SMOKE DENSITY CHAMBER

ASTM MANUAL

Catalog Numbers: 4-5800115V-ASTM
4-5800230V-ASTM

FOR SMOKE DENSITY CHAMBERS STARTING IN 1995

ASTM SPECIFICATIONS

REVISIONS

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLES

DRAWINGS

I. INTRODUCTION

The Superpressure-NBS Smoke Density Chamber provides a fixed volume chamber in which the total smoke and effluent of materials are accumulated and photometrically measured. The Smoke Density Chamber was first developed by the Fire Technology Scientists at the National Bureau of Standards and described in an ASTM research symposium in 1966.[1] Since then, there have been numerous publications reporting on its application and studies of the correlation of results of inter-laboratory tests through its use.[2]

There are two (2) burning conditions simulated by the Smoke Density Chamber: radiant heating in the absence of ignition and flaming combustion in the presence of supporting radiation. If the test specimen is thermoplastic, the melting specimen can be retained in the zone of radiant flux and flame impingement. The cumulative smoke obscuration measurements are made using a collimated light beam from an incandescent light source. The intensity of light passing through the smoke is measured by a photomultiplier (PM) microphotometer system capable of detecting extreme light level differences (up to 0.001% of the original transmitted light). All measurements are in Specific Optical Density, a quantitative value that may be factored to estimate the smoke potential of the material under conditions of actual usage in accordance with the established geometrical relationship of:

$$\text{SPECIFIC OPTICAL DENSITY} = \frac{\text{OPTICAL DENSITY X VOLUME}}{\text{LIGHT PATH LENGTH X SURFACE AREA}}$$

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[1]Gross, D., Loftus, J.J., and Robertson, A.F., "Method for Measuring Smoke From Burning Materials, Fire Test Methods - Restraint and Smoke", ASTM STP No. 422, 1967.

[2]Gross, D., Loftus, J.J., Lee, T.G., Gray, V.E., "Smoke and Gases Produced by Burning Aircraft Interior Materials", NBS Bldg. Sci. Series Bss 18, U.S. Govt. Printing Office, Washington, D.C., Feb. 1969.

Brenden, J.J., "Usefulness of a New Method for Smoke Yield From Species and Panel Products", Forest Prod., J., 21, 23-8, 1971.

Lee, T.G., "Interlaboratory Evaluation of Smoke Density Chamber", NBS Tech. Note 708, Dec. 1971.

Lee, T.G., "The Smoke Density Chamber Method for Evaluating the Potential Smoke Generation of Materials", NBS Tech. Note 757, 1/73.

Standard Test Method for Smoke Generated by Solid Materials, NFPA No. 258, May 1976.

"Minimum Requirements of Construction Equipment for Hospital and Medical Facilities", HEW Publication (HRA), 74-4000.

"Military Specifications, Pad Litter", MIL-P36816, 3.3.2., 4.4.6, 6.6.

"Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials", ANSI/ASTM E 662-83.

OPTIONAL ITEMS:

- Insulated Wire testing accessories for U.S. Dept. of Transportation FAA/ASTM F7.06 specifications. Accessories include:

- 68086016700 Straight Burner

- 68086023400 - 20 Gage Wire Frames and/or 68086023500 12 Gage Wire Frames

- 68086037300 Retaining Clip to hold thick samples

- 68086031100 Ten (10) Inch Strip Chart Recorder (single-pen) for recording PM, Microphotometer, and Radiometer outputs. The Recorder uses 68086031300 Blue Pens and 68086031200 Chart Paper (available in 100 foot rolls).

- 78024001208 Step-Down Transformer (230-115V) for operation on 208/230V 50/60 Hz

- 4-5803 Radiometer Calorimeter for recalibration of the 4-5801 Radiometer

- 4-5802 NSI "SCIP" Program (Smoke Chamber Interface Program) (IBM compatible computer not supplied.)

- 4-5804 Smoke Chamber Modifications to install computer equipment

- 4-5806 Hardware used for SCIP Program

II. INSTALLATION

SERVICES AND MATERIAL REQUIRED FOR OPERATION

Prior to installing the Smoke Density Chamber, ensure that the following items are available and requirements are met.

FILTERED COMPRESSED AIR: For radiometer calibration of the furnace voltage, compressed air at 15-25 psi is needed to maintain the radiometer body at 200°F (93°C). For flaming tests, compressed air at 500 cc/min. to the burner is required. The approximate maximum volume of air required is 2-3 cubic ft/minute. It is recommended that the Smoke Density Chamber be connected to the air source with a flexible hose and flared fitting (1/4 inch) connector.

PROPANE: Two (2) ICC-approved tanks of propane in the size listed in Table 2 are recommended (one (1) for standby).

REGO REGULATOR[3] (or equivalent single-stage pressure regulator:

[3]REGO Company, Highway 100 at Rego Drive, Dept. TR, Elon College, NC 27244

(6 oz. or 11 inches H_2O), factory set, complete with POL connector to the propane tank and a suitable hose connector to the Smoke Density Chamber.

NOTE: A SLIGHTLY HIGHER PRESSURE REGULATOR MAY BE REQUIRED FOR SOME SAMPLES THAT BURN VIOLENTLY.

ELECTRICAL: The 4-5800-115V and 4-5800-230V Smoke Density Chamber require 115V, 60 Hz, 50 Hz single phase, and approximately 650 watts of electrical power. A 1 KW, 230/115V step down transformer (P/N 78024001208) is required for operation on 230V, 50/60 Hz. The Smoke Density Chamber should be provided with a separate power service. The 3-prong power plug on the Smoke Density Chamber and Microphotometer not only grounds the instrument but also polarizes the connection. Prior to connecting these units to the 115 VAC source ensure that the power outlet meets the following requirements:

1. Use only a 3-hole, parallel blade, grounded power outlet. (NEMA 5-15)

2. Verify that the ground conductor is continuous to the main power panel. This should also be grounded directly to a water pipe or other earth ground.

