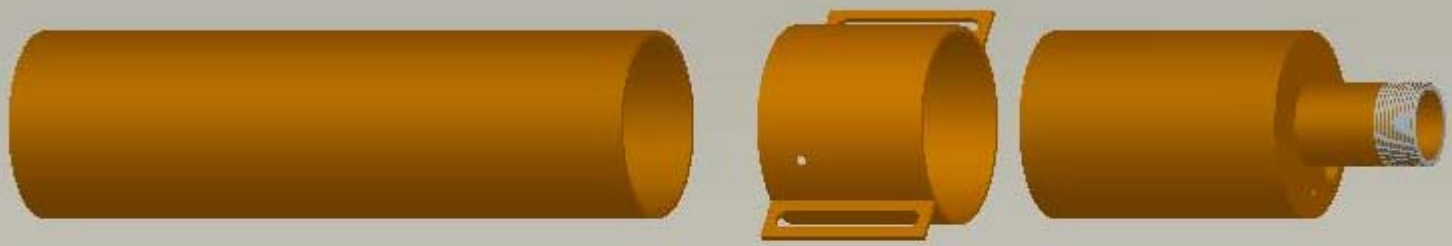
Next Generation Fire Test Burner: Plans and Information

Updated March 2011

Federal Aviation Administration

NexGen Burner Housing

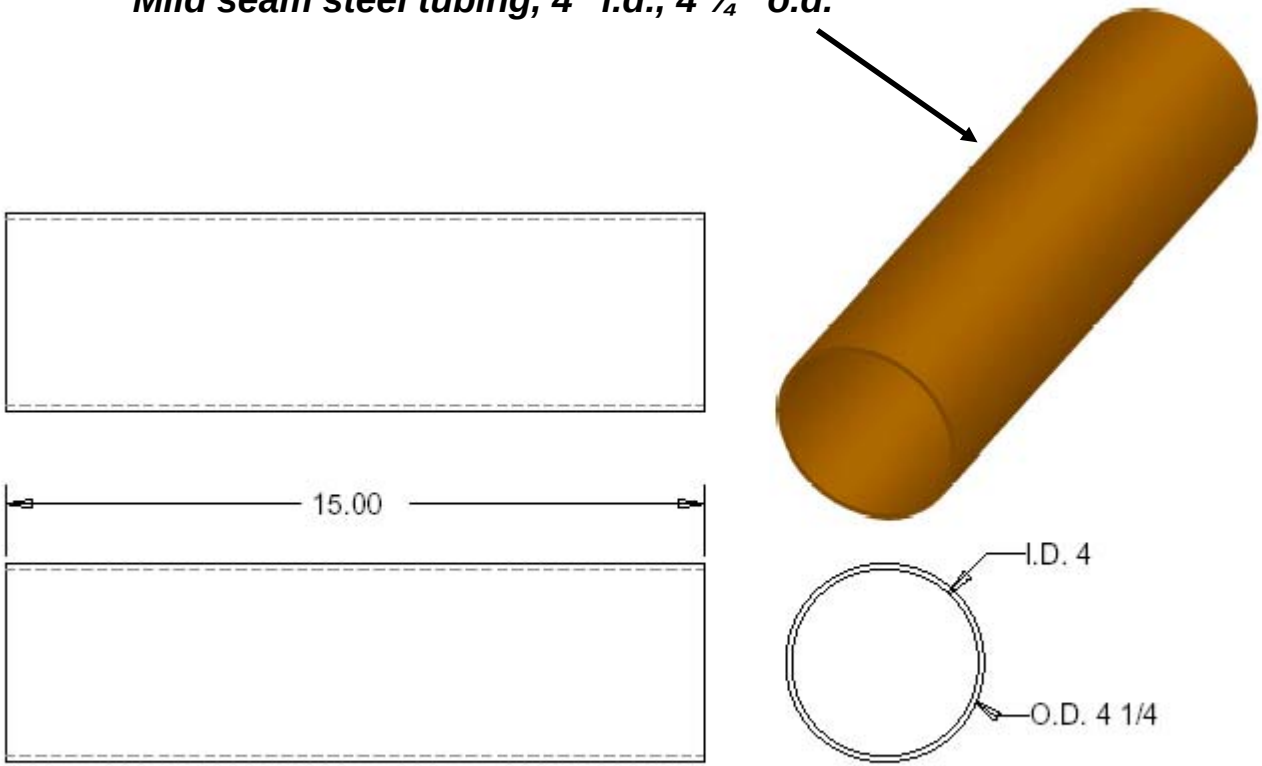


Draft Tube ***Coupling*** ***Back Section***

Draft Tube

ALL DIMENSIONS ARE INCHES

Mild seam steel tubing, 4" i.d., 4 ¼" o.d.

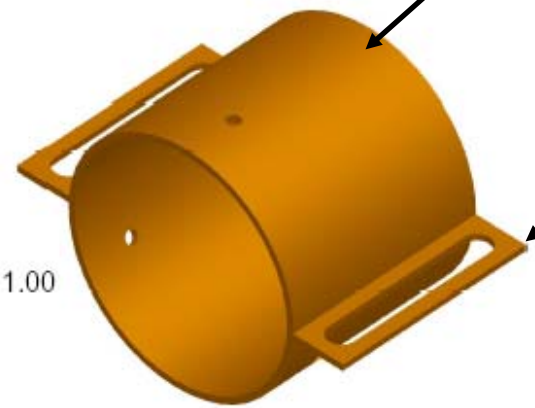


Coupling

ALL DIMENSIONS ARE INCHES

Mild seam steel tubing, 4 ¼" i.d., 4 ¾" o.d

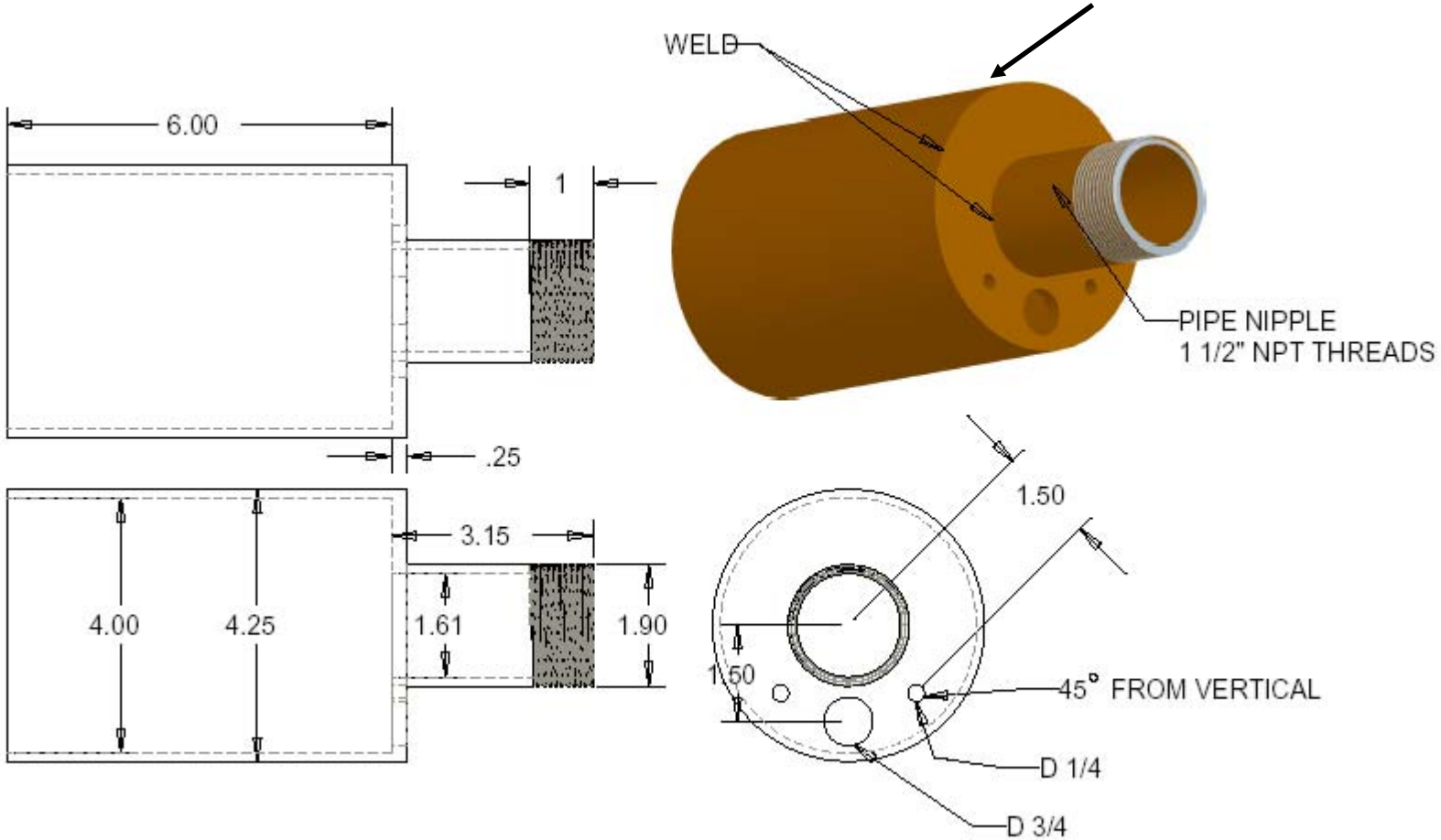
Steel plate, 1/8" thickness



Back Section

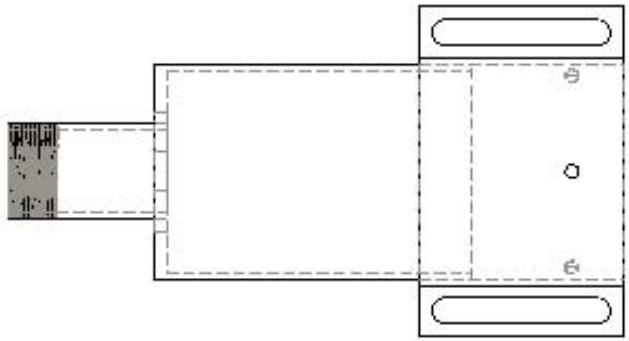
ALL DIMENSIONS ARE INCHES

Mild seam steel tubing, 4" i.d., 4 ¼" o.d.

