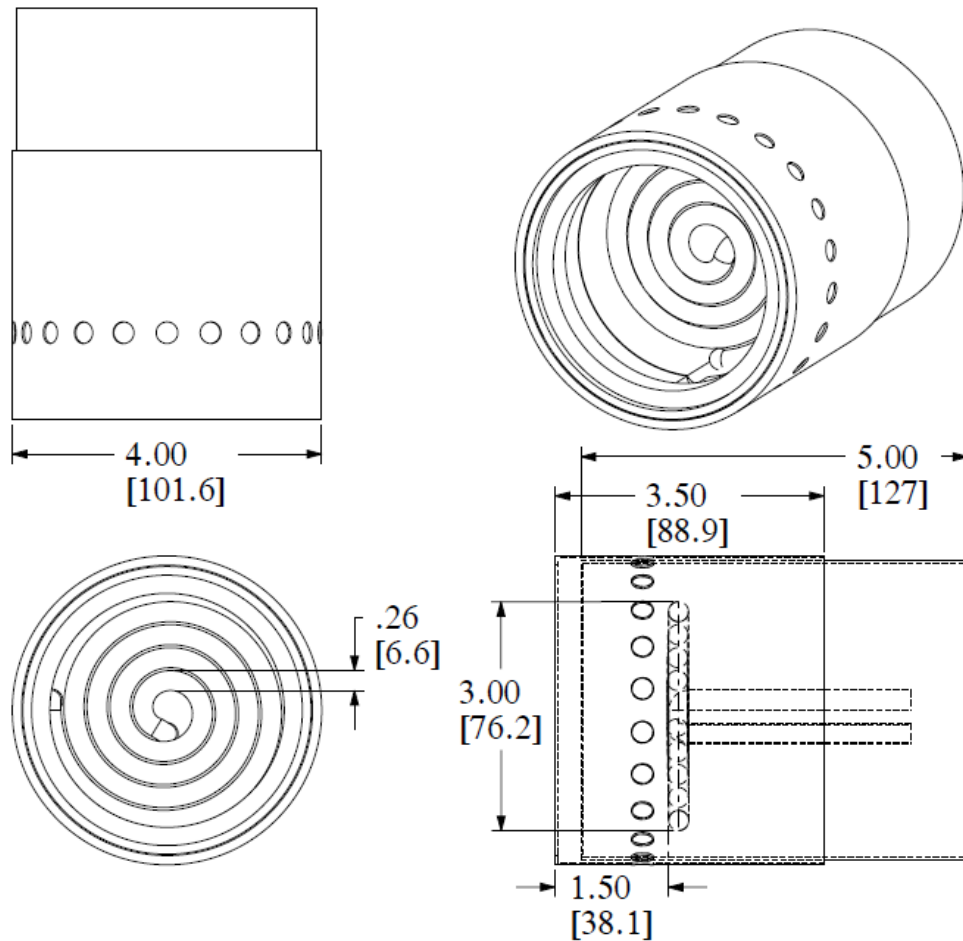


**Figure J-3. Dimensioned drawing of the frame**

### J.3.3 ELECTRIC FURNACE

An electric radiant furnace with a 3-inch (76-mm) diameter opening, as shown in figure J-4, must be used to supply a constant irradiance on the sample surface. The radiant furnace uses a spiral tubular heating element with a 0.260-inch Inconel sheath diameter as the heat source. The diameter of the spiral element is nominally 3 inches. It is an 875-Watt, 120-Volt alternating current (AC) element with an internal resistance of approximately 17 ohms. The front half of the furnace housing is constructed from rolled sheet metal with an outer diameter (OD) of 4 inches (102 mm) and inside diameter (ID) of 3.938 inches (100 mm). The back half has an OD of 3.875 inches (98 mm) and an ID of 3.813 inches (97 mm). The face of the furnace coil is recessed 0.0938 inch (2.4 mm) from the edge of the front housing. Ceramic insulating rings are placed inside the housing to fill the space between the heating coil and the housing.