3. Check the power outlet polarity and change the wiring, if required, to ensure proper polarity.

4. Ensure that no voltage gradient exists between the ground and neutral conductors.

NOTE: CONNECTION TO CIRCUITS THAT ARE NOT POLARIZED OR GROUNDED SHOULD BE CHECKED BY LICENSED ELECTRICIANS TO PREVENT MALFUNCTIONS.

EXHAUST SYSTEM: The Smoke Density Chamber must be connected to an exhaust system capable of exerting a minimum of two (2) inches of H_2O (negative pressure) on the Smoke Density Chamber with the vents open and connected by means of a flexible hose (2 to 4 inches in diameter). The lower vent is operated by the front T handle that actuates a floor-mounted blower to aid in exhausting the test effluents.

WARNING: CONNECTION TO AN EXHAUST SYSTEM WITHOUT SUFFICIENT CAPACITY WILL PERMIT ESCAPE OF HAZARDOUS DISCHARGES.

NOTE: THE HOOD OVER THE CHAMBER AND PRESSURE RELIEF TO BE CONNECTED TO AN EXHAUST SYSTEM TO REMOVE ANY RESIDUAL FUMES WHEN THE CHAMBER DOOR IS OPENED.

AMBIENT TEMPERATURE: Conduct all tests in a room or enclosed space having an ambient temperature of $73\pm5°F$ ($23\pm3°C$) and relative humidity of 50 ± 20 percent at the time of the test.

CHAMBER PRESSURE MONITORING: The internal pressure of the chamber may vary when the enclosed air is heated during the initial phase of a test and when the pyrolyzed sample starts to emit it's effluent. The internal pressure can be monitored with a draft gauge or a pressure relief and indicator device connected to one (1) or more of the ¼ inch tube fittings on the chamber roof (the other fittings can be connected to gas sampling or analysis apparatus). The draft gauge can be purchased from a laboratory supply outlet. The pressure relief and indicator device is provided as described on page 13.

CHAMBER SAFETY BLOWOUT PANEL: A 125 square inch aluminum foil panel taped over the chamber floor opening provides protection against sudden pressure increases. The blowout panel is designed for a maximum internal pressure of four (4) to six (6) inches of H_2O. Before installing a blowout panel, thoroughly clean and wipe the area around the floor opening. Use heavy-duty foil (0.0015±0.0005 inch thick). Do not wrinkle the foil since leakage may occur at the creases. Use a two (2) inch Mylar adhesive backed type (Minnesota Mining and Manufacturing #351 or 471) to secure foil to floor. Do not butt or fold tape at corners, instead overlap tape at the corners. A cover fabricated from stainless steel wire or expanded mesh can be placed over the panel to protect the panel. The drip pan should be positioned below the furnace to catch drips and to help prevent panel damage.

INSTALLATION PROCEDURE:

The procedure for installing the Smoke Density Chamber is as follows:

1. Carefully unpack all items. Do not dispose of any wrappings or cushioning material until all items have been inspected. Store any unused compensating filters in a manila envelope for future use. Place radiometer in a dust/corrosive free container. Do **not** touch front black surface or handle radiometer by its cable or fittings. Connection and disconnection of the cable to the radiometer should be performed by hand. Tools should **not** be used in order to prevent damage.

2. If the PM tube and lens housing is packaged separately, install the unit to the Smoke Density Chamber cabinet.

   A. Place the PM tube and lens housing over the glass window on the top left side of the cabinet. Align the housing with the cabinet's asymmetrical pins to ensure correct mounting position and secure with eight (8) attaching screws provided.

   B. Ensure that the compensating filter and its holder have not been dislodged in shipment. To inspect, remove the screws securing the front cover of the PM tube and lens housing and note that the compensating filter holder is securely located on top of the lens bracket.

3. Remove the PM tube from its box.

PRECAUTION: DO NOT TOUCH THE GLASS ENVELOPE OF THE PM TUBE. FINGERPRINTS ON THE GLASS ENVELOPE WILL DEGRADE THE EFFECTIVENESS OF THE PM TUBE.

4. Insert PM tube into the PM tube housing so that the pin enters the slot in the housing. Tighten housing screw to secure the tube.

5. Place the Microphotometer on top of the control box. The four (4) holes fit the feet of the Microphotometer.

6. Insert the cable connector from the PM tube cable into the connector labeled "High Voltage" located on the rear panel of the Microphotometer and lock it.

7. Ensure that the ND-2 Filter is inserted in the upper hole of the filter shutter assembly, Dwg. #BROCH9. Install this assembly into the front of the PM tube housing, with filter side up. Lock clips.

8. If test data is to be recorded, use a 50-millivolt full-scale recorder. Connect the recorder input to the connectors labeled "Mv Output" located on the Microphotometer rear panel.

NOTE: THE RECOMMENDED RECORDER IS NSI P/N 68086031100. THIS IS AN OPTIONAL ITEM.

9. Place three (3) sample holders on the support rods as shown in Dwg. #BROCH3.

10. Insert furnace into furnace holder, Dwg. #BROCH4 ensuring that the heater side is facing the sample holder, with the four (4) mounting screws positioned in the stainless steel channels. See Heater Assembly Dwg. #68086038800 for top of heater location.

WARNING: THE THERMOCOUPLE TIP MUST BE 1/16" TO 1/8" FROM FURNACE ELEMENT, BUT NOT TOUCHING. ELECTRICAL SHOCK WILL OCCUR IF CONTACT IS MADE.

11. Place the aligning gauge between the furnace and middle sample holder, Dwg. #BROCH3. Note that the straight lip of the gauge faces the furnace and the bent lip faces the sample holder.

12. Using the four (4) adjusting screws on the furnace holder, adjust the position of the furnace so that:

- The straight lip of the gauge rests on top of the furnace and the vertical sides of the gauge are flush against the face of the furnace.