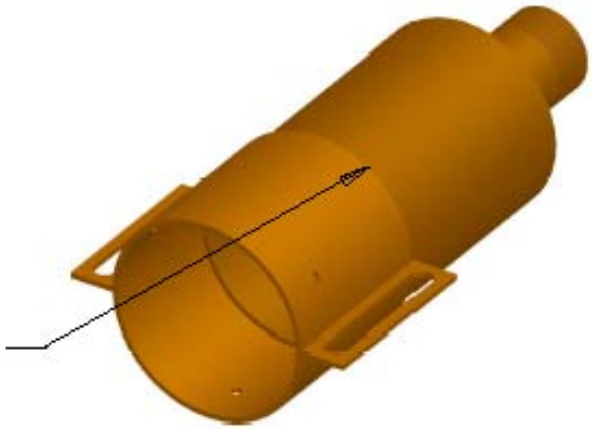


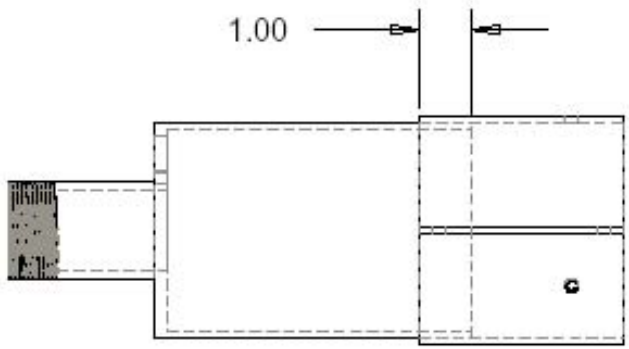
Assembled Back Section and Coupling

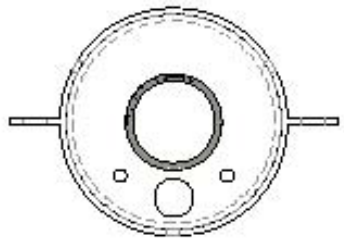
ALL DIMENSIONS ARE INCHES



INSERT 1" - WELD IN PLACE



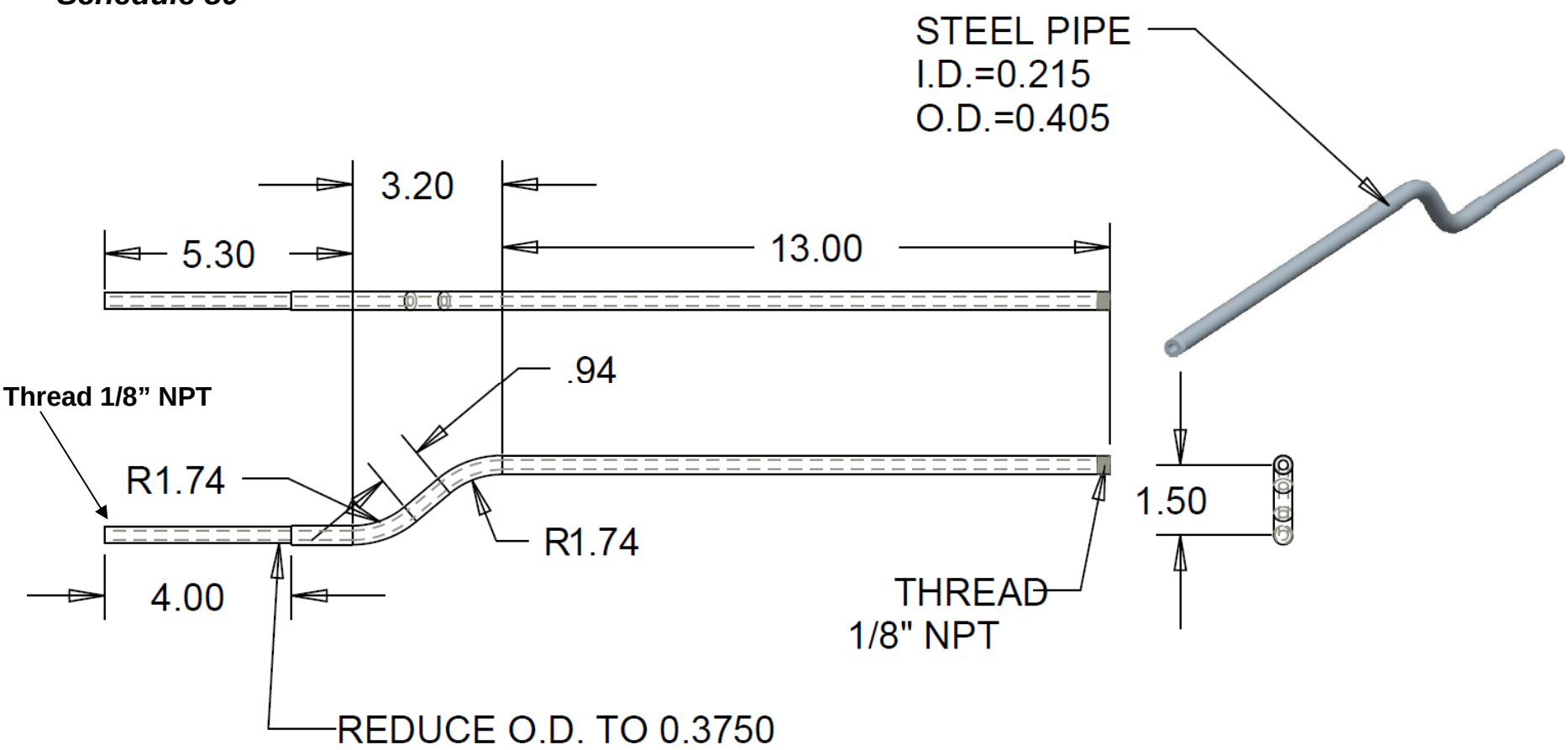




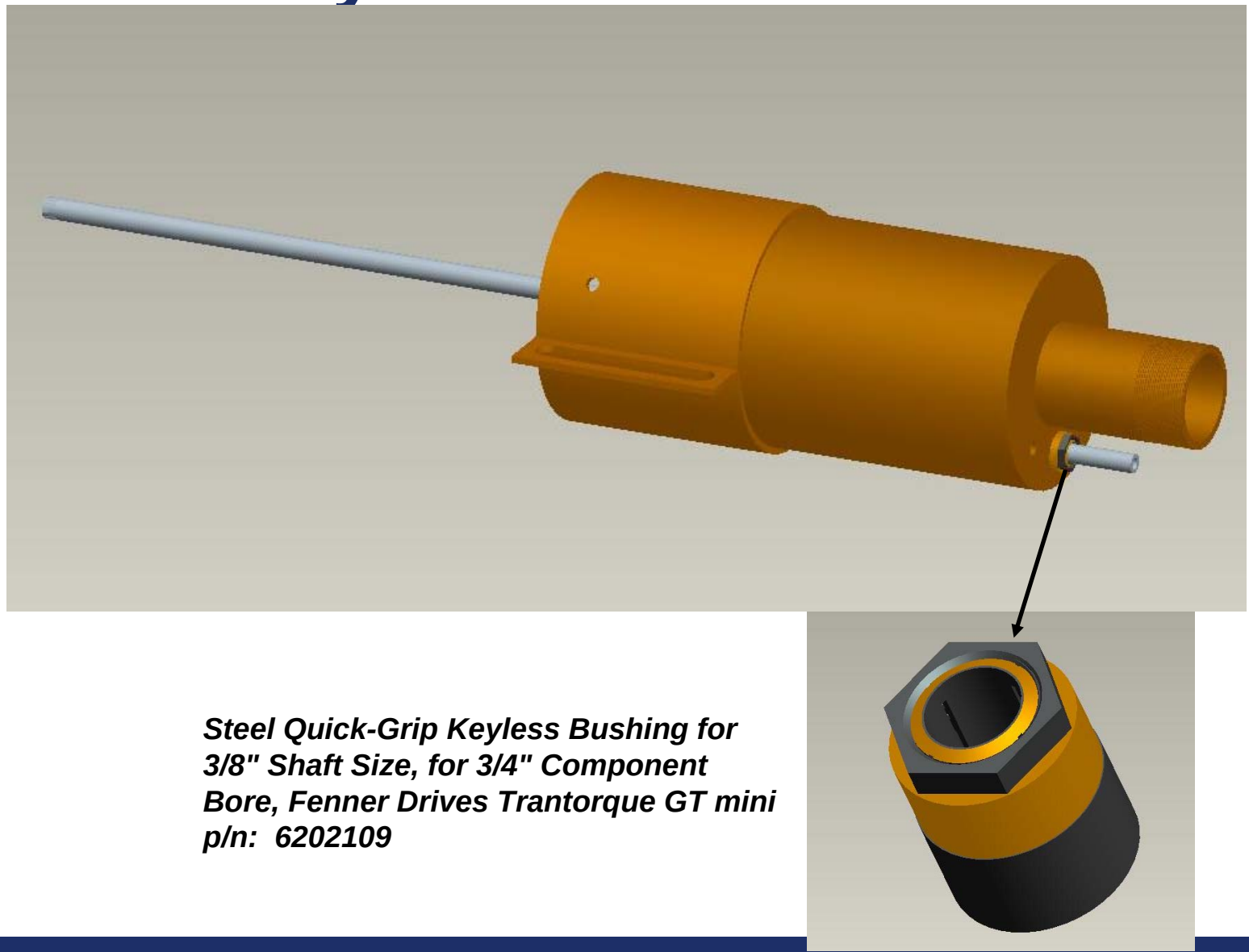
Fuel Tube

Thick-Wall Steel Seamless Pipe 1/8" Pipe Size
Schedule 80

****ALL DIMENSIONS ARE INCHES****



Assembly



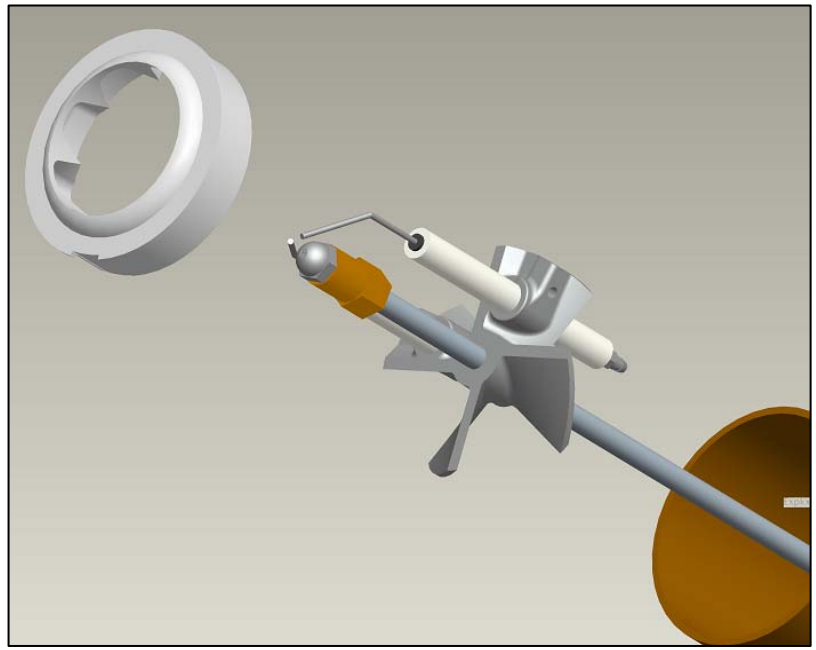
Steel Quick-Grip Keyless Bushing for 3/8" Shaft Size, for 3/4" Component Bore, Fenner Drives Trantorque GT mini p/n: 6202109

Internal Components

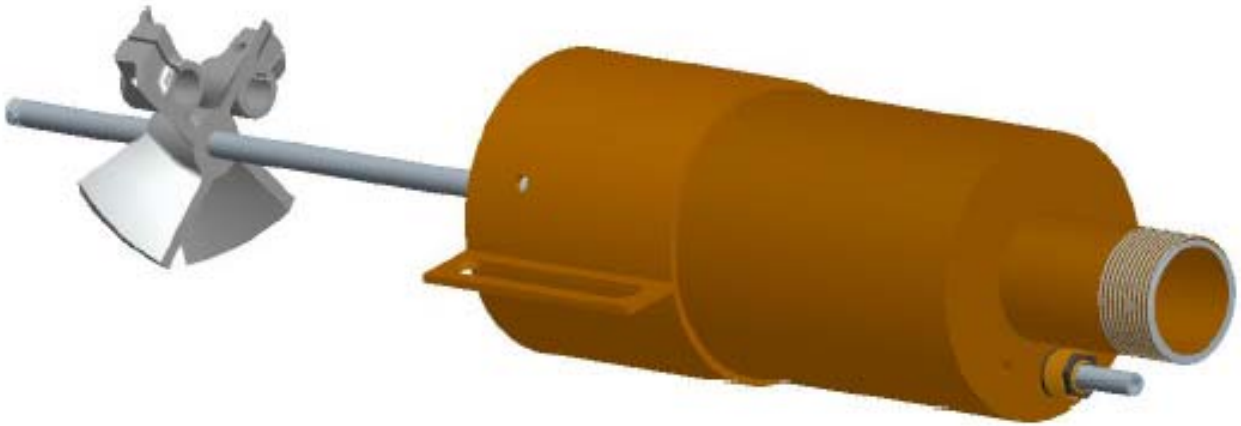
- **A working group participant was able to digitize the original stator and turbulator**
- **They were able to correct irregularities and asymmetries in design software**
- **A computer numerical controlled (CNC) mill was used to cut new, corrected stators and turbulators**
- **Comparison testing validated the performance of the new components**
- **The parts can be purchased from Marlin Engineering**
  - http://www.marlinengineer.com/
  - Stator: p/n ME1513-1
  - Turbulator: p/n ME1512-1

Turbulator

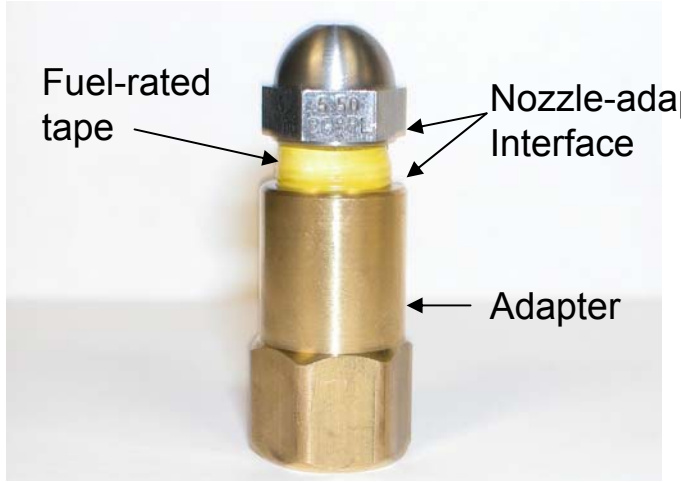
Stator



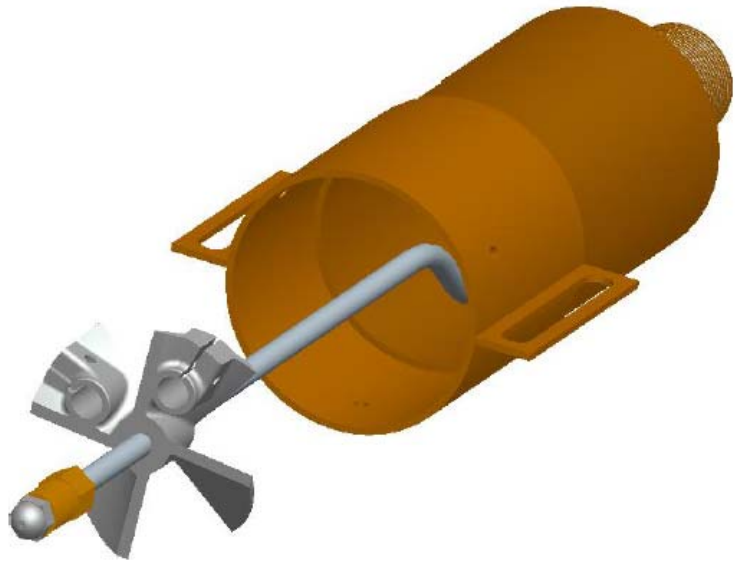
Assembly



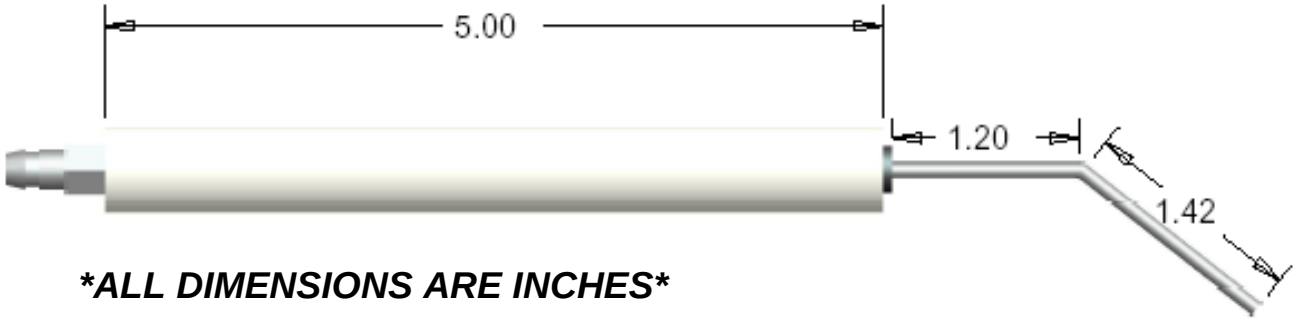
Fuel Nozzle



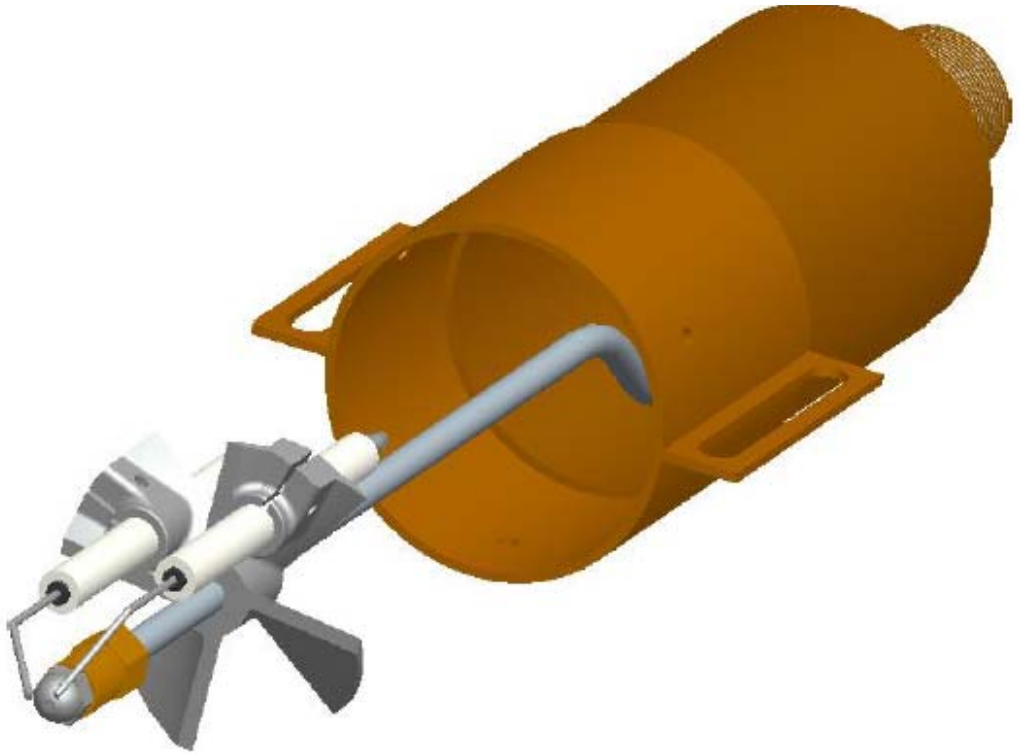
- **Monarch 80° Oil Burner Nozzle**
  - Burnthrough: 5.5 gph PL hollow cone @ 120 psig →6.0 gph
  - Seat Cushion: 2.25 gph PLP semi-solid @ 95 psig→2.0 gph
- **Standard female nozzle adapter, brass, 1/8” NPT**
- **Fuel rated thread tape used to prevent fuel leakage**



Igniters



ALL DIMENSIONS ARE INCHES



Westwood Products, South River, NJ

www.westwoodproducts.com

1-800-442-1630

p/n E5-2M5

Insulator length 5”

Insulator diameter 9/16”