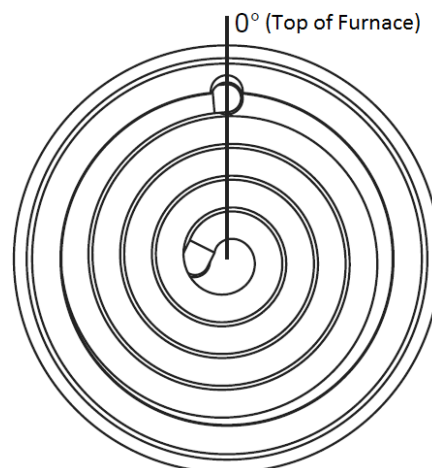
*NOTE: A suitable 875-Watt electric furnace is manufactured by Newport Scientific Inc. of Jessup, MD, 301-498-6700. Part numbers 68086038000 and 68086040400 are both acceptable. This is the same furnace used in the NBS Smoke Density Chamber*



**Figure J-4. Dimensioned drawing of the electric radiant furnace**

#### J.3.3.1 Heating Element Orientation

The heating element must be oriented as shown in figure J-5. This orientation will minimize interlab differences, as results have shown that orientation influences the shape of the heat profile impacting the test sample.



**Figure J-5. Heating element orientation**

#### J.3.3.2 Heating Element Position

The location of the heat element must be 1.5 inches from the open face of the furnace.

#### J.3.4 FURNACE POWER CONTROL

A variable voltage or power control unit—115-Volt, 600-Watt minimum—will be connected to the electric furnace power supply to adequately control the heat flux from the furnace. The furnace control system will be capable of maintaining the irradiance level under steady state conditions for a minimum of 20 minutes.

*NOTE: A suitable power control unit is manufactured by Keysight Technologies of Santa Rosa, CA. Model AC6802 Basic AC Power Source rated at 1000 VA is acceptable.*

#### J.3.5 VOLTMETER

The voltmeter is used to measure the input AC voltage going to the furnace, and must have a range capable of measuring the maximum AC voltage produced by the input circuitry (typically 0–120 Volts or 0–240 Volts).