- The bent lip of the gauge rests on top of the middle sample holder and the vertical sides of the gauge are flush against the sample holder.

This positioning ensures that the planes through the furnace and sample holder are parallel. Some further minor adjustment might be required if the pyrolysis pattern is not centered on test.

13. With all three (3)-sample holders on the support rods, check that the center holder is exactly centered from side to side with the furnace. If necessary, loosen the stop collars on the support rods, center the holder and retighten the stops. With two (2) holders or a holder and radiometer in place, one (1) of the two (2) items will always be centered whenever the other is against the stop.

14. Connect the furnace line cord connector to the heater AC power outlet on the chamber floor, as in above picture Dwg. BROCH4. Connect the thermocouple cord to thermocouple on back of furnace.

15. **Use Burner Positioner 68086035400 installed in sample holder.** Connect the burner into the air/propane outlet on the chamber floor, Dwg. #BROCH4, and tighten the gland nut finger tight. Check the alignment of the burner to ensure that the two (2) outer tips are ¼ inch above the bottom opening in the face of the sample holder and that both tips are located ¼ inch away from the face of the holder, (refer to Dwg. #BROCH18). If the burner is bottomed in its socket and the tip height is too low, raise the burner in its gland nut before tightening. After tightening the nut it may not be possible to move or alter the height. To adjust he distance between the two (2) outer tips and the sample holder face, loosen the furnace frame wing screws and moving the frame to the correct position. When the correct position is obtained, tighten wing screw securely. See Burner Positioner Dwg. #68086035400.

16. Place the drip pan below the furnace (in front of burner) to protect the aluminum blowout panel in case a sample holder is accidentally dislodged. A separate cover fabricated from stainless steel wire or expanded mesh can be placed over the panel for additional protection.

17. For each flow meter on the front panel, ensure that the toggle valve is closed (down).

18. Connect a suitable line (a flexible hose with a flared ¼ inch fitting connector is recommended) between the source of propane and the upper ¼ inch gas (refrigeration flare) connector on the side panel as indicated.

19. Connect a suitable line between a source of clean compressed air and the lower ¼ inch air (refrigeration flare) connector on the side panel as indicated.

20. Connect a suitable hose from the exhaust blower outlet to an exhaust hood or vent. The four (4) inch diameter blower flange should be adapted to a suitable flexible hose connected to the exhaust system. The exhaust capacity of the blower is sufficient for a two (2) to four (4) inch diameter hose not exceeding eight (8) feet in length.

The use of an exhaust hose smaller than two (2) inches in diameter of longer than eight (8) feet is not recommended. A hose larger than four (4) inches will decrease the effective performance of the blower. A flange adapter suitable for connecting a two (2) inch diameter hose is provided.

Similarly, a suitable hose should be connected to the chamber door hood and provided with an exhaust to a location away from the chamber and areas frequented by personnel.

NOTE: THE HOSE CONNECTED TO THE CHAMBER PRESSURE RELIEF CONNECTOR SHOULD BE CONNECTED TO A SUITABLE CONTAINER FOR ANY OVERFLOW.

WARNING: ENSURE THAT ALL GASEOUS PRODUCTS ARE COMPLETELY AND SAFELY VENTED. THE PRODUCTS PRODUCED BY THESE TESTS MAY BE HAZARDOUS.

21. Ensure that the LINE, LAMP and HEATER switches on the Smoke Density Chamber are set to OFF. Ensure that the Microphotometer POWER switch is set to OFF.

22. Insert the line cord plug from the Microphotometer into one (1) of the two (2) convenience outlets on the left side of the cabinet. If a recorder is to be used, the recorder line cord may be plugged into the remaining convenience outlet.

23. Insert the line cord of the Smoke Density Chamber into a standard 3-hole, 115 VAC parallel blade, grounded outlet (15 or 20 ampere capability). (NEMA Receptacle Configuration 5-15 or 5-20)

WARNING: THE POWER OUTLET MUST BE PROPERLY GROUNDED AND POLARIZED. IMPROPER GROUNDING COULD RESULT IN A SHOCK HAZARD.

24. Perform the procedures in the "Checkout Procedures" paragraph to verify that the Smoke Density Chamber is operational.

PRESSURE RELIEF AND MANOMETER

A chamber pressure relief and manometer, Dwg. #BROCH6 (with one (1) inch part) as illustrated for 68086035100 Blow Out Tube Assembly and 68086035600 Container Assembly are provided. Any pressure less than the depth of immersion of the tube in the glass jar will be displayed as a displacement of the water level in the manometer. Any pressure excess of the depth of the immersion will cause the excess to bubble through the water until the pressure is reduced to the desired level.

Connect the clear plastic tubing from one (1) of the roof fittings to the manometer, which has magnets for mounting wherever is convenient. The other three (3) fittings are supplied plugged, but can be used for connecting to gas sampling and analysis apparatus.

CHECKOUT PROCEDURES

1. Turn on and check optical system as follows:

   A. Ensure that the ND-2 filter is in the optical path (upper filter rod on filter shutter assembly is in out position) and that the PM tube shutter is closed (lower shutter rod is in out position), see Dwg. #BROCH9.

   PRECAUTION: ENSURE THAT THE PM TUBE IS INSTALLED INTO THE PM TUBE HOUSING BEFORE APPLYING HIGH VOLTAGE. EXPOSING THE PM TUBE TO ROOM LIGHT WITH THE HIGH VOLTAGE APPLIED WILL PERMANENTLY DAMAGE THE PM TUBE.