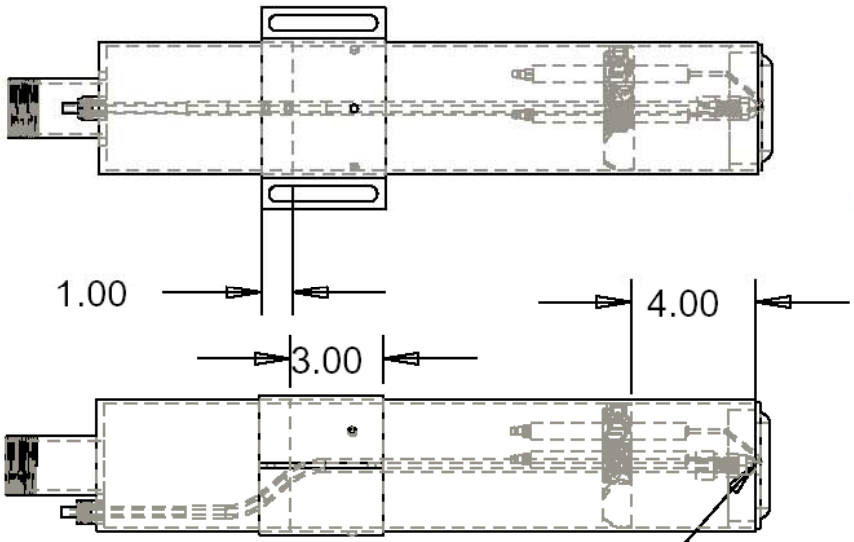
Electrode diameter 3/32”

Connector diameter 3/16”

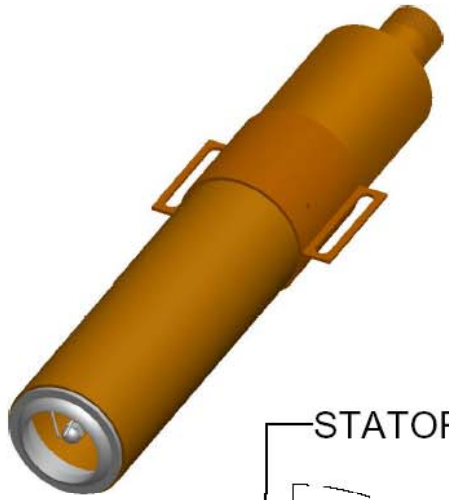
Igniter Wires

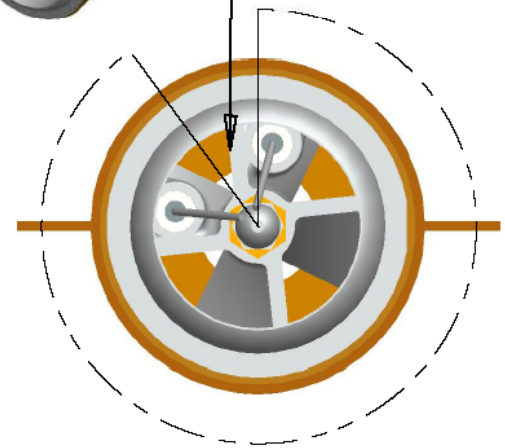
Assembled NexGen Burner Housing

ALL DIMENSIONS ARE INCHES



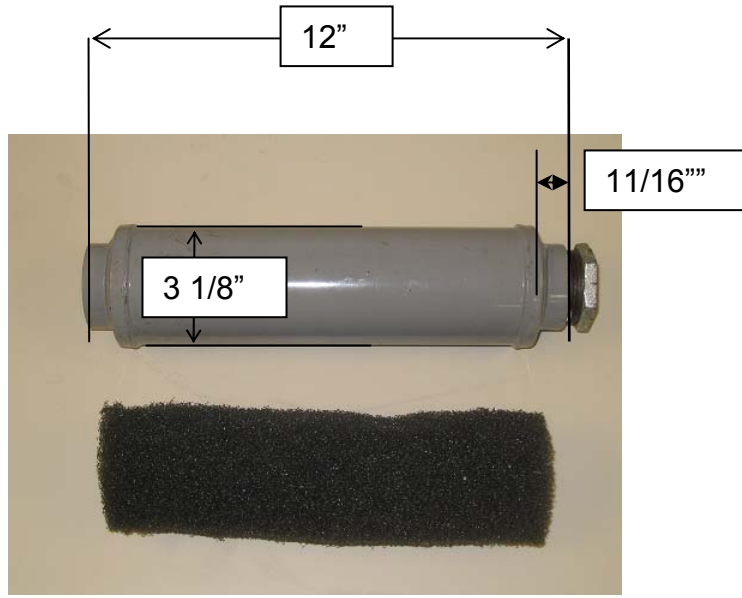
NOZZLE DEPTH 5/16"
IGNITOR DEPTH 5/32"
STATOR DEPTH 4 5/16"
FROM TURB EXIT PLANE

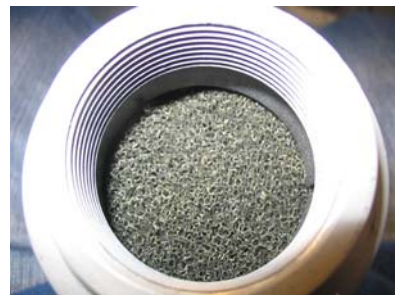




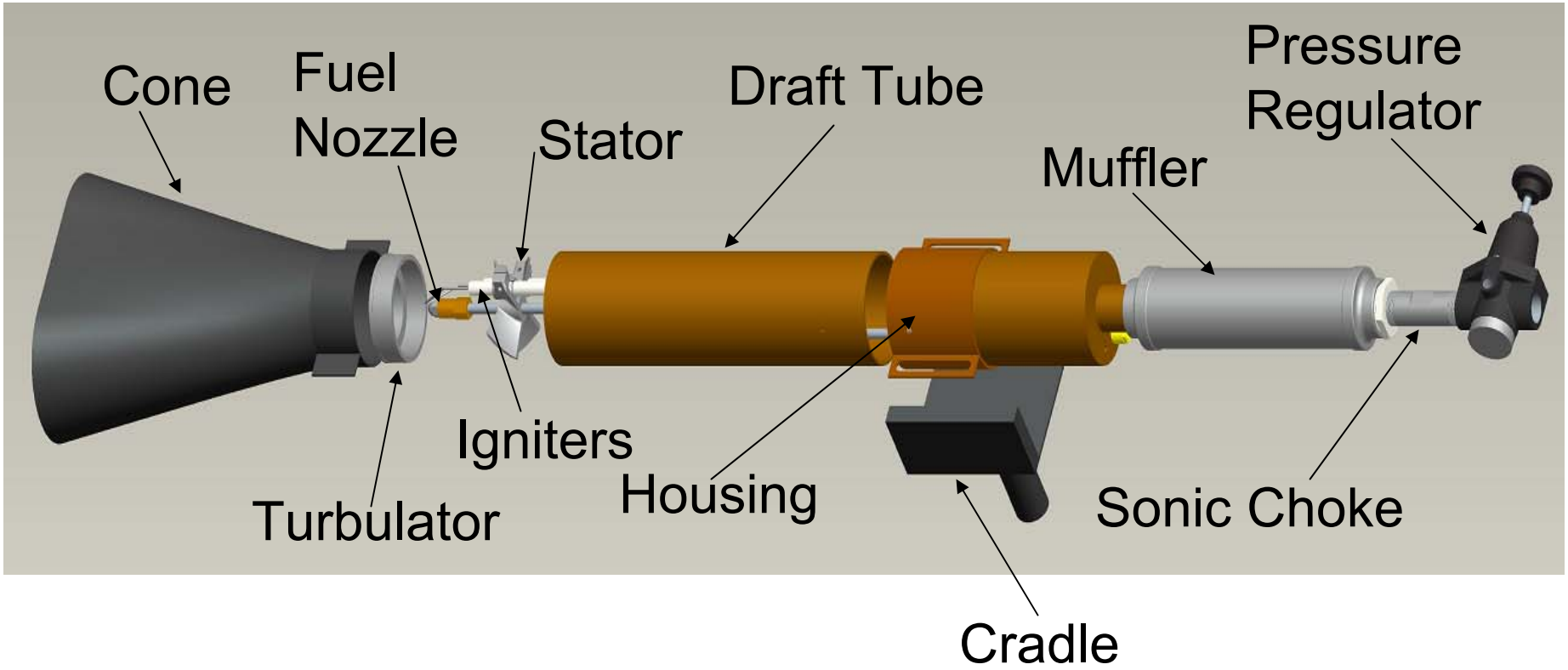
Regulator and Muffler

- **Air Pressure Regulator**
  - ARO Ingersoll Rand high flow general purpose regulator, p/n 27364-000
  - If not available, any high flow 1” NPT pressure regulator should work, as long as can maintain a steady pressure during calibration and testing
- **Muffler**
  - Heavy duty inline muffler, McMaster-Carr p/n 5889K73
    - If unable to purchase from mcmaster carr, the specifications are:
      - 1 ½” NPT female thread ends
      - 155 SCFM rated flow
      - ~3lbs weight
  - A foam insert is used to reduce noise from sonic choke
    - Polyurethane safety foam
      - 1.2-1.5 lb/ft^3
      - 21.5-33.0 pores per inch
    - Foam can be cut into a 12” long x 2 ½” diameter cylinder to fit inside the muffler
    - Foam insert has no effect on burner output