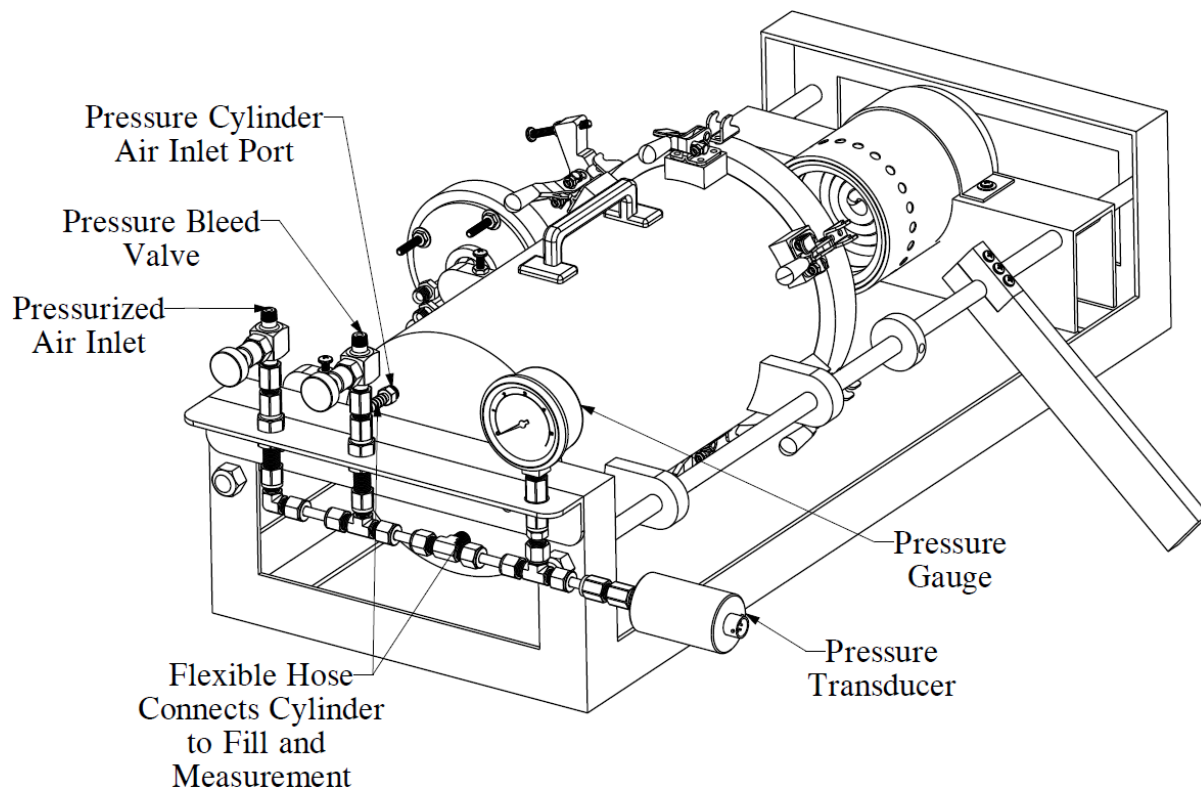
#### J.3.6 AMMETER

The ammeter is used to measure the input AC current going to the furnace, and must have a minimum range of 0–7.5 amperes.

#### J.3.7 APPARATUS FRAMEWORK

##### J.3.7.1 Pressure Supply and Equipment

Compressed air is supplied to the pressure cylinder through a needle valve attached to the end of the framework. A tee-manifold on the outlet side of the valve provides for a 0 to 5 psig pressure gauge, a transducer, a flexible tube to supply air to the rear plate of the pressure cylinder, and a bleed valve, as shown in figure J-6.