   B. Switch the DISPLAY selector to RELATIVE INTENSITY. Switch the multiplier to 100. Turn on the Microphotometer.

   C. Open PM tube shutter (lower shutter rod pushed in).

   D. Adjust the meter to 100.0% transmittance by rotating the SENSITIVITY control. If the meter cannot be adjusted to read 100%, check the light beam alignment (refer to the Light Beam Alignment procedure in Section VIII. Maintenance). The Microphotometer should be left on and allowed to stabilize for about ONE (1) hour. Once stabilized, readjust to read 100% transmittance before proceeding.

   E. Zero the dark current at the Microphotometer as follows. Close the PM Tube shutter and switch the multiplier to the 0.1 position. Adjust the ZERO knob until the display reads 0.0. This adjustment is extremely sensitive and may take some practice.

   F. After zeroing the Dark Current, switch the multiplier to 100. Open the PM tube shutter and readjust the meter to read 100.0% transmittance by rotating the SENSITIVITY control. If a recorder is used, set the recorder pen to the 100% line on the chart while the Microphotometer displays 100.0%. If unable to achieve the relationship, adjust the RECORD ADJUST control on the rear panel of the Microphotometer until the spans correspond.

   G. Close the PM tube shutter (lower shutter rod in out position) and depress the Microphotometer POWER switch to the OFF position.

2. Check heater voltages as follows:

   A. Set the HEATER switch to ON.

   B. Monitor HEATER ADJUST METER. Red is HEATER Temperature. Green is HEATER Set point.

C. When HEATER Temperature reaches 500°F, set HEATER switch to off.

D. Set the LAMP and LINE switches to OFF.

3. Check the Chamber for leakage as follows:

NOTE: THE CHAMBER MAY BE TESTED FOR LEAKAGE AT INSTALLATION OR WHENEVER ODORS ARE DETECTED DURING OPERATION TO VERIFY THAT THE CHAMBER IS PROPERLY SEALED. THE TEST USES A MANOMETER DESCRIBED ON PAGE 7.

A. Ensure that the HEATER switch is set to OFF. (Test is more effective when furnace is at room temperature.)

B. Close INLET VENT, EXHAUST VENT and chamber door.

C. Pressurize chamber to three (3) inches as indicated on manometer by opening FLAME AIR toggle valve (up-position) and rotating the needle-valve control of the FLAME AIR flow meter counterclockwise (open).

D. Close toggle and needle valves. Time the decrease in pressure from three (3) to two (2) inches on the manometer. **The minimum time for operation should not be less than 5.0 minutes.**

E. If chamber does not adequately maintain pressure, check the following items:

a. Make sure all plugs are in place on chamber. Vents should be closed on both the chamber door and chamber blower. Ensure chamber door is closed.

b. Plug burner fitting. Using air, pressure test chamber while cold. Take chamber up to about 4". Snoop Leak Detection will now work better.

c. Check that the seal around the door is tight. The blow out assembly should be checked with Snoop from the bottom of the chamber to ensure the flow meters are closed when testing. Using the radiometer air hose, check all fittings on manometer for leakage. Ensure that all fittings below the chamber are tight and that all screws on chamber door are tight.

F. If chamber still does not adequately maintain pressure, replace the aluminum foil panel as described in the "Chamber Blowout Panel Replacement" paragraph in Section VIII., Maintenance.

The Smoke Density Chamber is installed and ready for operation. Perform the steps in the "Daily Setup Procedure" paragraph in Section V. to prepare the chamber for a test run.

III. PRINCIPLES OF OPERATION

System Operation, the Smoke Density Test Method and the Controls and Indicators on the Smoke Density Chamber are described in this section.

SYSTEM OPERATION

The Smoke Density Chamber provides a sealed test chamber, an electrical furnace and gas burner, and a photometric system with a collimated light beam passing through the chamber to enable smoke production studies of materials and assemblies. Additional instrumentation, i.e., pressure gauges for monitoring internal pressures, can be connected to roof-mounted fittings on the chamber without breaking the seal. The thermal output of the furnace and the air/gas mixtures for the burner are calibrated to ensure the air/gas mixtures for the burner are calibrated to ensure standardization of test method. Initially, only the furnace is turned on with the LINE and HEATER switches and adjusted to an approximate thermal output with the HEATER TEMPERATURE ADJUST control. When the CHAMBER TEMPERATURE meter indicates that the wall temperature of the chamber has stabilized at 95°F, a calibrated radiometer is placed in front of the furnace and connected to the chamber's compressed air supply. The air supply is adjusted by the RADIOMETER AIR flow meter until the thermometer placed in the radiometer reaches and maintains a temperature of 200°F. The HEATER TEMPERATURE ADJUST control is then adjusted until a precalibrated signal level is obtained at the RADIOMETER MILLIVOLTS jack with the Radiometer body still at 200°F. When these levels are obtained, the output irradiance of the furnace is at 2.5 watts/cm^2±0.05 watts/cm^2. For flaming exposure tests, a six-tube burner is connected to the chamber's air and propane supply lines and centered in front of the sample holder. Calibrated FLAME AIR and GAS flow meters ensure a ratio of 500 cc/min. for the air and 50 cc/min. for the propane. Proper orientation of the sample to the furnace and burner is assured through the use of support rods with adjustable stops to support and align the sample holders.

The light beam and PM tube are oriented vertically in the chamber to reduce smoke stratification effects. The light source is a tungsten lamp and lens system mounted in a light-tight box below the chamber. The lamp is operated at reduced regulated voltage (4±0.1 VDC) to assure long lamp life and negligible spectral variations. The lamp is isolated from the interior of the chamber by an optical window in the chamber floor. This optical window incorporates an electric heater to minimize smoke condensation on the window. The PM tube is contained within a housing mounted over the optical window on the chamber roof directly above the light source. The PM tube converts the intensity of the light beam to corresponding electrical signals. These signals are measured and displayed as RELATIVE INTENSITY units (% Transmittance) by the Microphotometer. The PM tube housing contains a shutter-filter assembly. The shutter is used to interrupt the light beam during the 0% Transmittance calibration adjustment or to prevent PM tube fatigue due to extensive light intensity.