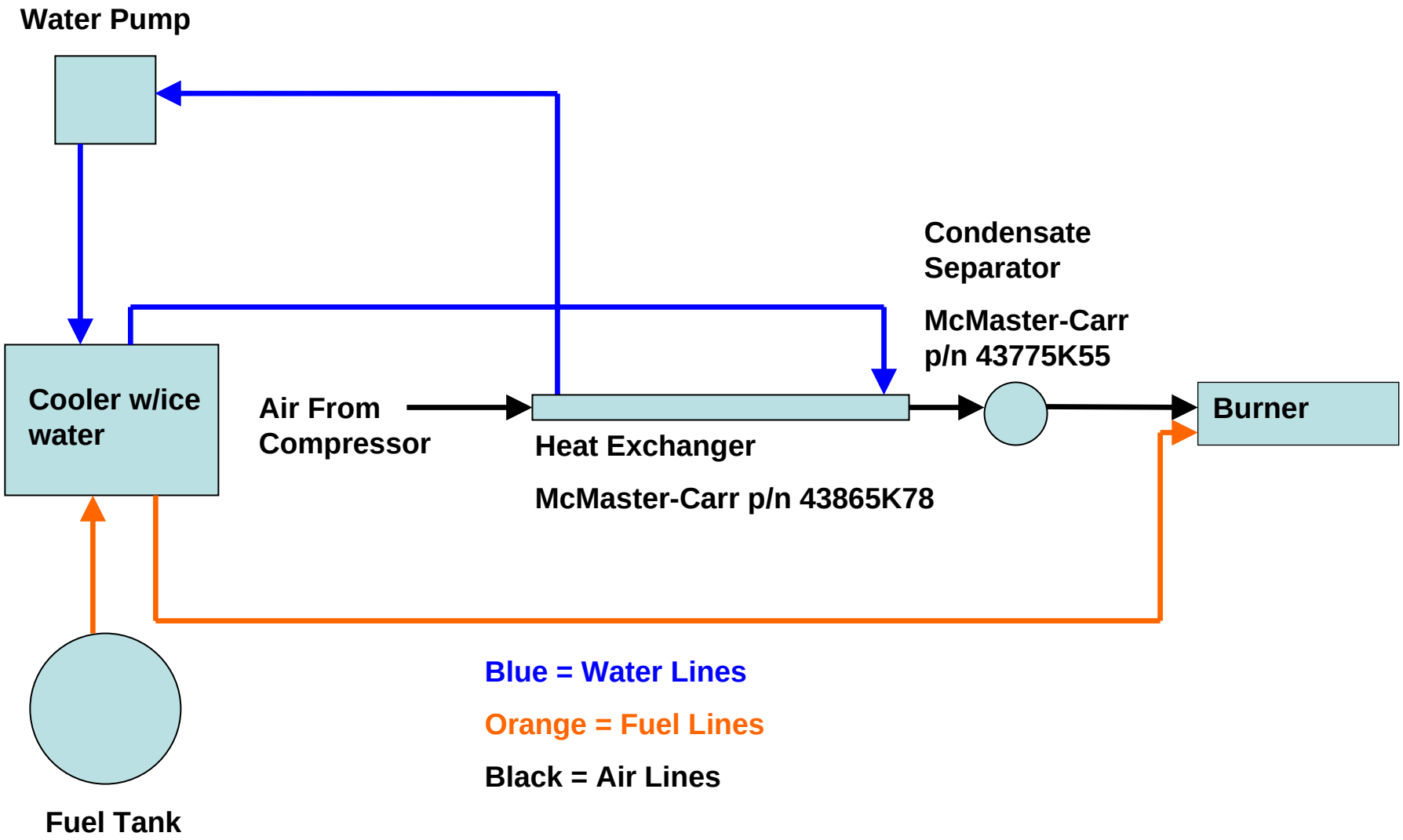




NexGen Burner

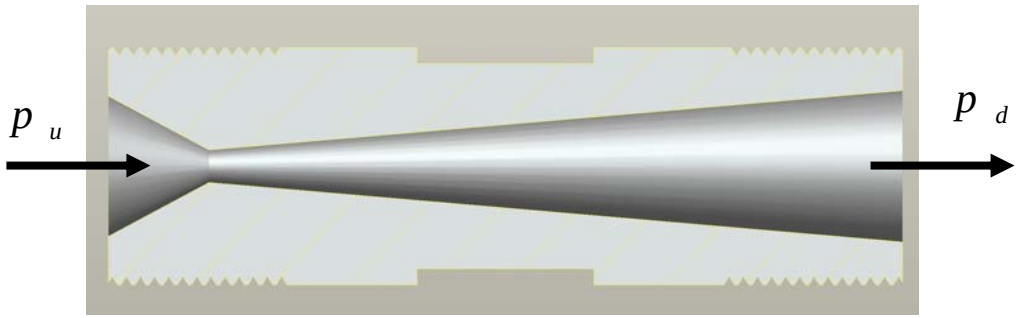


Heat Exchange System

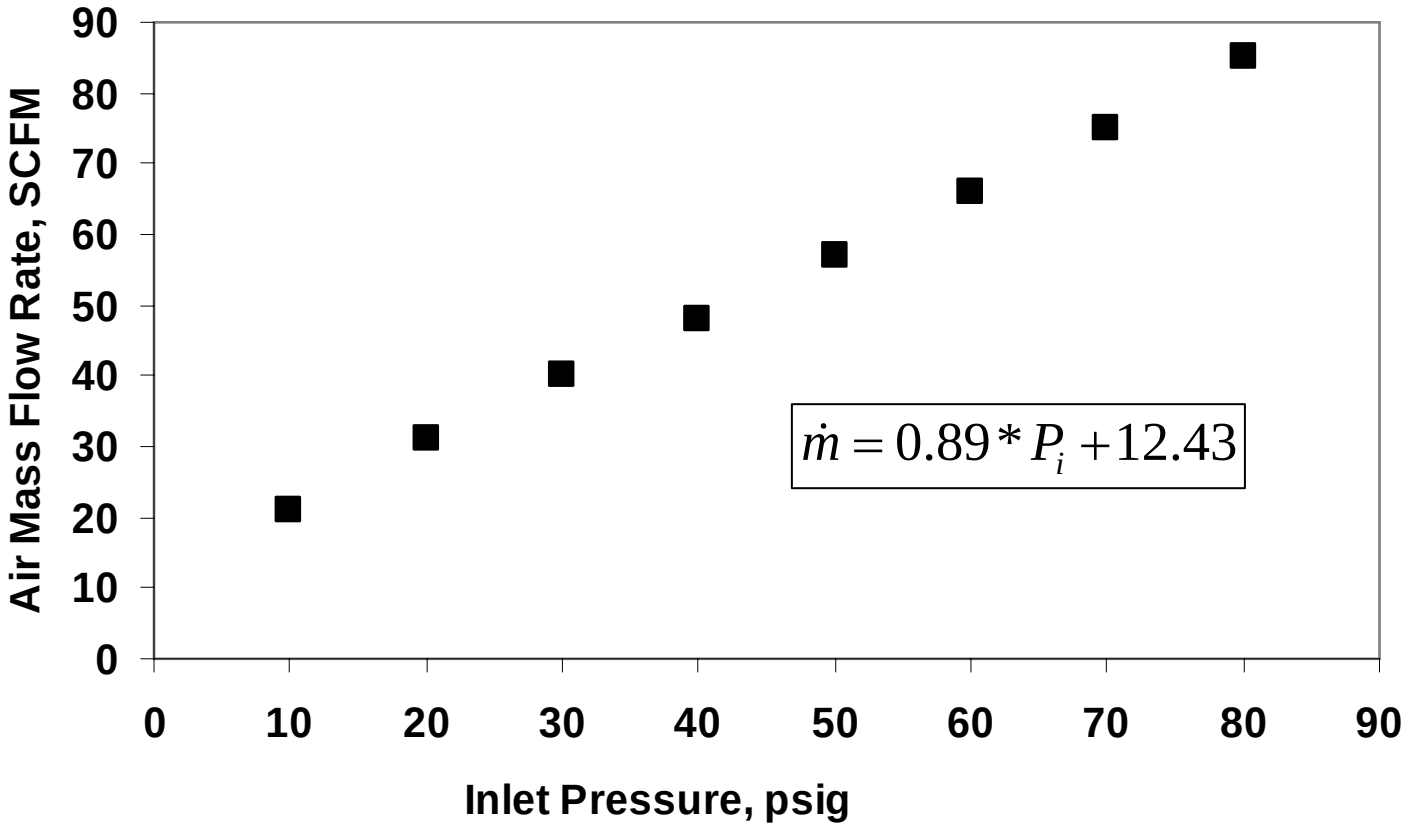


NexGen Components – Air Delivery

- **Critical Flow Venturi (Sonic Choke)**
  - Applied fluid dynamics
    - Converging-Diverging nozzle theory derived from:
      - Continuity (conservation of mass)
      - Equation of State (ideal gas)
      - Isentropic Flow Relations (2nd Law of Thermodynamics – Reversible Flow)
    - Flow is motivated by a pressure difference between the upstream converging section and the downstream diverging section
    - Each upstream pressure results in choked flow and a fixed mass flow rate, as long as the downstream pressure is less than 88% of the upstream pressure.
  - The details of the sonic choke chosen for the NexGen burner are
    - Fox Valve, Inc. of Dover, NJ
    - p/n 612021-8
    - Design point – 80 SCFM at 75 psig inlet pressure
    - Construction – 1” pipe, 304 stainless steel, male NPT ends

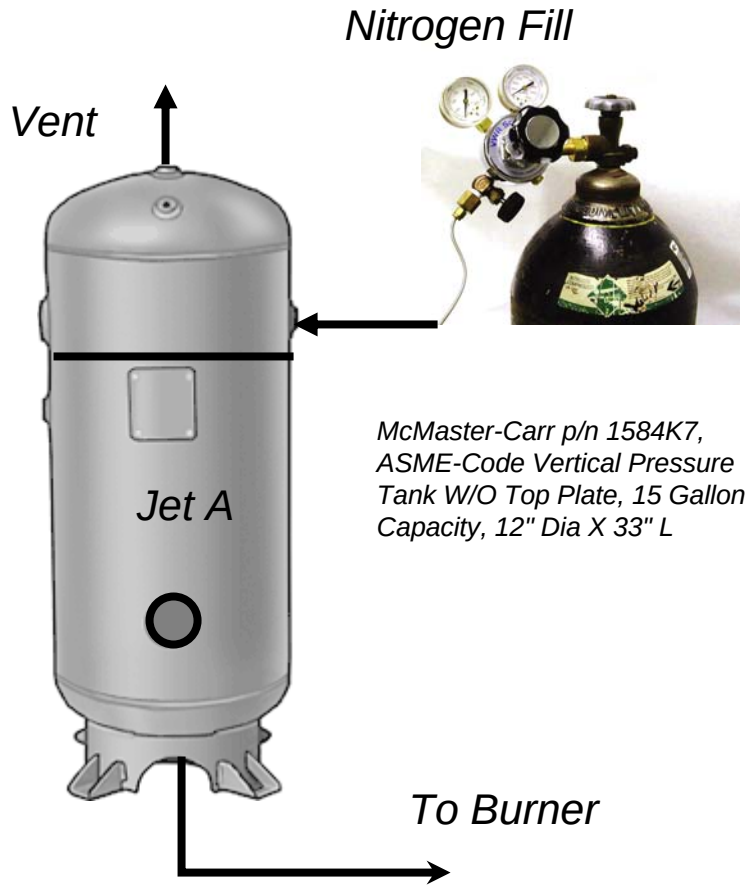


Sonic Choke Calibration



NexGen Components – Fuel Delivery

- **Fuel will be provided by a pressurized fuel tank**
  - Headspace gas pressure controlled with a precision regulator
  - Fuel pressure can be measured at the back of the burner for an accurate reading nearest to the fuel nozzle
  - **Note: equivalent results have been obtained using a mechanical fuel pump to achieve the same pressure*



McMaster-Carr p/n 1584K7, ASME-Code Vertical Pressure Tank W/O Top Plate, 15 Gallon Capacity, 12" Dia X 33" L

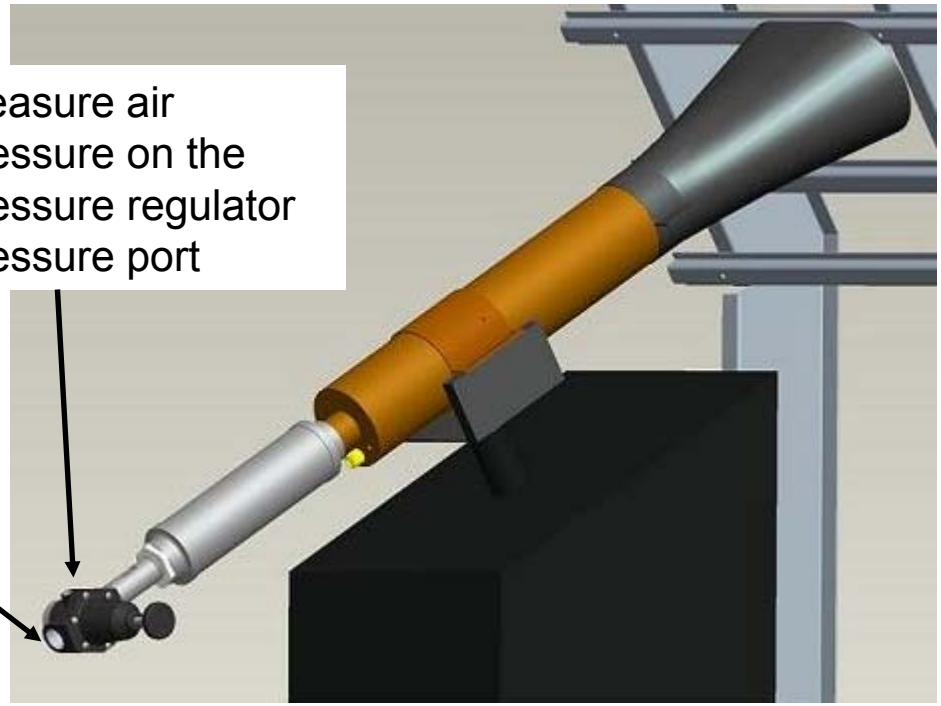
Measurement of Burner Inlet Parameters

- **It is critical that all inlet parameters are measured accurately and in a consistent manner**
  - For the NexGen burner, since the burner construction and components are more standardized, flame output will be consistent for given inlet conditions
- **For standardization, all NexGen burners must measure inlet conditions at the same location**
  - To get an accurate measurement of the conditions entering the burner, the measurements are made nearest to the burner inlet

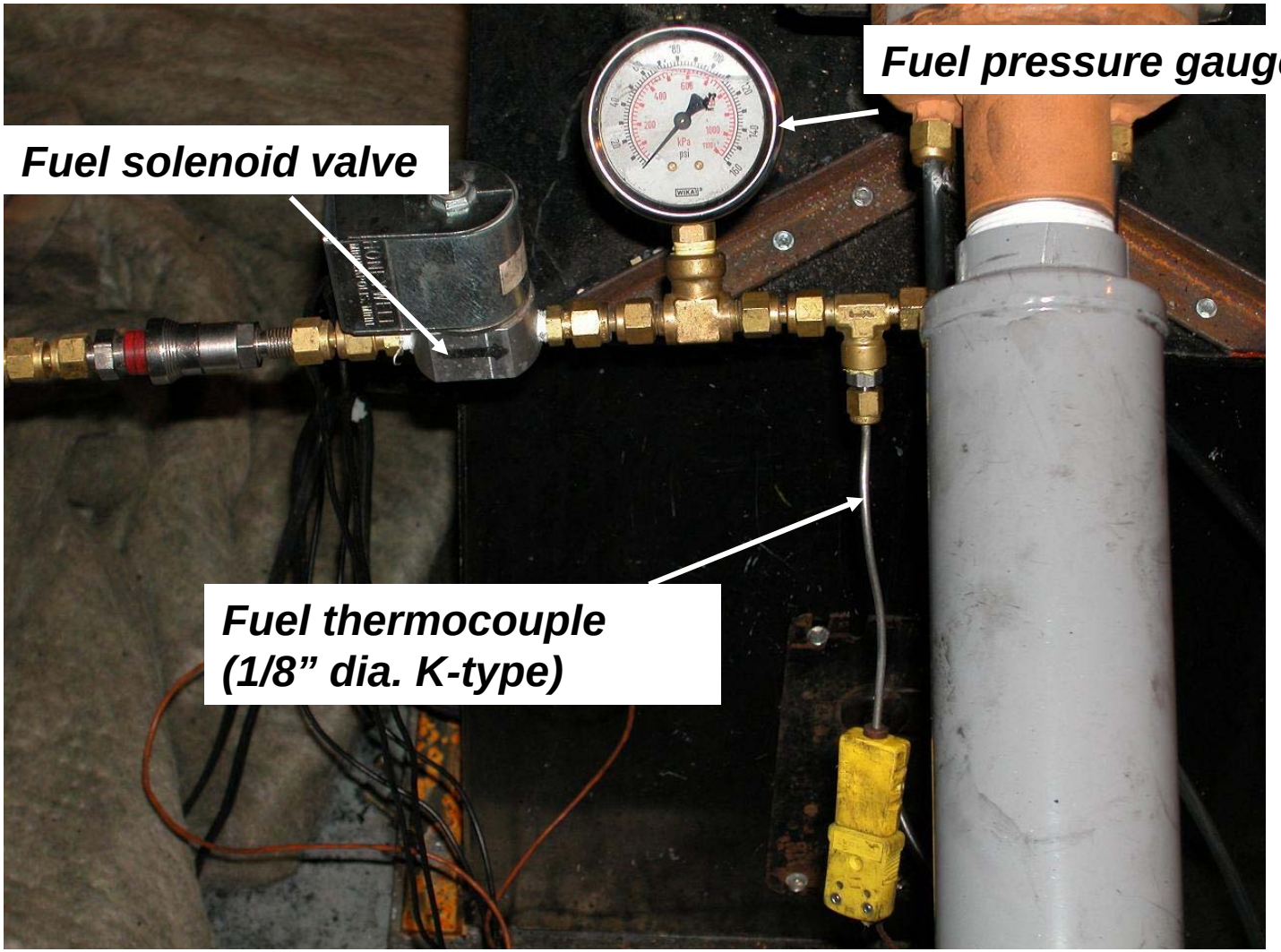
Air Measurement

Measure air temperature just upstream of the pressure regulator with a 1/8” K-type thermocouple