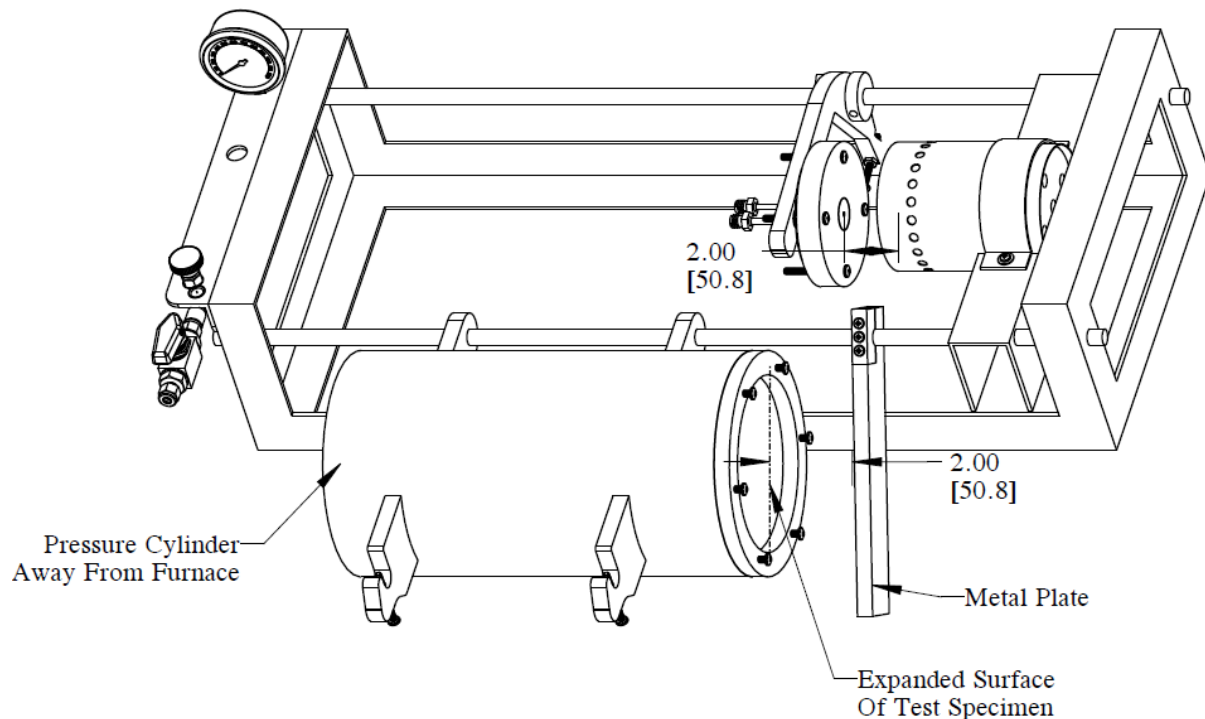


**Figure J-6. Evacuation slide test apparatus in test position**

#### J.3.7.2 Heat Flux Gauge

A 0 to 4.4 Btu/ft<sup>2</sup>s (0 to 5 W/cm<sup>2</sup>) water-cooled, Gardon-type heat flux gauge (HFG) must be used to measure the heat flux from the furnace. The HFG will be mounted in a 4.5 inch (114 mm)-diameter by 0.75 inch (19 mm)-thick insulating block, such as calcium-silicate millboard, with the surface of the HFG flush with the surface of the insulating block. The HFG will be hinged to one of the sliding bars of the framework and centered with the furnace, as shown in figure J-1. The surface of the HFG must be 2 inches from the front edge of the radiant heater, as shown in figure J-7. The HFG cooling water temperature, pressure, and flow shall be maintained within the manufacturer's recommendations. Ensure no condensation occurs on the gauge surface at any time (often caused by cooling water being too cold).

The HFG must have a thin, full-faced, opaque coating of high-temperature, high-emissivity, ultra-flat black paint. The sensitivity of the gauge is a function of the surface condition. Changes in the coating may cause drift in the overall characteristics of the gauge. Regularly inspect the measuring surface for physical damage or dust particles that may have accumulated. Cleaning can be accomplished by gently wiping a soft, water-dampened sponge across the sensor face. Damage done to the coating during the cleaning process will affect the measurement accuracy of the sensor. To maintain accuracy, the measuring surface must be recoated at regular intervals, followed by annual recalibration. See Appendix H for full details on the HFG and its required calibration.



**Figure J-7. Sample and heat flux gauge to furnace distance measurements**

### J.3.8 ALIGNMENT TOOLS

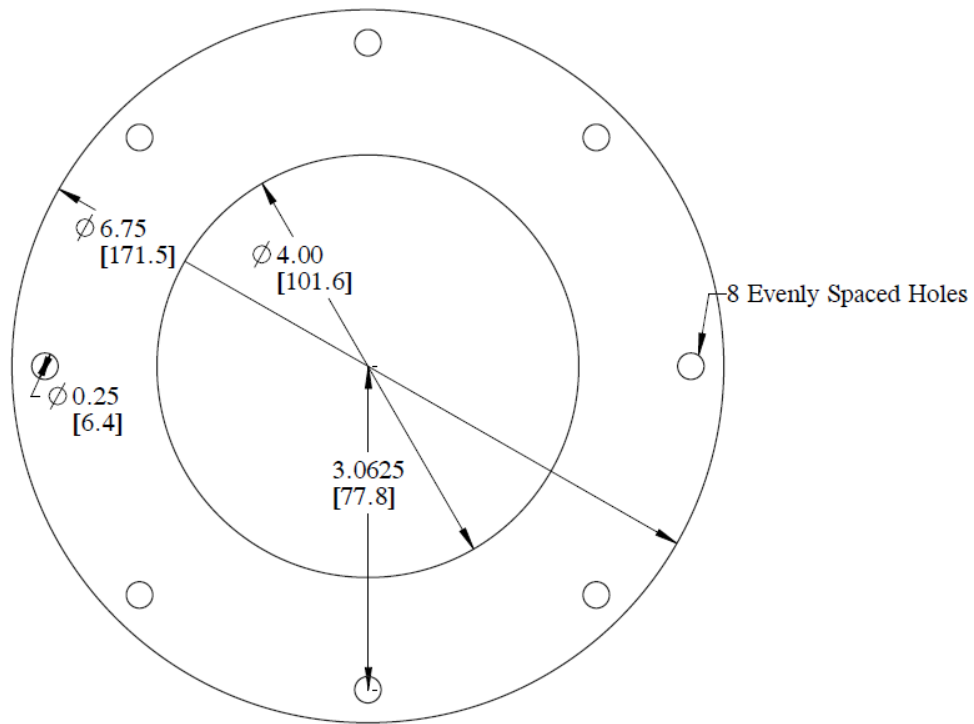
Before performing the calibration and test procedures, center points of the HFG and pressure cylinder must each align with the center point of the furnace. Two tools should be used to easily perform and periodically inspect these alignments.