The filter is a neutral density 2 (1 %Transmittance) filter which will attenuate the light beam light levels, this filter can be removed from the optical path to extend the measuring capabilities of the system. The PM tube lens housing also contains a mounted compensated filter (s). This filter was initially selected during final testing of the chamber to enable the Microphotometer to indicate 100% Transmittance with the SENSITIVITY control when the following conditions are met:

- MULTIPLIER switch set to 100;
- chamber purged of sample effluent;
- light beam on and PM tube shutter open;
- neutral density filter is in the optical path; and
- both optical windows are clean.

Any shift of intensity above or below 100% Transmittance, usually due to discoloration of the optical windows, PM tube replacement or PM tube aging, can be compensated for with the SENSITIVITY control. However, if the shift is beyond the range of this control, the compensating filter must be changed to one (1) or more of the nine (9) filters supplied. With the Microphotometer set to 100% Transmittance, quantitative measurements of the continuous decrease in light transmission as the smoke accumulates in the chamber are made. A recorder should be connected to the Microphotometer to obtain a % Transmittance versus time plot. Sample reaction to the thermal exposure can be observed through the front door glass window. At the end of the test, the sample is displaced from the front of the furnace by the sample positioning control. A brief summary of the Smoke Density Test Method and the Derivation of the Specific Optical Density are presented in the following paragraph. The compensating filters are numbered from one (1) through nine (9) with the lower numbers having the greatest optical density and a value of about 0.1 optical density per step.

SMOKE DENSITY TEST METHOD (SEE ASTM E662)

The Smoke Density Test Method enables quantitative measurements of smoke by providing a light attenuation versus time plot for the specimen under test. The maximum quantity of smoke accumulation as well as the smoke production rate is obtained. The results of the smoke measurements are reported in terms of specific optical density.

The concept of specific optical density permits studying smoke characteristics of materials in terms of the area of specimen involved, the volume of the chamber and the optical path length of the light beam. Specific optical density provides the basis for predicting the smoke density that can be developed by the same product in other fire-involved areas and in other enclosure volumes.

The equation for converting percent Transmittance (%T) values obtained on the Microphotometer or recorder to specific optical density (D_s) values is based on Bouguer's or Beer's laws:

$$D_s = G[\log_{10} (100/T)]$$

Where $\log_{10}$ (100/T) equals the optical density and G represents the geometrical factor for the Smoke Density Chamber. G is derived from the dimensions of the exposed sample area (A), the chamber volume (V), and the light beam path (L) as follows:

$$G = \frac{V}{LA} = \frac{18\ ft^3}{3\ ft \times 0.0456\ ft^2} = 132$$

The volumes of the furnace and door recess are less than 1 percent and may be neglected. For example, the specific optical density when the Microphotometer indicates that the percent light transmittance has been reduced to 1% T is:

$$D_S = 132 [\log_{10} (100/T)]$$

$$D_S = 132 [\log_{10} (100/1)] = 132 [2] = 264$$

Table 4 directly converts Microphotometer or recorder data (% Transmittance) to specific optical density based upon the above relationships. The conversions for the first decades are presented in table and graph form.

CONTROL AND INDICATORS

The controls, indicators, and connectors used on the Smoke Density Chamber are described in the following paragraphs. Each item described is illustrated, Dwg. #BROCH4 and keyed to its associated description.

CHAMBER CABINET

Convenience outlets	Provide 115 VAC power for the Microphotometer and recorder.
Inlet Vent Control	Controls the vent airflow into the chamber, before and after testing. Also used to prevent negative pressure during test.
Sample Positioning	Allows the sample to be displaced from front control without opening the chamber door.
Exhaust Vent	Enables chamber to be purged of the gaseous control products at the end of a test. When in the OPEN position, an outlet vent within the chamber opens and the exhaust blower activates to vent the chamber.

CONTROL PANEL (Dwg. #68086020800)

LINE Switch #3	Switch controls the application of 115 VAC power to the lamp, heater, and exhaust blower circuits.
LINE Indicator	Lights when power is applied.
LAMP Switch	Switch controls the application of power to lamp.
LAMP Indicator	Lights when power is applied to lamp.
HEATER Switch	Switch controls the application of power to the furnace heater coil.
HEATER Indicator	Lights when power is applied to HEATER TEMPERATURE control.
LAMP VOLTS jacks #5	Provides test jacks to check lamp voltage (4±0.1 VDC). The adjustment opening is located on the side of control panel.
RADIOMETER MILLIVOLT jacks	Provides monitoring jacks to check radiometer output signal when furnace is calibrated. This must be connected to a ten (10) millivolt high impedance readout instrument.
HEATER TEMPERATURE ADJUST control #6	Controls temperature level applied to the furnace heater coil, to obtain the required 2.5 watts/cm^2 irradiance.
HEATER TEMPERATURE	This indicates temperature applied to the furnace coil. This temperature is controlled by the HEATER TEMPERATURE ADJUST control, as required by the radiometer recalibration. This setting must be rechecked before each test.
RADIOMETER MILLIVOLT METER #7	Provides digital radiometer readout when furnace is calibrated.
CHAMBER TEMP. METER °C or °F	Indicates temperature of rear chamber wall. All tests must be performed at chamber temperature above 35°C or 95°F.
FLAME GAS #8	Controls the flow of propane to the burner when associated toggle valve is open. When needle-valve control is completely counterclockwise, the flow is at the maximum. Flow rate is indicated by the center of the floating ball and corresponding gradient on the glass tube. The flow meter value indicated in the attached inspection report will provide a flow of 50 cc/min. when the FLAME AIR flow meter is passing 500 cc/min.