Measure air pressure on the pressure regulator pressure port



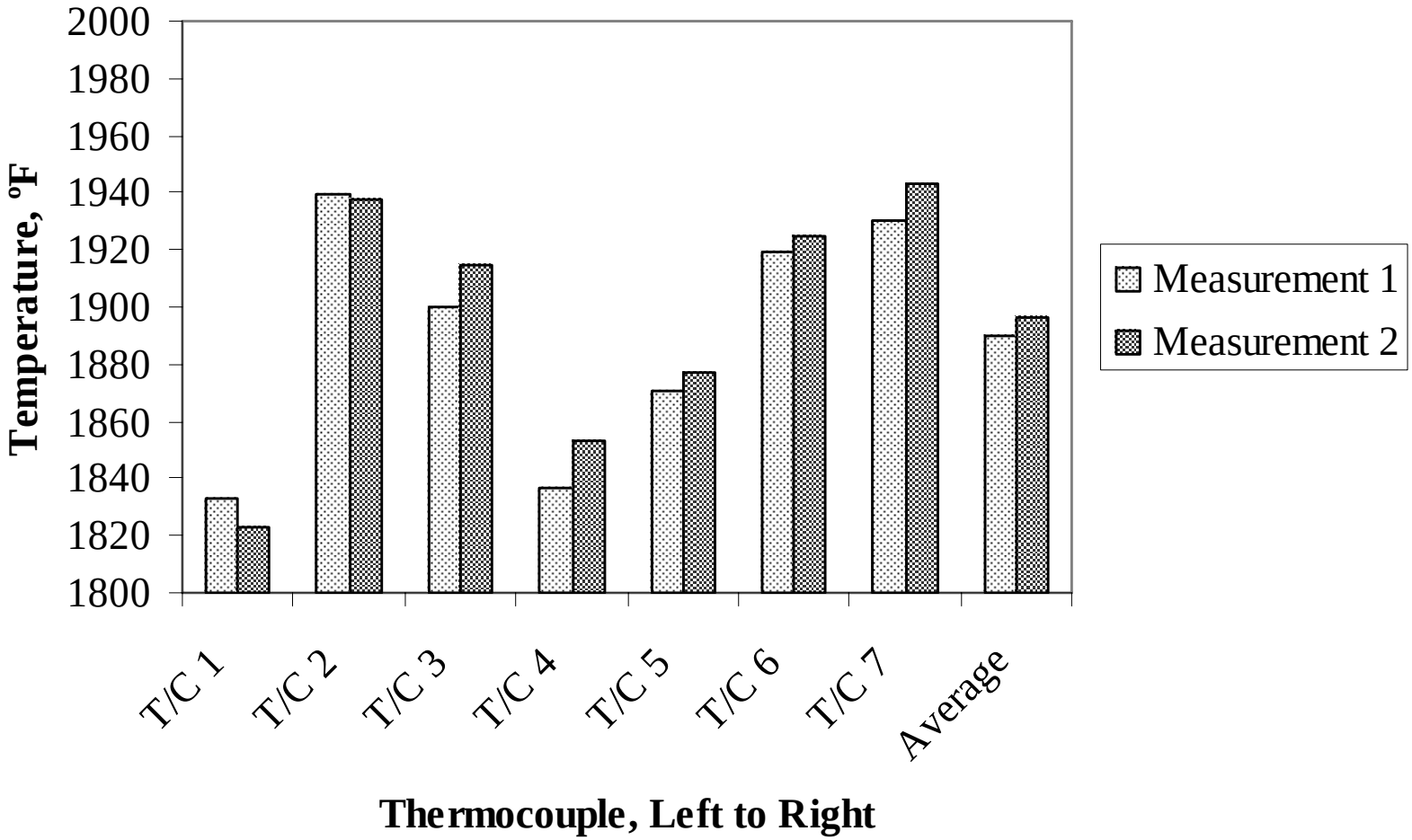
Fuel Measurement



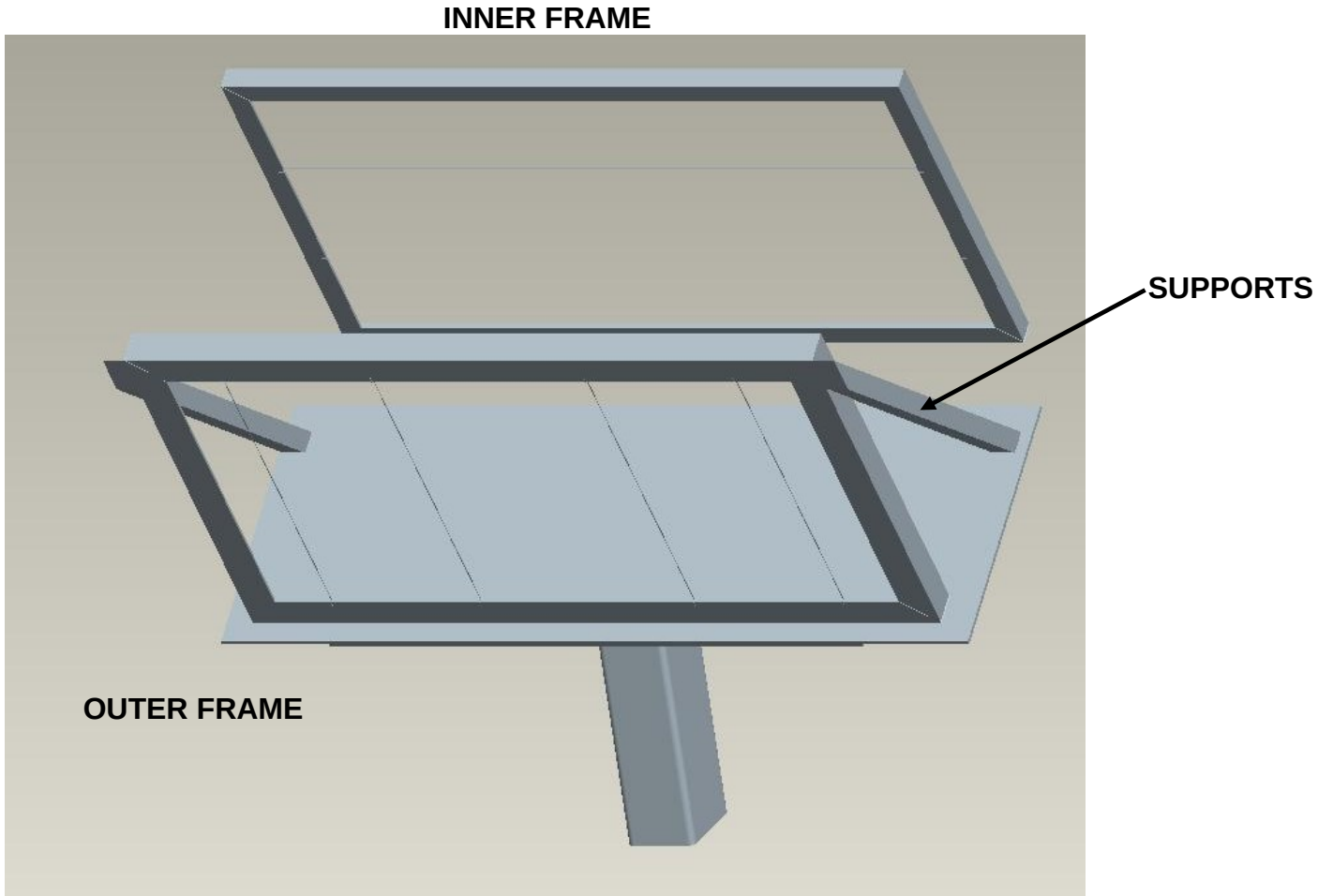
Burner Operational Parameters: Insulation Burnthrough

- **Fuel**
  - Type: JP8, Jet A or equivalent
  - Nozzle: Monarch 5.5 gph 80°PL
  - Pressure: 120 psig (±2 psig)
  - Temperature: 42°F (±10°F)
  - Flowrate: 6.0 gph (±0.3 gph)
- **Air**
  - Pressure: 60 psig (±2 psig)
  - Temperature: 50°F (±10°F)