Various methods of mounting the furnace are in practice and some include methods which may be prone to unintentional misalignment. The frequency of alignment inspection should be dictated by the rigidity of fixture, i.e., if the fixtures are rigid and do not easily allow misalignment, then the frequency of fixture alignment should be monthly and each time the HFG is replaced.

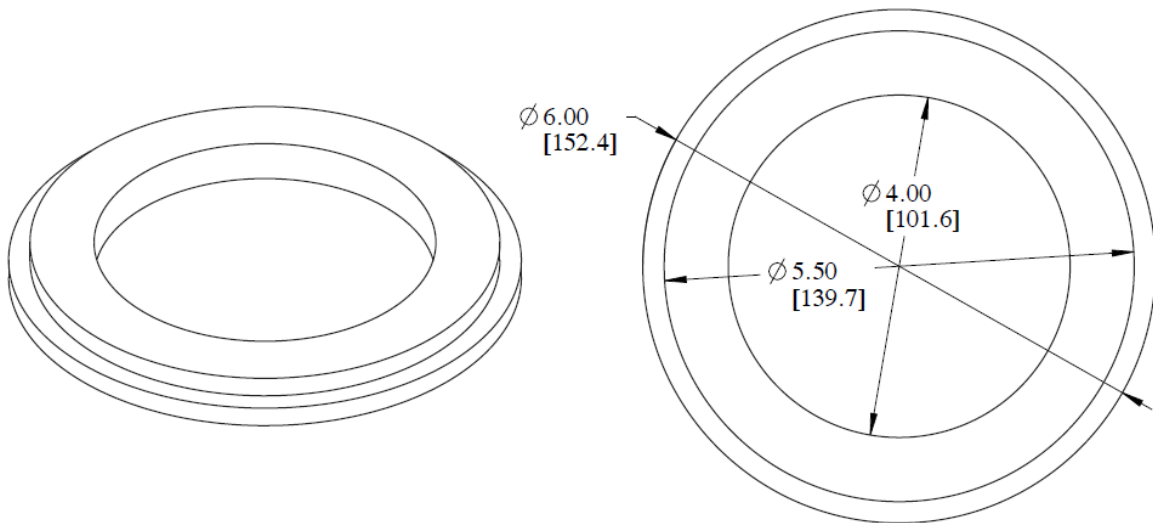
#### J.3.8.1. Pressure Cylinder Alignment Tool

It is recommended that a tool be used in order to align the center of the furnace with the pressure cylinder. The tool must be a round disk with a 4-inch hole in the center and designed to either be bolted to the pressure cylinder or fit with the toggle clamps. An example of a tool that can be bolted is a 6.75-inch diameter disk with 8 evenly spaced holes placed 3.0625-inch from the center (see figure J-8). An example of a tool to fit a pressure cylinder with clamps has a 5.5-inch diameter lip to fit inside the inside diameter of the pressure cylinder (see figure J-9).