FLAME AIR #9	Controls the flow of air to the burner when flow meter associated toggle valve is open. When needle-valve control is completely counterclockwise, the flow is at the maximum. Flow rate is indicated by the center of the floating ball and corresponding gradient line on the glass tube. The flow meter value indicated in the attached inspection report will provide a flow of 500 cc/min. when the FLAME GAS flow meter is passing 50 cc/min.
RADIOMETER AIR #10	Enables the radiometer to reach and maintain the proper body temperature needed for calibration by controlling the air flow to the radiometer when associated toggle valve is open. When needle-valve control is completely counterclockwise, the flow is at the maximum. Flow rate is indicated by the center of the floating ball and corresponding gradient line of the glass tube. The flow meter value shown in the attached inspection report is for information only. The flow should be adjusted to provide a temperature of 200°F as indicated by the Radiometer thermometer.
RADIOMETER AIR VALVE #11	Controls application of air from air supply toggle valve to the RADIOMETER AIR flow meter. Up position is open and down position is closed.
FLAME AIR VALVE	Controls application of air from air supply toggle valve to the FLAME AIR flow meter. UP position is open and down position is closed.
FLAME GAS VALVE	Controls application of propane from propane toggle valve supply to the FLAME GAS flow meter. Up position is open and down position is closed.
HEATER FUSE #39	Provides overload protection for the furnace 16 amperes heater circuit.

GAS SAFETY SHUT OFF VALVE

CAUTION

Turn off gas flow meter and gas pilot valve. The chambers main power switch must be on to energize gas safety valve. The safety valve switch and the red "on" light are located on the bottom left corner of the instrument panel.

1. Turn on gas safety tank.

2. Turn on chambers main power switch.

3. Turn on gas safety, shut off valve switch. The red light indicates gas is on to flow meter and gas pilot valve.

BURNER FLAMELITS IGNITOR

1. Open gas pilot valve and ignite pilot. Adjust flame to approximately ½ inch in length.

2. Open air and gas flow meter valves. Move pilot flame across burner flamelits (in either direction). NOTE: Pilot flame may need to be readjusted. While under test, three (3) minutes is the maximum time permitted for flame re-ignition of "Horizontal and 45 degree Pilot Burner Flamelits".

CAUTION

While burner is not in use, turn off gas pilot valve, air and gas flow meters, gas safety shut off valve switch, and gas supply tank.

PILOT BURNER POSITIONER

1. Install burner positioner, P/N 68086035400, into a sample holder. It is recommended that a sample holder with or without trough be used solely for this positioner.

2. Install holder on support rod in front of burner. See Dwg.# 68086035400, and Smoke Chamber Instruction Manual, Dwg. #BROCH18.

NOTE: This alignment procedure is done without ignition of flamelits.

MICROPHOTOMETER

For a description of the Microphotometer controls, indicators, and connectors, refer to the instruction manual supplied with the Microphotometer. Once the 0 and 100 calibration values have been set with the light beam of the Smoke Density Chamber, the RELATIVE INTENSITY scale becomes percent Transmittance (%T). The %T indicated must be read in conjunction with the MULTIPLIER switch. For example, with the MULTIPLIER switch to the .1 position, the 0-100 scale is read as 0 to .1 %T scale. Thus an indication of fifteen (15) is a 0.015 %T.

MULTIPLIER POSITION	METER SCALE	SCALING FACTOR	RANGE	TRANSMITTANCE
				WITH ND-2 FILTER
100	0-100	1	0-100	0-100 %T
10	0-100	.10	0-10	0-10 %T
1	0-100	.01	0-1	0-1 %T
.1	0-100	.001	0-.1	0-.1 %T
				WITHOUT ND-2 FILTER
1	0-100	.0001	0-.01	0-.01 %T
.1	0-100	.00001	0-.001	0-.001 %T

The SENSITIVITY control is used to establish 100 %T. The output jacks on the rear panel provide output %T signal to an optional 50 mv recorder. The value of %T is recorded and used to determine the equivalent D_S value from either Table 4. Output signal is adjusted for 50 millivolts output at 100%T. Output impedance is 5k ohms at 50 millivolts. Red jack is plus and black jack is ground.

PM FILTER-SHUTTER ASSEMBLY

1. Filter Rod — When out, ND-2 filter is in light path. When pushed in, ND-2 filter is out of light path.

2. Shutter Rod — When out, shutter is closed, thus preventing the chamber light beam from reaching PM tube. With shutter closed, 0% T is set on Microphotometer. When pushed in, shutter is open thus enabling the passage of the chamber light beam to the PM Tube.

IV. PERFORMANCE CHARACTERISTICS AND SPECIFICATIONS

SPECIMEN SIZE: 3 by 3 inches ± 0.03 inch and up to and including 1 inch thick with an exposed area of 2.562 by 2.562 inches.

BURNER: Six (6) tube multidirectional burner operating on 550 cc/minute total flow of gas/air mixture. Mixture consists of 500 cc/minute air at 25 psi±5 psi and 50 cc/minute propane at 8.5 inches of H_2O. A Straight Burner (P/N 68086016700) is available for wire and other special tests requiring an unidirectional burner.

RADIOMETER IRRADIANCE: 2.5±0.05 watts/cm^2 over 1.5 inches (3.8 cm) diameter opening with a body temperature at 200°F±5°F (93°F±3°C).

FILTERS: Nine (9) compensating filters and one (1) neutral density filter

COMPENSATING FILTER NO.	OPTICAL DENSITY (APPROXIMATELY)
1	.9
2	.8
3	.7
4	.6
5	.5
6	.4
7	.3
8	.2
9	.1

CHAMBER VOLUME: 18 ft^3 (0.51 m^3)

LIGHT PATH: 36 inches (914 mm) vertical light beam

PHOTO DETECTOR: Selected Microphotometer using PM tube with S-4 spectral response, with minimal dark current at maximum gain.