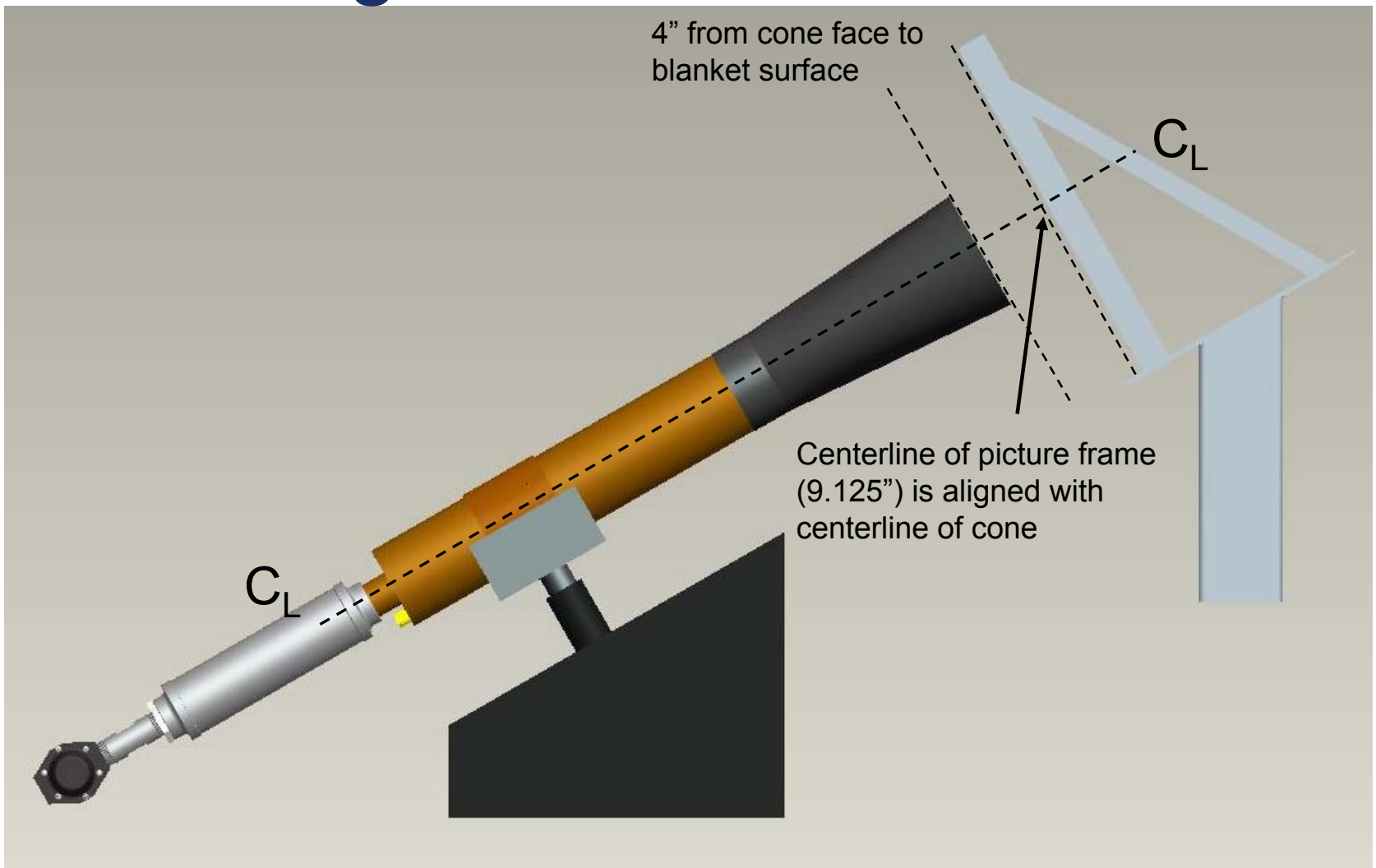
Flame Temperature Measurement



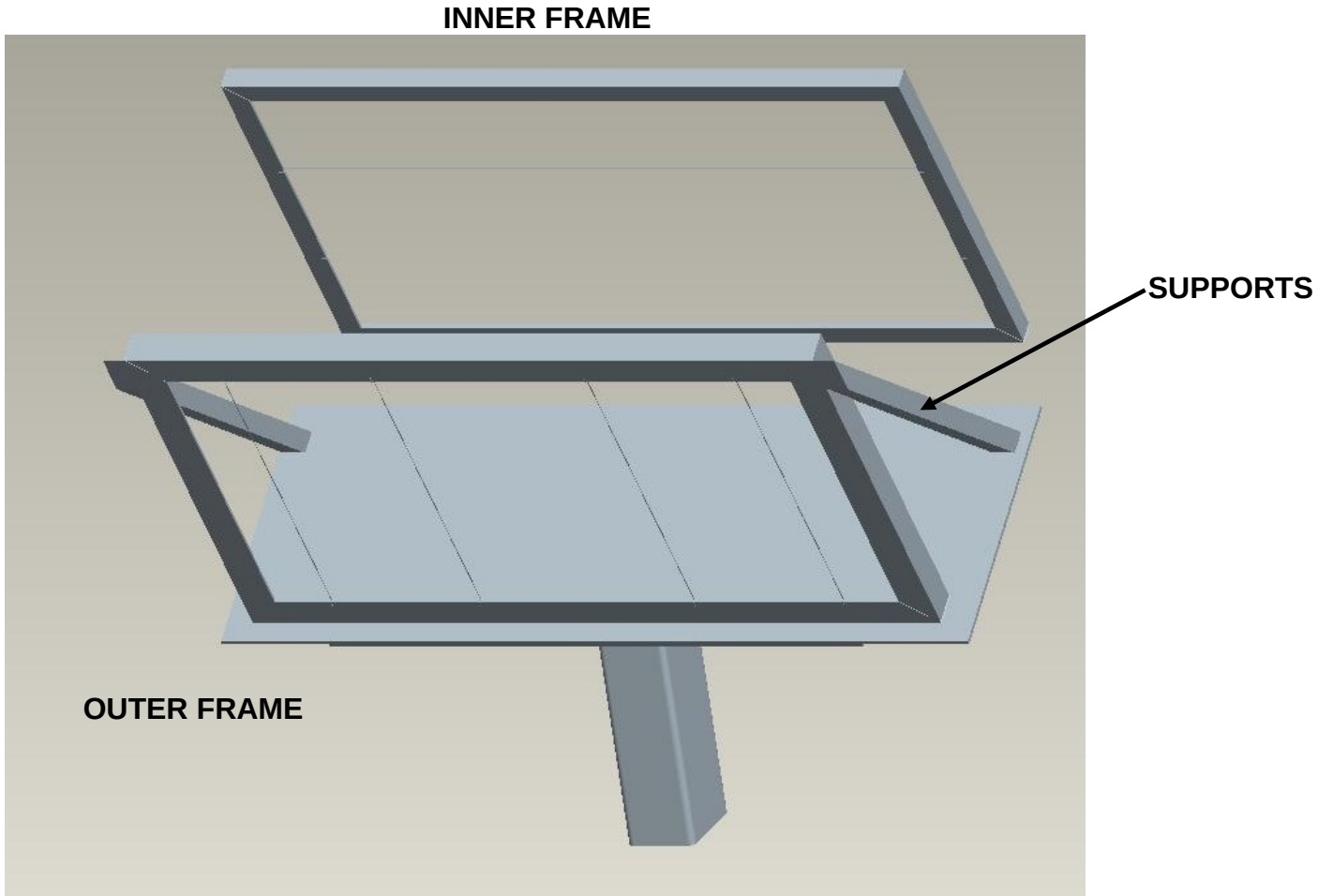
Picture Frame Blanket Holder



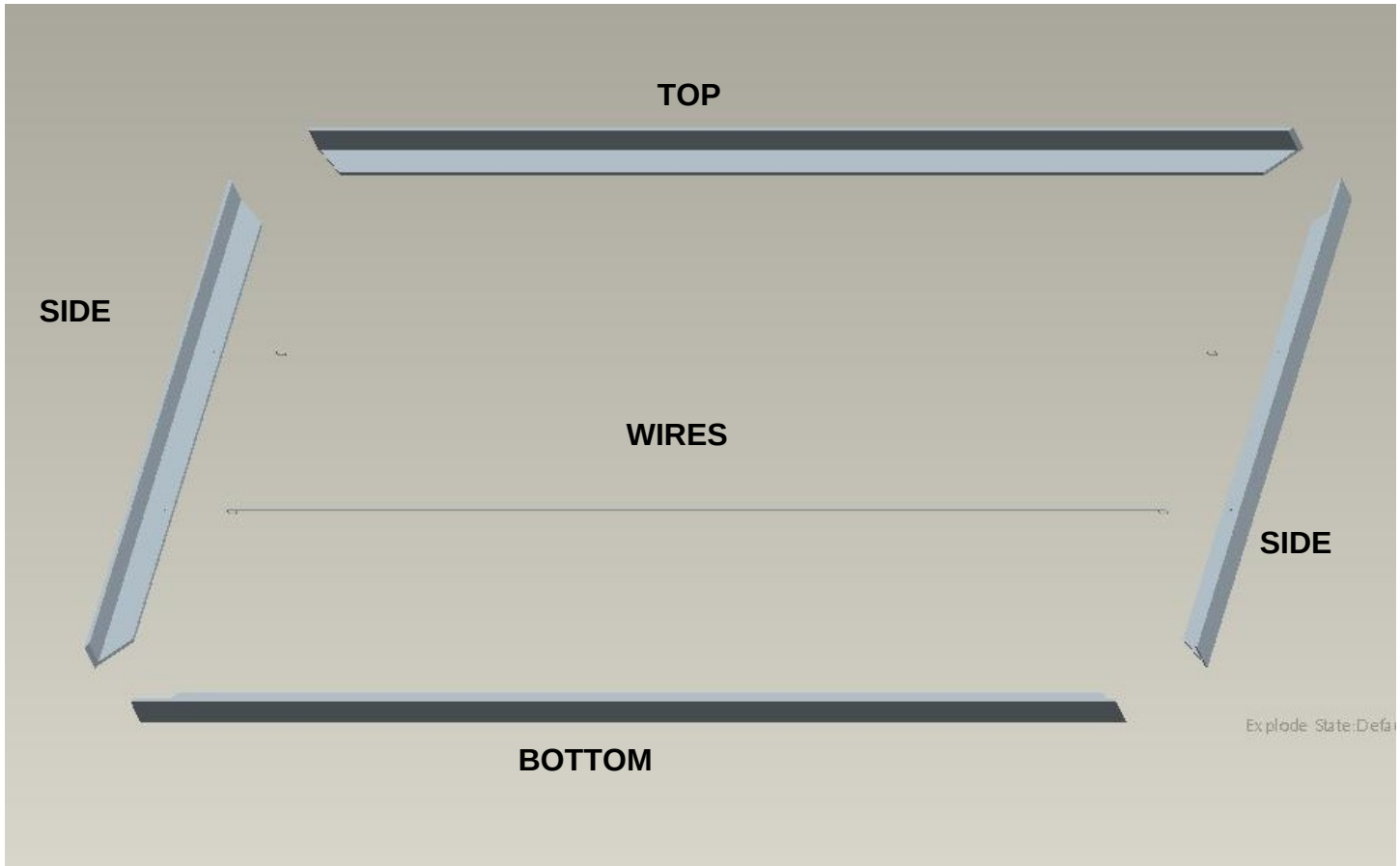
Frame Alignment



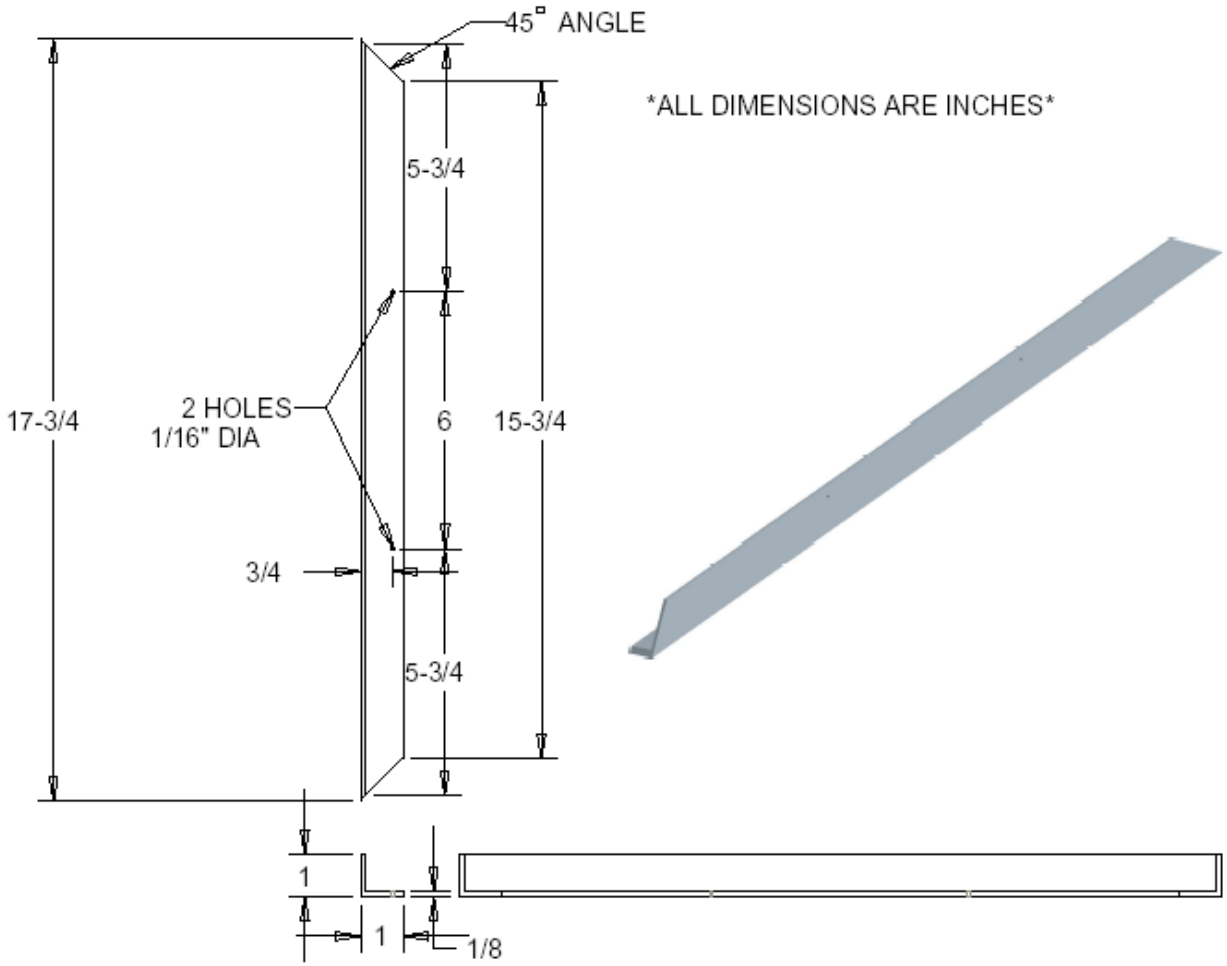
Picture Frame – Component View



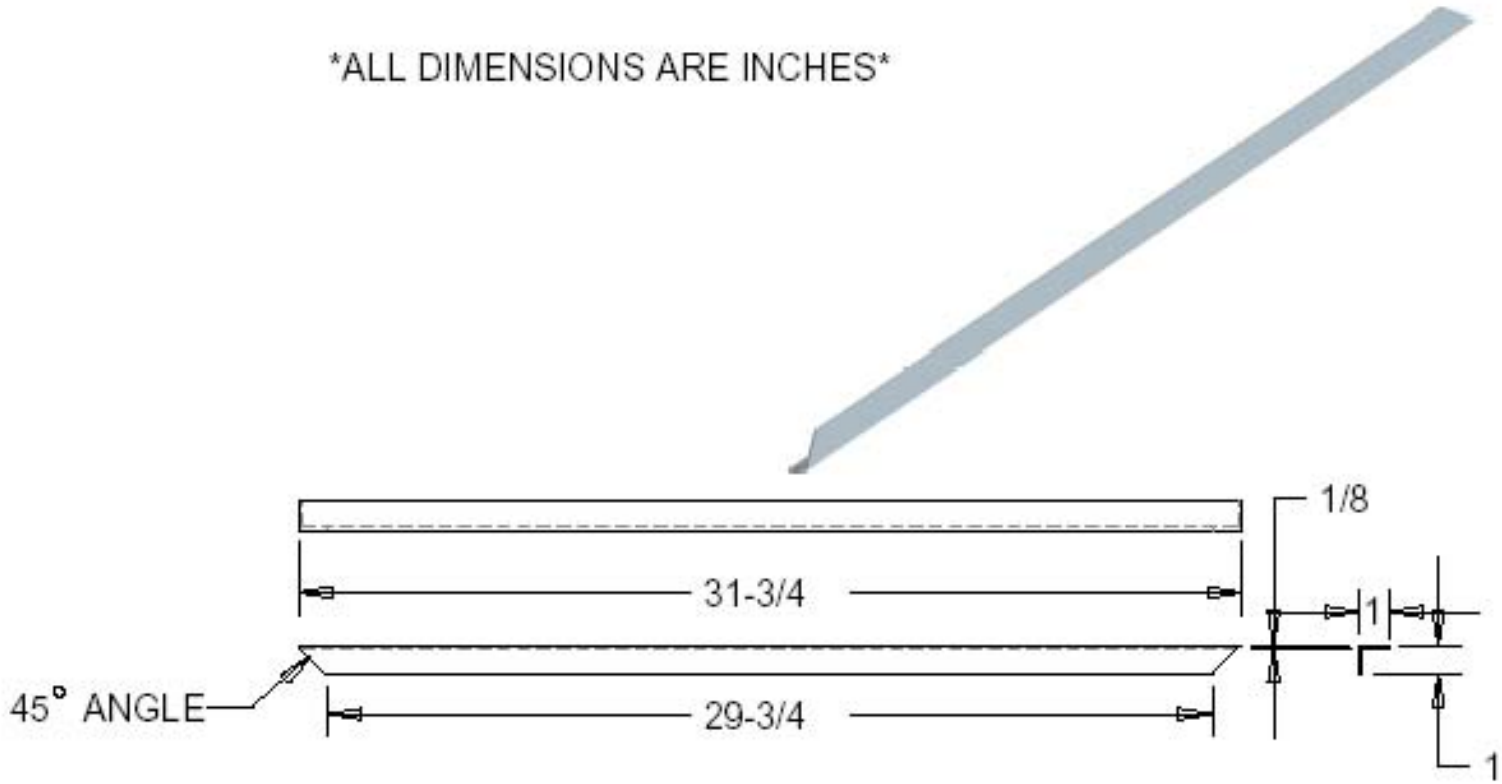
Inner Frame – Exploded View



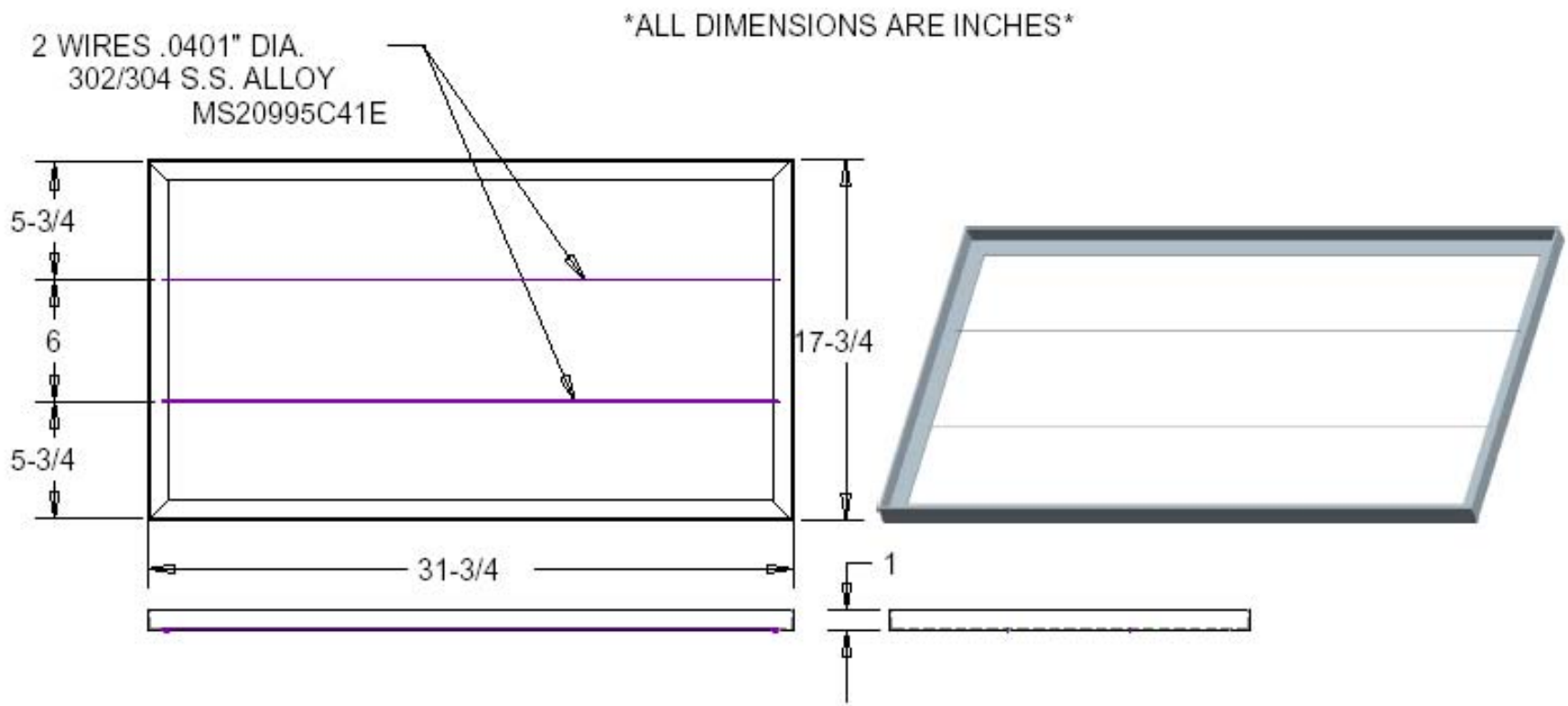
Inner Frame Components – Sides



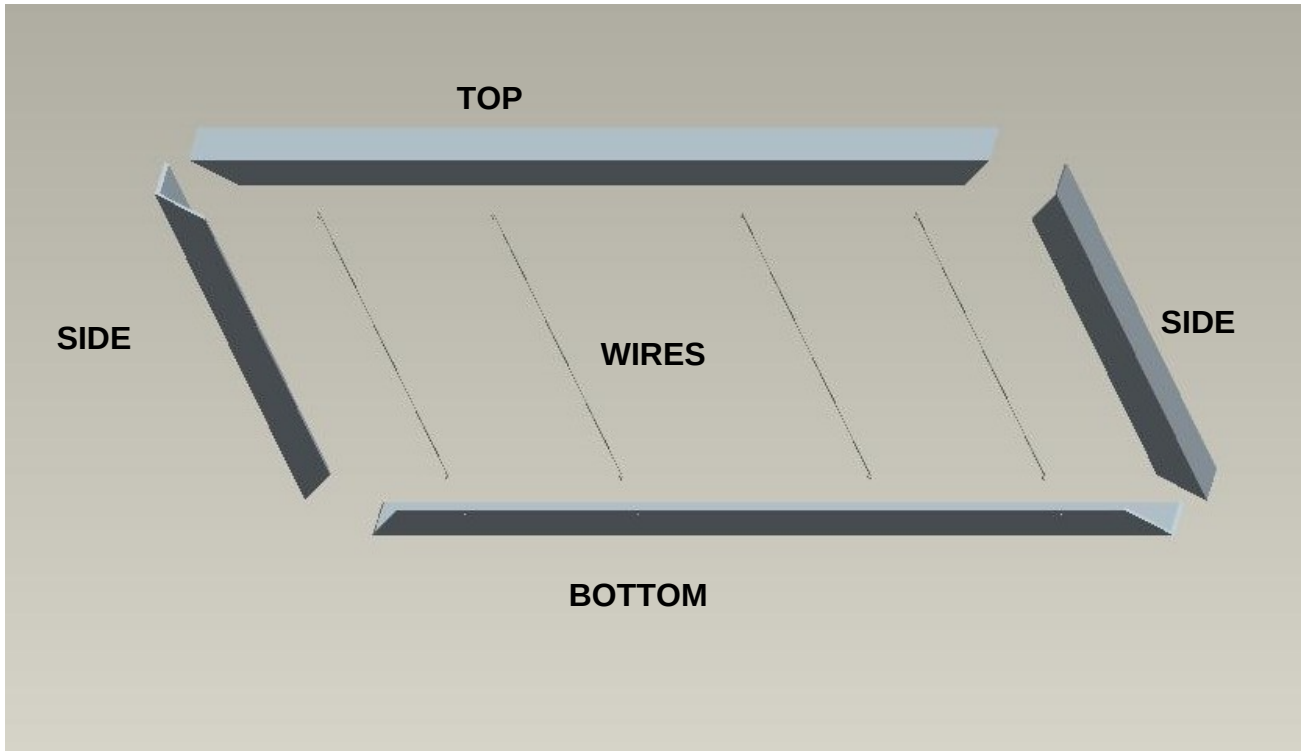
Inner Frame Components – Top & Bottom



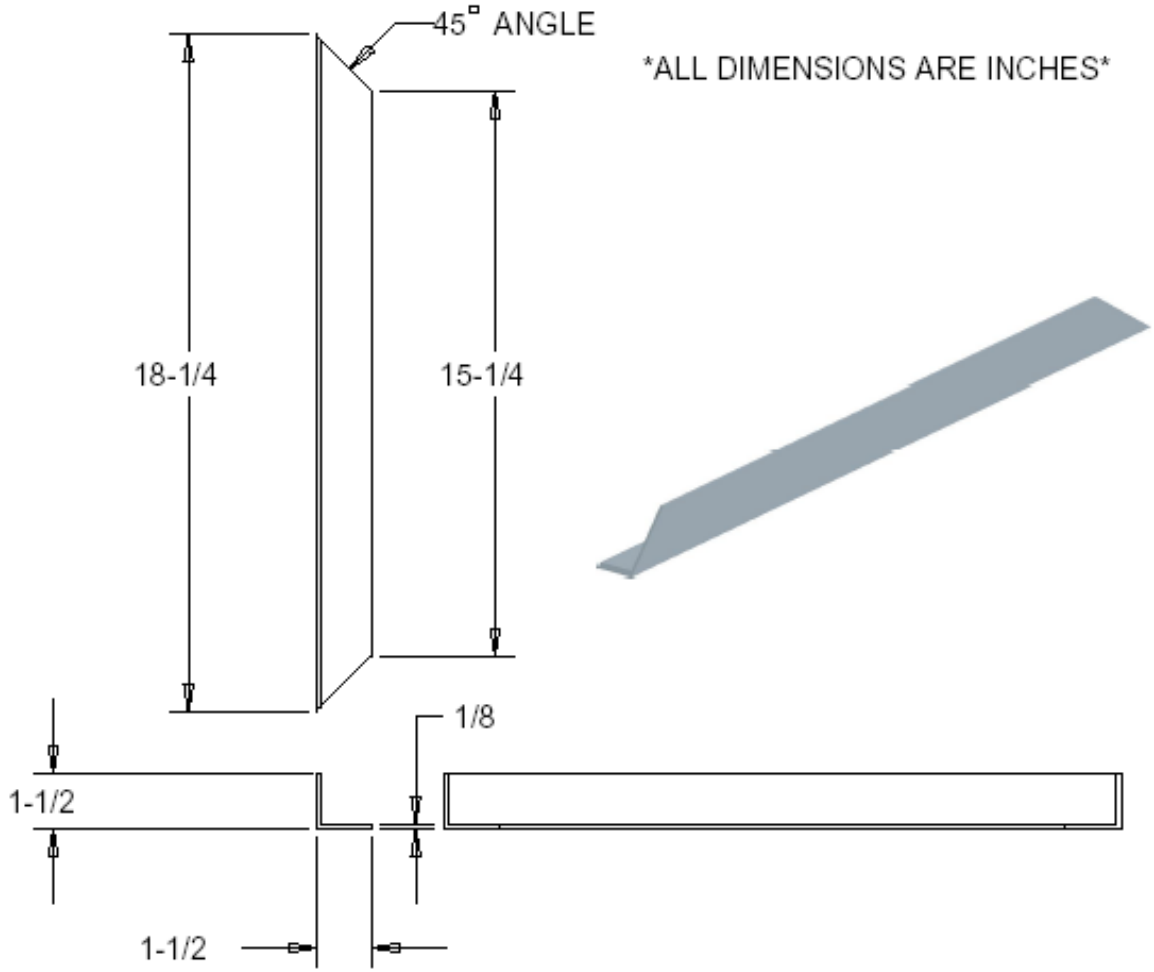
Inner Frame - Assembled



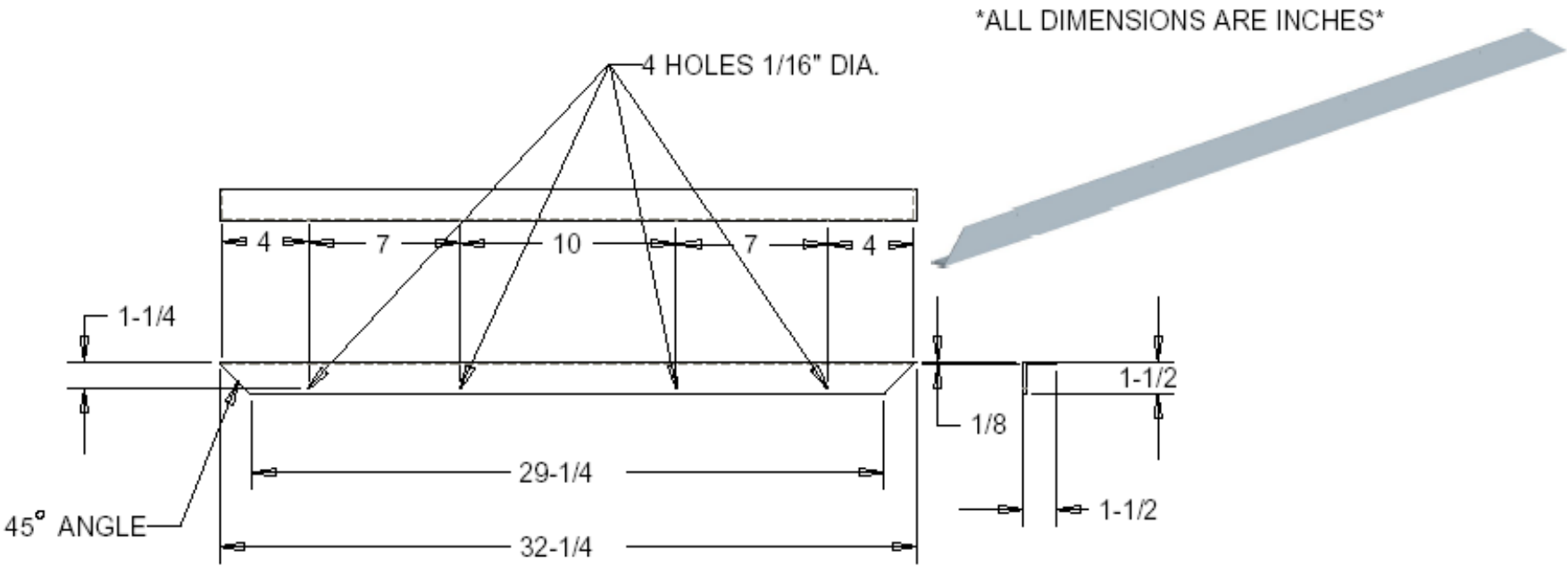
Outer Frame – Exploded View



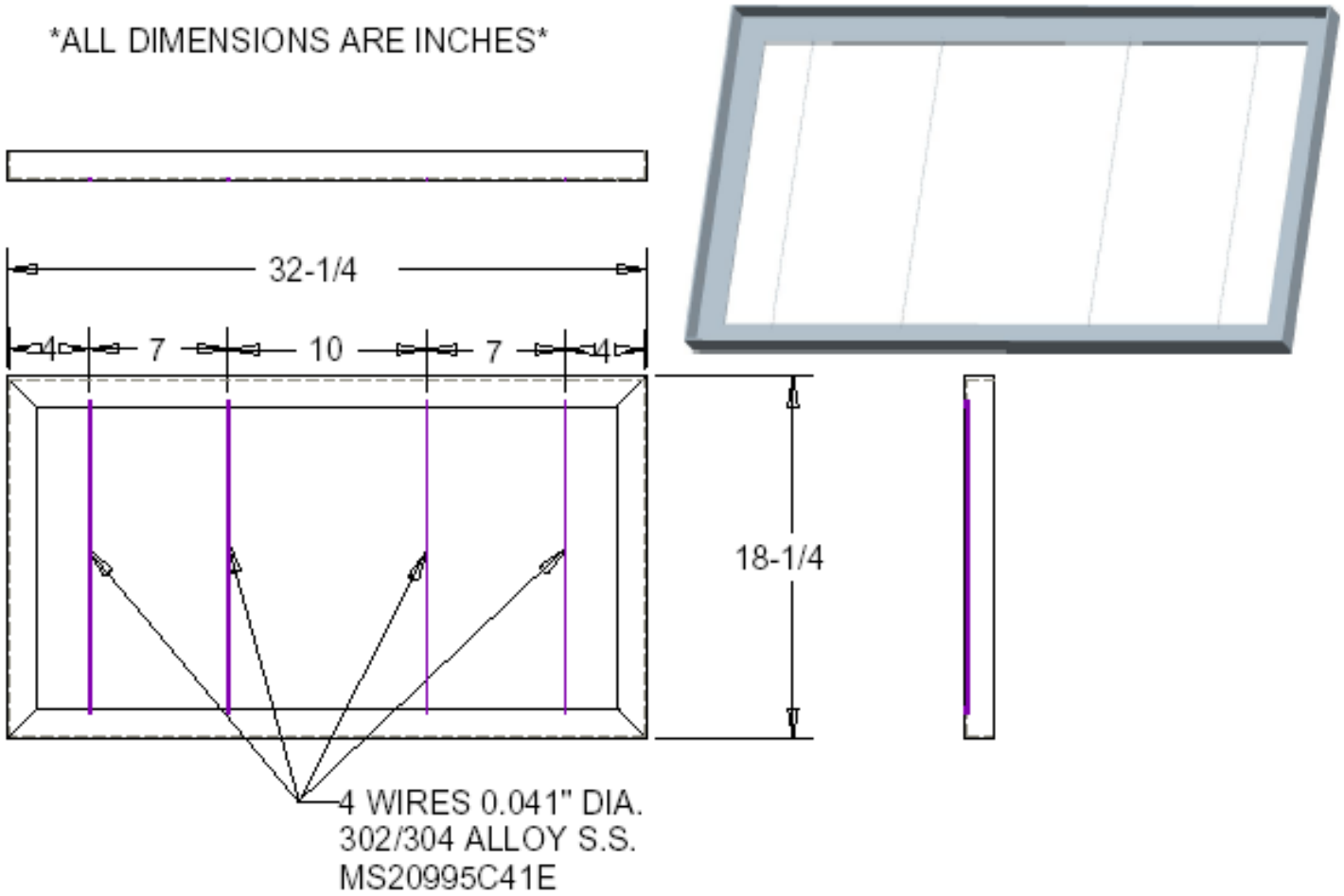
Outer Frame Components - Sides



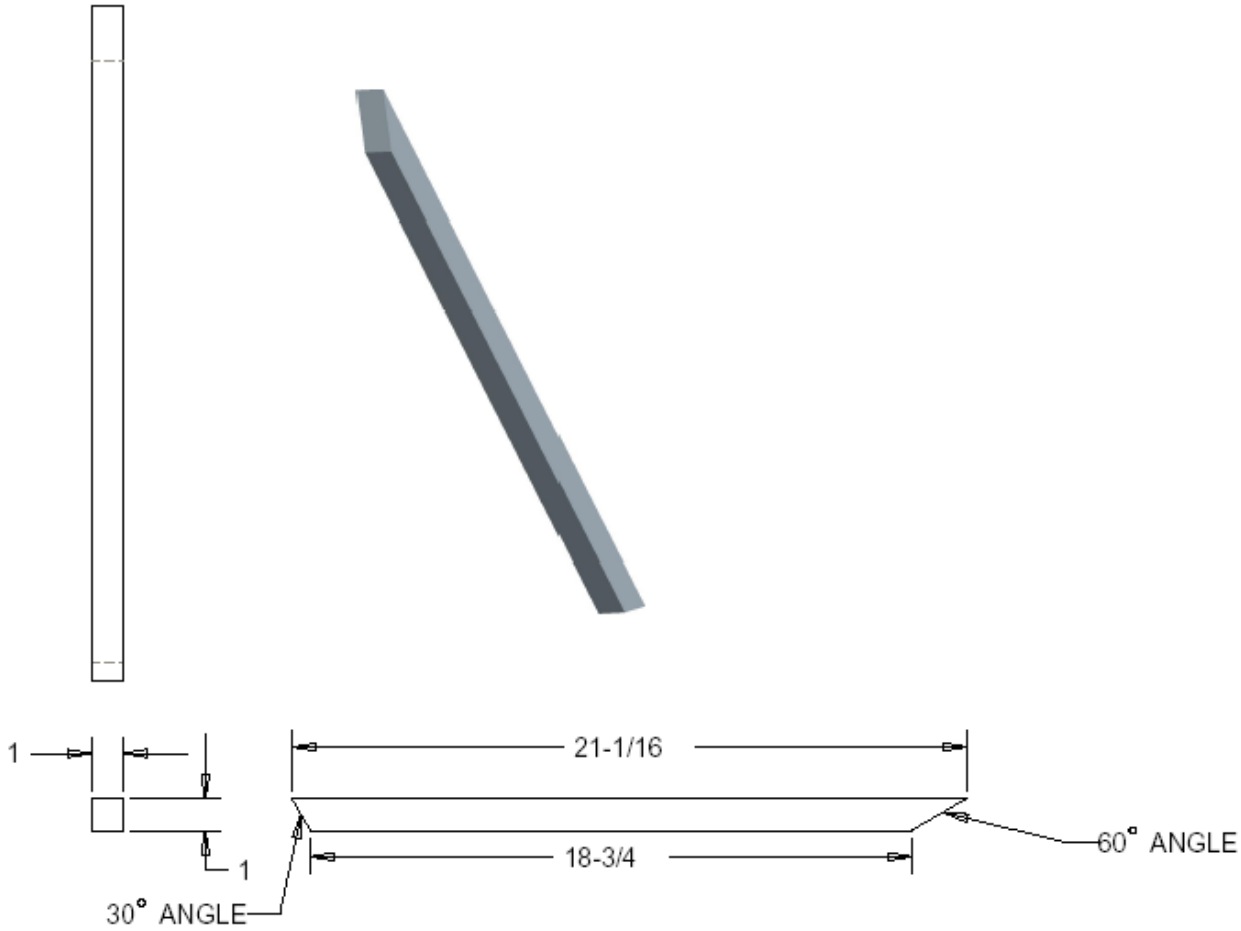
Outer Frame Components – Top & Bottom



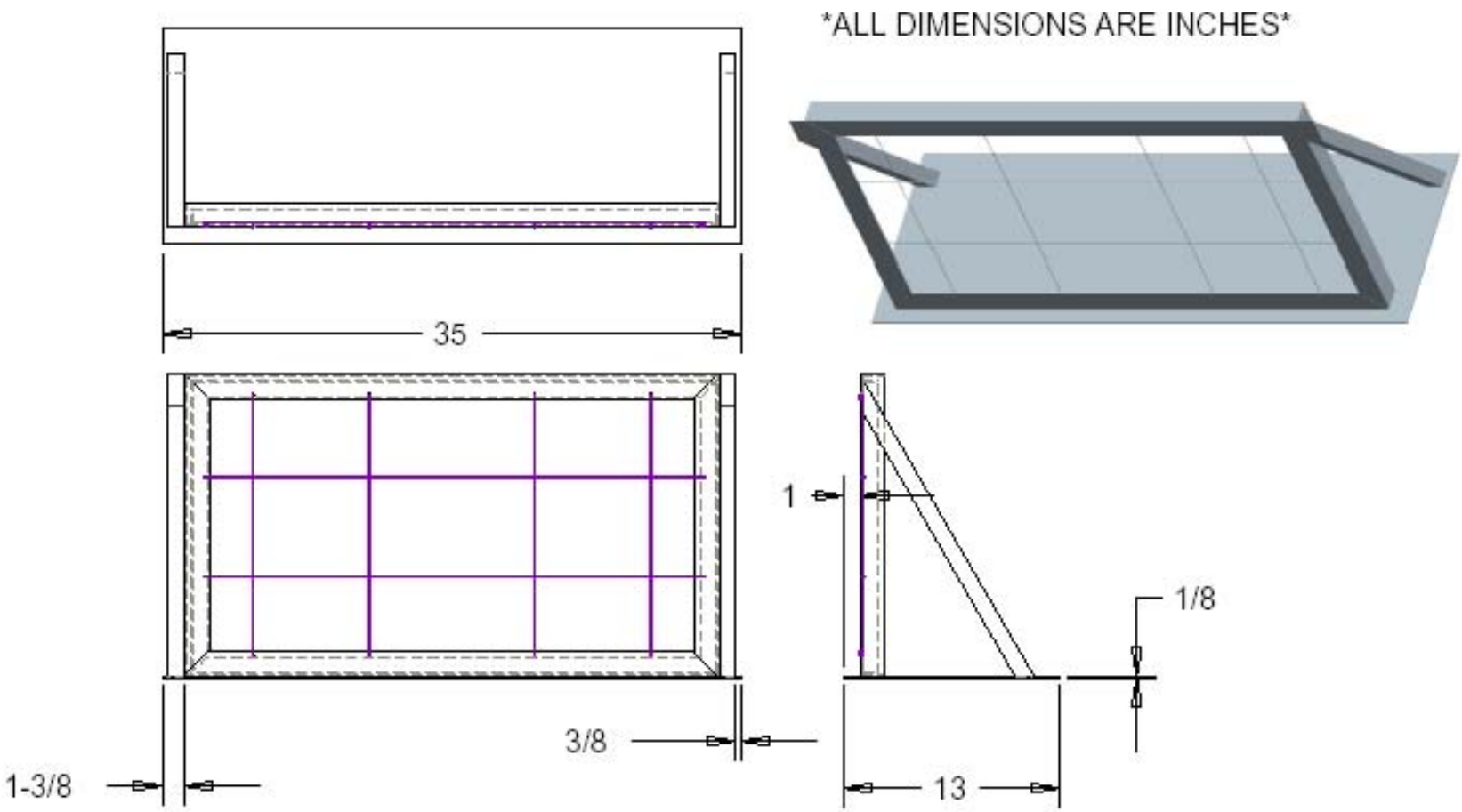
Outer Frame - Assembled



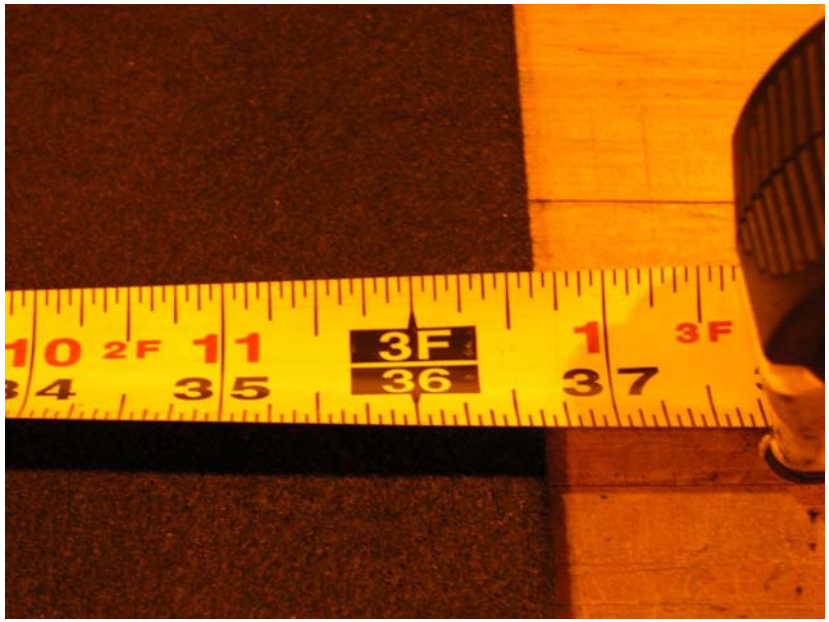
Supports



Frame Assembly

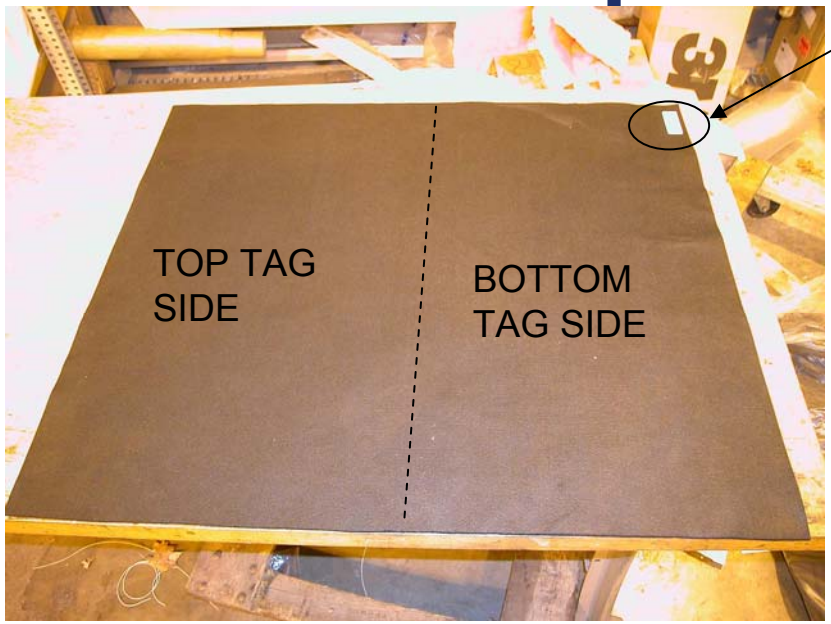


Blanket Preparation