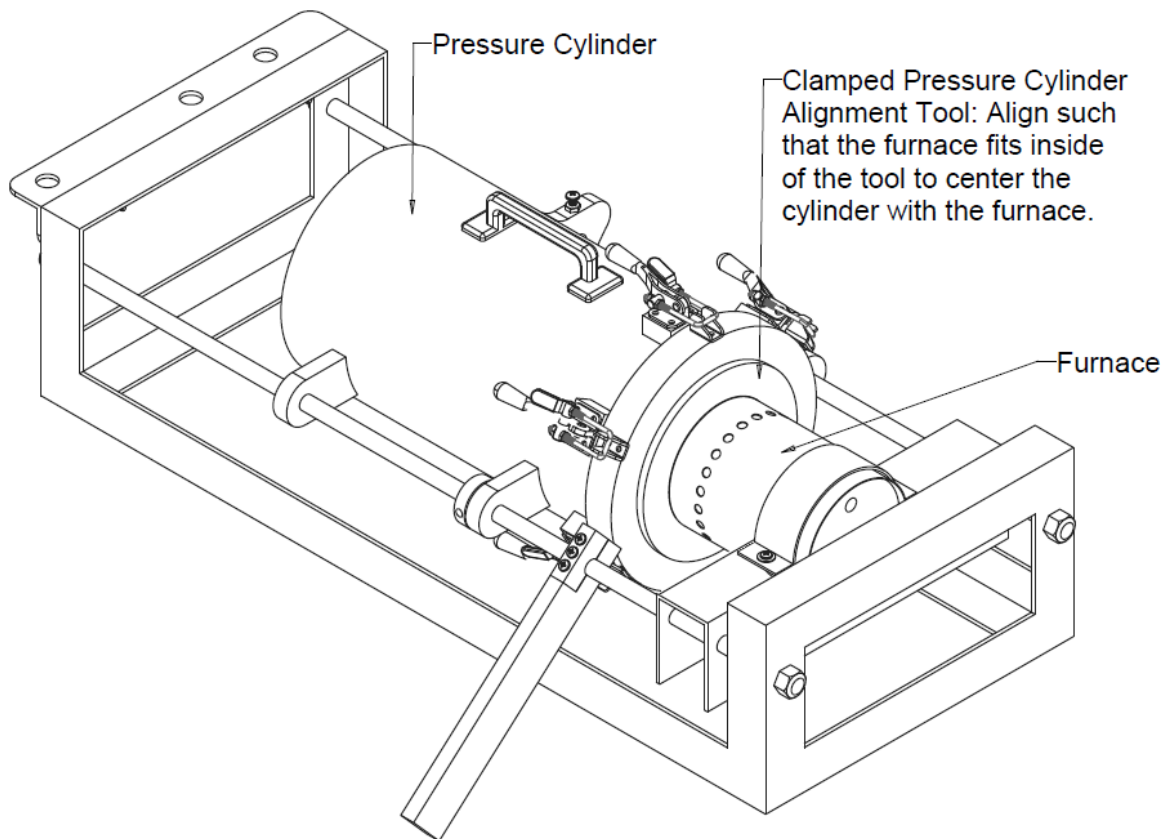
No matter which design is used, it must be mounted on the front of the pressure cylinder and slid in front of the furnace. Then adjustments must be made to align the 4-inch inner diameter of the tool with the 4-inch outer diameter of the furnace (see figure J-10).



**Figure J-8. Pressure cylinder alignment tool for bolted design**



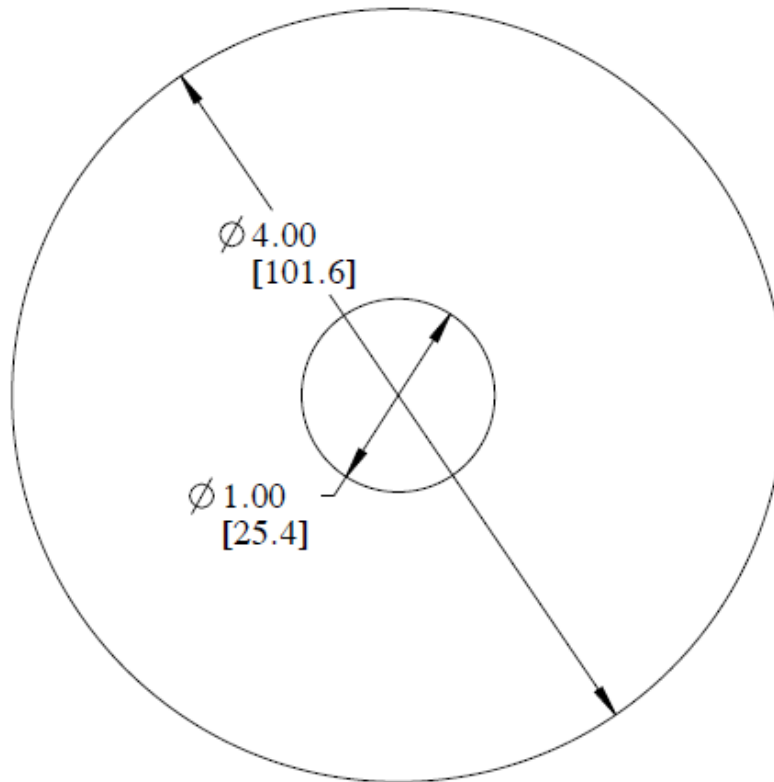
**Figure J-9. Pressure cylinder alignment tool for toggle clamps**