POWER REQUIREMENT: 115V, 50/60 Hz (Approximately 650 Watts)

LIGHT SOURCE: Incandescent lamp operated at 4±0.1 DC

CHAMBER WALL TEMPERATURE DETERMINATION:
Thermocouple mounted to wall. Chamber wall maintained at 35°C or 95°F minimum.

V. OPERATION

This section contains the procedures that are used in preparing the samples for testing, calibrating the test equipment, conducting the flaming and non-flaming test, calculating specific optical density values and reporting the test results. The procedures are in accord with the NFPA-258-76[4] and ANSI/ASTM E662-83[5] Standards. For a more detailed description of the operating procedures, obtain copies of these standards from their respective organizations.

TEST SPECIMENS

Observe the following guidelines when preparing material for testing.

SIZE

The test results are valid only for the thickness and form in which the material is tested. Cut the material into three (3) inch squares, +0, -0.03 inch (76.2 by 76.2, +0, -0.8 mm). Up to and including one (1) (25.4 mm) thickness can be accommodated. Specimens greater than one (1) inch thick must be sliced to one (1) inch thickness. If required, test each original (uncut) surface separately.

ORIENTATION

If specimen has pronounced grain patterns or other non-isotropic properties, test the specimens in two (2) or more orientations and report all results.

ASSEMBLY

Select specimens, which are representative of the material to be tested. Test flat sections of same thickness and composition. Substrate or core materials shall be the same as those for the intended application. If the material will be exposed to a potential fire on either side, test both sides of the sample. When an adhesive is intended for field application of finish material or substrate, the prescribed type of adhesive and its spreading rate shall be noted and used for test. Finish materials, including sheet laminates, tiles, fabrics, and other materials secured to a substrate with adhesive and composite materials not attached to a substrate, may be subject to delamination, cracking, peeling, or other separations effecting their smoke generation. To evaluate these effects, it may be necessary to perform supplementary tests on a scored (slit), exposed surface or on interior layers or surfaces, when supplemental tests are performed, record the methods used and the test results in the report.

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[4]National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02210

[5]American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103

Use the following procedure for screening and for comparative tests of finished materials without a normal substrate or core:

1. Use standard testing procedures for rigid or semi-rigid sheet materials, regardless of thickness.

2. If the assembly system of the combustible base material is not specified, apply the paints, adhesives, etc. to the smooth face of ¼ inch (6.4 mm) thick tempered hardboard, with a nominal density of 50 to 60 lb./ft^3 (0.8 to 0.9 g/cm^3), using recommended application techniques and coverage rates. Conduct separate tests on the hardboard alone and record the results.

3. Apply film samples (paints, adhesives, etc.) intended for application to noncombustible substrate materials to the smooth face of ¼ inch (6.4 mm) thick Marinite I/cement board, with nominal density of 120 lb./ft^3 (1.9 g/cm^3), using recommended (or practical) application techniques and coverage rates.

4. Staple fabrics (or their flexible films that tend to shrink, bunch, blister, or pull out from under the specimen holder with it's aluminum foil wrapper) to the millboard backing. Position horizontally at the center and at the center of the quadrants, five (5) wire staples: approximately ½ by ¼ by 0.02 inch (12.7 by 6.3 by 0.5 mm).

MOUNTING

Cover all specimens across the back, along the edges, and over the front surface with a single sheet of aluminum foil with the dull side in contact with the specimen. The aluminum foil thickness should be 0.0015±0.0005 inch (approximately 0.04 mm). Carefully trim the foil away to expose the entire face of the sample without cutting through or otherwise damaging the exposed surface. **Do not puncture or unnecessarily wrinkle the foil when wrapping the specimen.** Fold foil to minimize losses of melted material from the bottom of holder. Cut and bend foil forward at the spout to permit flow of melting materials. Back specimen with a sheet of ½ (12.7 mm) thick insulation millboard and secure specimen and millboard with spring and modified C-Shape retaining rod or similar device. Do not deform compressible specimen.

NOTE: NEWPORT SCIENTIFIC'S SAMPLE HOLDER IS PROVIDED WITH TWO (2) WIRE RETAINERS TO PREVENT THE SAMPLE FROM DRIPPING OUT.

For carpet and other resilient materials where thickness is difficult to define or where the specimen projects beyond the face of the sample holder, the following optional mounting procedure may be used (this procedure uses an adjustable retaining clip as shown in Dwg. #68086037300).

1. Place a sample holder face down in contact with a flat surface. Insert the carpet material in the holder with the sample surface facing down.

2. Compress sample by placing a 3 x 3 x ½ inch steel plate (weight about 1.3 lb.) against the sample.

SAMPLE TESTING GUIDELINES

NUMBER OF TEST SPECIMENS

Conduct three (3) replica tests under non-flaming pyrolysis and three (3) replica tests of the same material under pyrolysis with flaming. When any result(s) exceeds the minimum value by more than 50% for no apparent reason, test an additional three (3) samples in the same test mode and report the average of all six (6) tests in said mode. When one (1) or more samples demonstrate abnormal behavior as discussed in "Test Limitations", run an additional three (3) tests in the same mode but average only the results of the sample demonstrating normal behavior. (See TEST LIMITATION.) Prior to testing but after conditioning, record the weight of each sample. Comparison of the respective weights with the individual optical density results may assist in assessing the reasons for variability in results.

TEST LIMITATIONS

If during the test, one (1) or more of the three (3) replica samples displays abnormal behavior, such as:

1. Specimen falling out of the holder;

2. Melted material overflowing the sample holder trough;

3. Self-ignition of the sample in the non-flaming pyrolysis mode.

4. Flame tiplets being extinguished even for a short time during the flaming pyrolysis.

5. Displacement of the sample under test from its calibrated position in front of the furnace and pilot burner.

An additional three (3) replica sample tests should be performed.

Only the normal test results should be reported and averaged, but the occurrence of the abnormal behavior shall be noted.