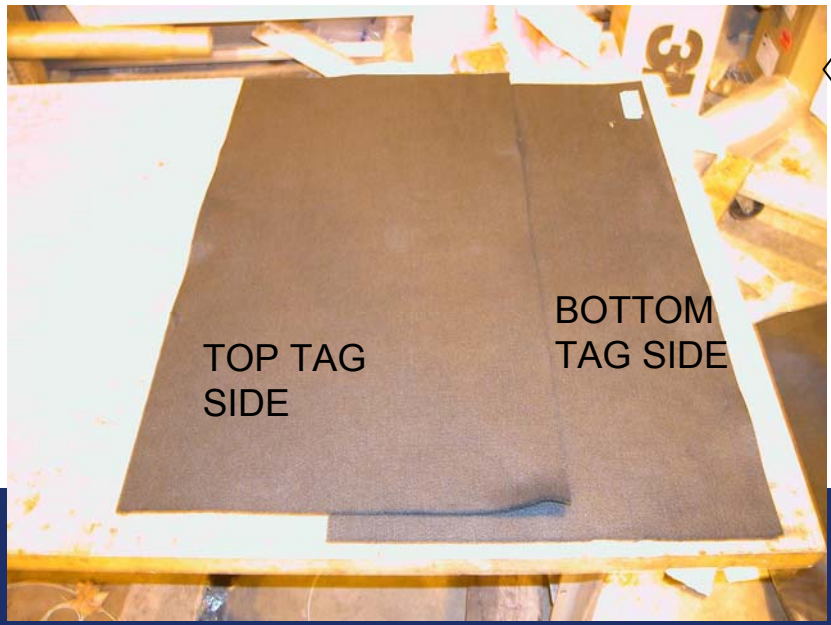


Most blankets are 36”L x 32”W, but some may be longer, like 36 ½”. Just divide the length in 2 and cut there – 18 ¼” in this case.

Blanket Preparation



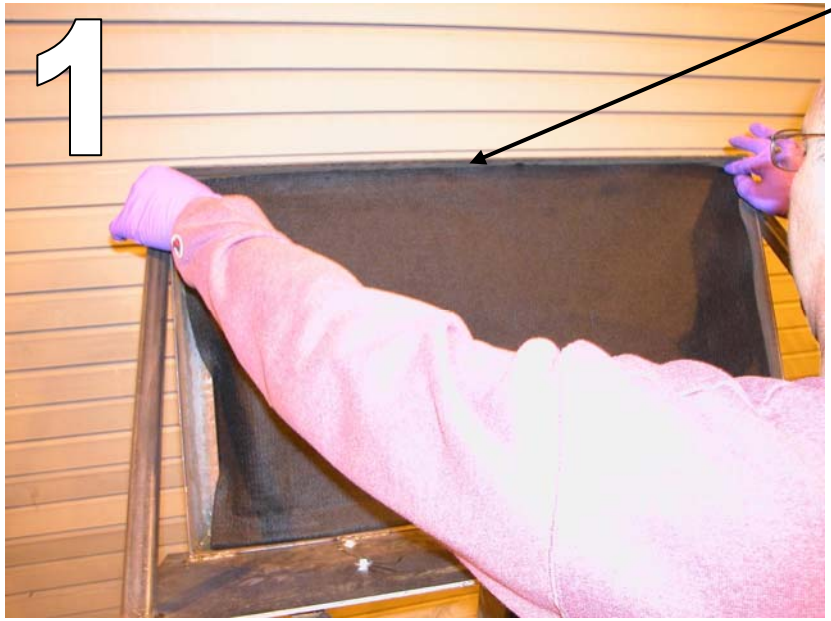
Tag indicates the “bottom” blanket, and also is the backside – not facing the flame.



On the top blanket, cut edge is installed on the bottom of the frame. On the bottom blanket, the tag gets installed on the bottom of the frame.

View From Back

Blanket Installation

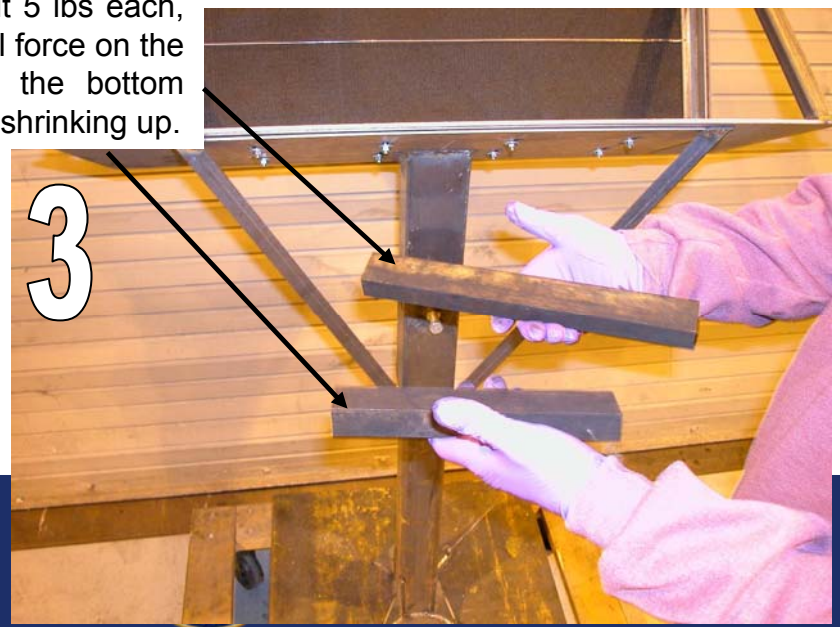


Start from the top, align the top edge of the blanket with the inner top edge of the frame

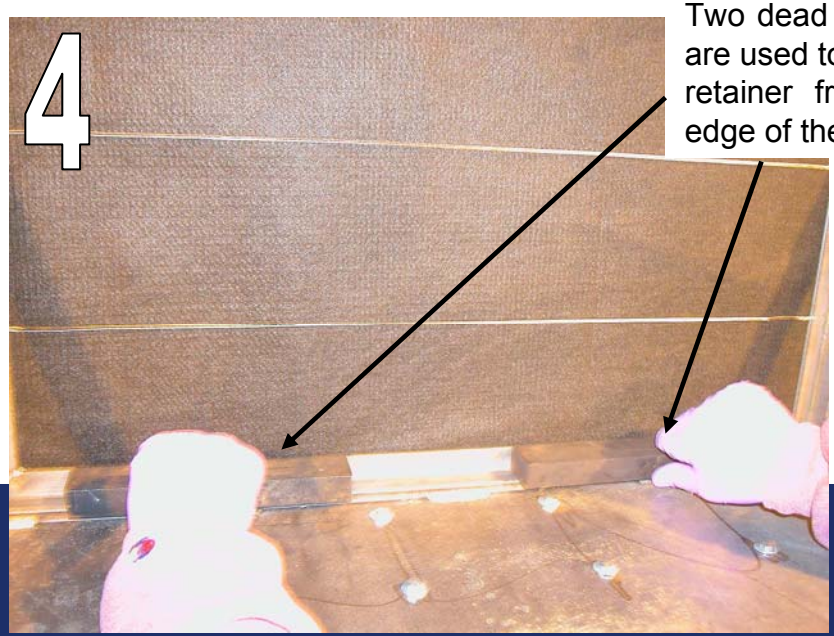
Holding the top in place, work the blanket into the holder from left to right

Blanket Installation

Roll the retainer frame in from the bottom to the top

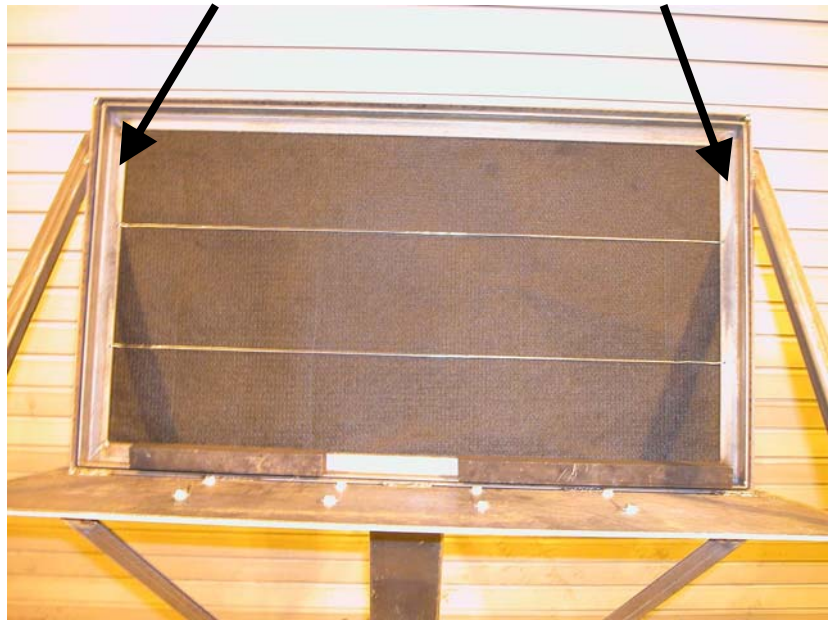


Two dead weights, about 5 lbs each, are used to put additional force on the retainer frame to keep the bottom edge of the blanket from shrinking up.



Finished Installation, Front and Back

If sample is too small, use two more 5 lb. bars on the vertical members of the inner frame to restrain the sample



Testing on the Picture Frame

- **Tex Tech® Polyacrylonitrile material**
  - 8579R: ~9 oz/yd^2, burnthrough typically around 180 sec.
  - 8611R: ~16 oz/yd^2, burnthrough typically around 225 sec.
  - 3M Nextel dot paper: 4 min heat flux ~ 2.8 BTU/ft^2*s

Typical Picture Frame Data

- In order to understand the statistical variation in the PAN material and test method, we can take the average and standard deviation of all picture frame tests every performed
- Data is from all tests – with various degrees of conditioning, including all experimental and trial and error tests
- Data indicates that overall, including all possible influences, the combined effect of the test method and the material amounts to a repeatability of about 7%
- Data shows that regardless of which roll of material is tested, average burnthrough times can be found within a very good standard deviation