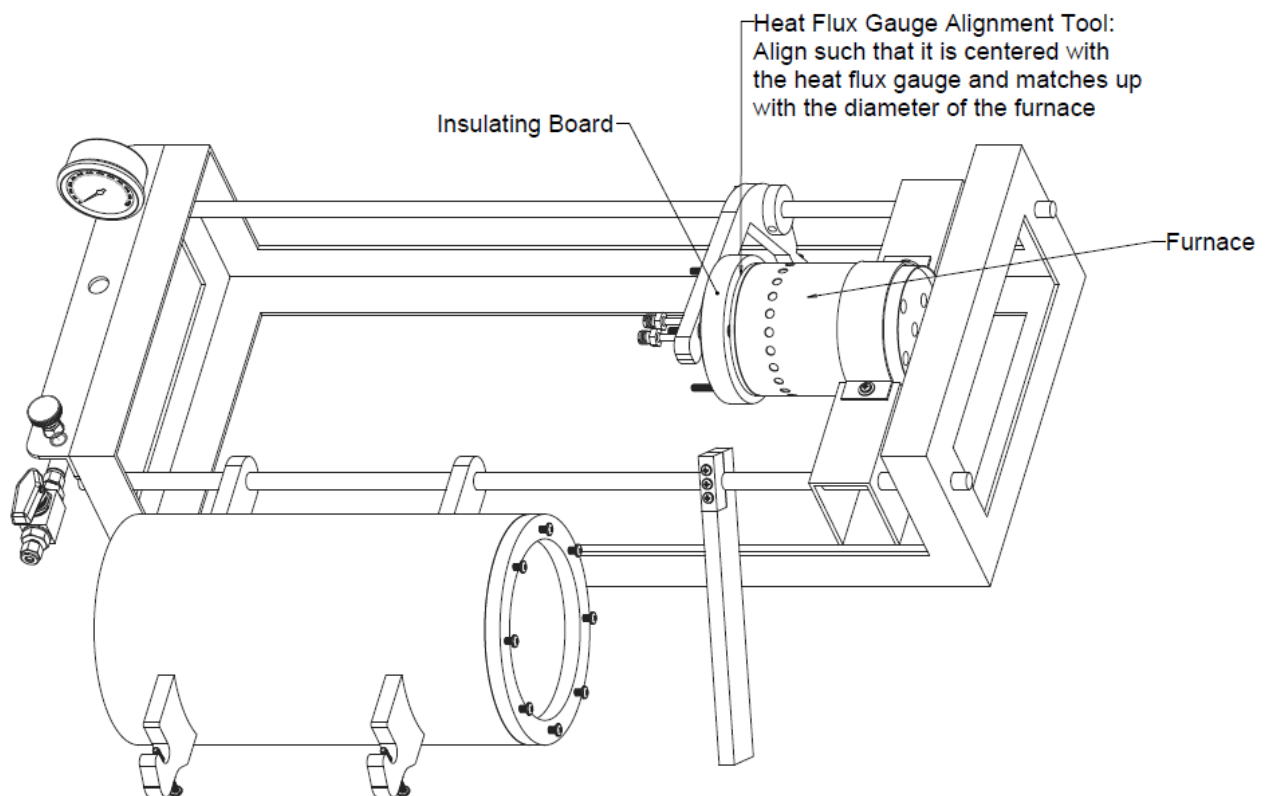
**Figure J-10. Clamped cylinder alignment tool in place**

#### J.8.3.2 Heat Flux Gauge Alignment Tool

The tool used to align the center of the HFG with the center of the furnace is a 4-inch diameter disk with a 1-inch diameter hole in the center, as shown in figure J-11. The disk is placed such that the 1-inch hole fits around the 1-inch diameter HFG. Then the HFG assembly and disk is slid over to match up with the front of the furnace. The 4-inch outer diameter of the disk needs to align with the 4-inch outer diameter of the furnace. Make the necessary adjustments until HFG and furnace are aligned, as shown in figure J-12.



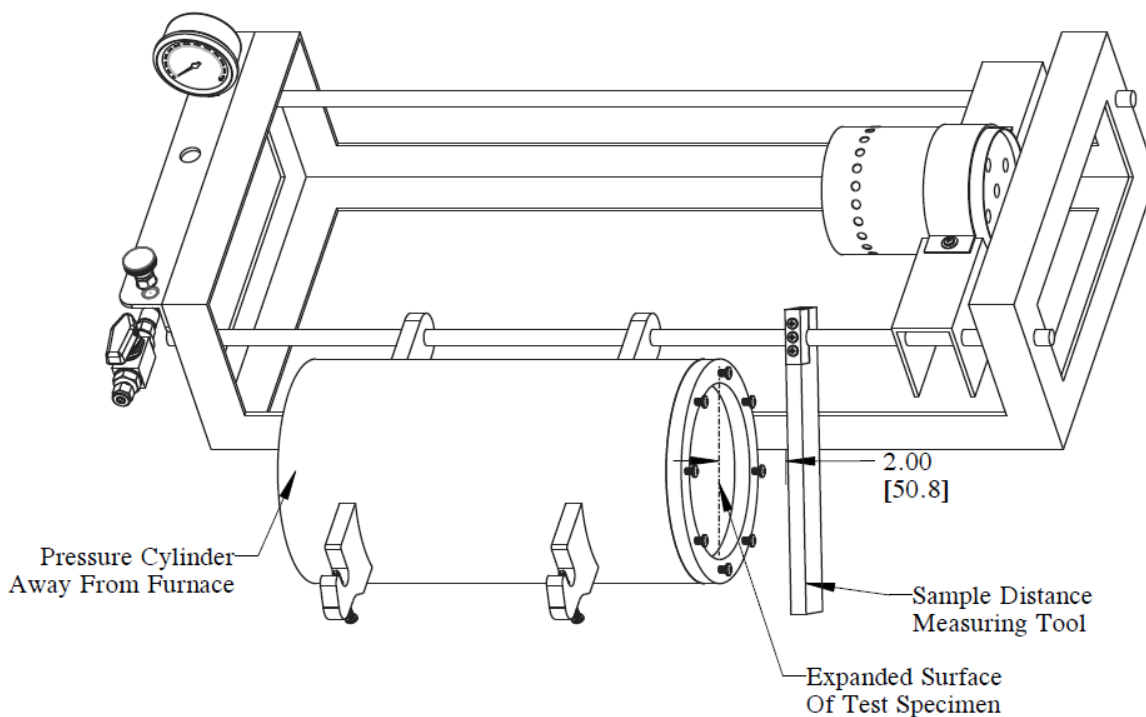
**Figure J-11. Heat flux gauge alignment tool**



**Figure J-12. HFG alignment tool placed between HFG and furnace**

### J.3.8.3 Test Sample to Furnace Distance Measurement Tool

After pressurizing the pressure cylinder with a test sample in place, the surface of the sample expands outward. The farthest edge of this surface must be placed 2 inches from the front of the furnace. This must be measured when the pressure cylinder is away from the furnace to not expose the sample to its radiant heat. Therefore, a metal plate that aligns with the front of the furnace is to be placed in front of the pressure cylinder when it is rotated out of position (see figure J-13). To reach the correct position, slide the pressure cylinder until the expanded surface of the test sample is 2 inches from the metal plate and tighten the sliding stop to hold that position.



**Figure J-13. Sample to furnace distance measurement**

## J.3.9 INSTRUMENTATION

### J.3.9.1 Data Acquisition

A calibrated recording device or a computerized data-acquisition system with an appropriate range must be used to measure and record the power input of the furnace and pressure transducer. If a voltmeter is used, it requires a resolution of 0.01 V and an accuracy of 0.3%.

### J.3.9.2 Timing Device

A stopwatch or other device, accurate to within  $\pm 1$  second per 8 hours ( $\pm 3$  sec/day), must be used to measure the time of application of the burner flame, and the test sample ignition and extinguishment times.