If more than three (3) of the six (6) tests reacted abnormally then the test procedure may be considered unsuitable for this material.

The test method has proven sensitive to small variations in sample geometry, surface orientations, thickness, density and composition. It is therefore important to cut samples to the same dimensions and to record the initial weight with each sample. Pre-selection of samples with identical weights and/or thickness may reduce variability but may not reflect the true variability of the normal material.

CONDITIONING

Pre-dry the sample for 24 hours at 140±5°F (60±3°C), then condition them to equilibrium (constant weight) at an ambient temperature of 73±°F (23±3°C) and a relative humidity of 50±5 percent. Use a forced-air movement conditioning chamber and support the specimen in a rack that allows access to all surfaces.

PROCEDURE

CHAMBER CHECKOUT

1. Ensure the chamber is free from contaminants, especially the optical windows separating the Microphotometer and light source housing from the interior of the chamber. Charred residues on the sample holder and rods should be removed between tests to avoid contamination. If necessary, clean the chamber by performing the steps in the "Test Chamber Cleaning" procedure in Section VIII., Maintenance.

2. Ensure that performing the "Checkout Procedures" paragraph in Section II., Installation, properly seals the chamber.

3. If burner is installed at this point, remove burner. To ensure correct radiometer measurements, the furnace is calibrated without the burner in place.

4. Place empty sample holder with insulating block and spring and retaining pin in place on the support rods directly in front of the furnace.

5. Close the chamber door.

CHAMBER WARMUP

After establishing the chamber is adequately clean and properly sealed, power is applied to the chamber and the chamber is allowed to warm up. When the temperature on the center surface of the back wall reaches a steady state value in the range of 95±4°F (35±2°C), the chamber is ready for furnace calibrating or sample testing. The procedure follows:

1. Open the Inlet Valve.

2. Close the Exhaust Vent.

3. Set the chamber LINE switch to ON.

4. Set LAMP switch to ON.

5. Turn the Microphotometer POWER switch to the ON position and set the MULTIPLIER switch to 100. Adjust Microphotometer to 100 %T using the SENSITIVITY Control. During the initial 1-2 hours the display may drift down scale due to "Burning in" of PM Tube. Readjust to 100 %T. Some tubes may require one (1) to two (2) days to stabilize.

6. **PRECAUTION: THE FURNACE RADIATES HIGH TEMPERATURES TO THE ADJACENT WALL THAT CAN PRODUCE ERRONEOUS RESULTS ON SUBSEQUENT TESTS. TO PREVENT OVERHEATING THIS WALL, ALWAYS PLACE A SAMPLE HOLDER WITH AN INSULATION BLOCK DIRECTLY IN FRONT OF THE SURFACE.**

   Set HEATER switch to ON. Set the HEATER TEMPERATURE ADJUST control to the previous radiometer calibrated setting. If this is an initial warm-up for the chamber, use the control setting noted in the attached inspection report.

7. Under optimum conditions, allow one (1) hour minimum for the CHAMBER TEMPERATURE meter to indicate 95°F. Under adverse conditions, an auxiliary heater may have to be used to reach the proper wall temperature. Conversely, the chamber exhaust blower may be used to decrease the wall temperature to 95°F.

FURNACE CALIBRATION

When the chamber wall temperature stabilizes at 95°F (35°C) or above, calibrate the furnace irradiance output with the radiometer. This calibration should also be performed at periodic intervals, normally once per test day before a test run. The procedure follows:

PRECAUTION: DO NOT HANDLE RADIOMETER BY ITS CABLE OR TOUCH THE FRONT BLACK SURFACE.

1. Connect a 10 millivolt full-scale high impedance meter or recorder to the RADIOMETER MILLIVOLTS jack on the control panel of the Smoke Density Chamber.

2. Set radiometer on the support rods, next to the sample holder. Do not place radiometer directly in front of the furnace at this time.

3. Place thermometer in the radiometer.

4. Remove cap from the radiometer electrical connector on chamber floor. Connect radiometer air hose and electrical cable to the appropriate connectors on chamber floor, **HAND** tighten the electrical cable.

5. **PRECAUTION: THE RADIOMETER IS A DELICATE INSTRUMENT. DO NOT ALLOW RADIOMETER TO REMAIN THE CHAMBER UNLESS RADIOMETER IS AIR COOLED. DO NOT ALLOW THERMOMETER TO INDICATE ABOVE 205°F. THE CHAMBER ATMOSPHERE MAY CONTAIN CORROSIVE PRODUCTS. DO NOT LEAVE RADIOMETER IN CHAMBER FOR EXTENDED PERIODS.**

   Push radiometer directly in front of furnace heater (displacing empty sample holder toward rear against the back stop) and close the chamber door.

6. When thermometer indicates 180 to 190°F, open (up position) RADIOMETER AIR toggle valve and rotate associated needle-valve control counterclockwise to start airflow.

7. Adjust heater temperature (arrow up or arrow down on Heater Meter Adjust) to a reading of approximately 1350°F. Allow heater temperature to stabilize and note Radiometer mV reading. Determine mV's required for 2.5 w/cm^2 from sheet supplied with Radiometer. If noted reading is higher than what is required, adjust thermocouple at rear for Furnace in (to the right) or out (to the left) if reading is lower. A reading within $\pm$0.2 mV will be sufficient. Tighten thermocouple.

NOTE: IT MAY BE NECESSARY TO READJUST THE AIR FLOW AS WELL AS THE FURNACE TEMPERATURE TO OBTAIN THE STABILIZED RADIOMETER OUTPUT WHILE STILL MAINTAINING 200°F BODY TEMPERATURE.

8. Fine adjust Heater Temperature to maintain required mV reading $\pm$0.03 mV by adjusting Heater Temperature up or down accordingly.

9. Record airflow, HEATER TEMPERATURE, and CHAMBER TEMPERATURE meter indications. These indications can be used to approximate control settings for future calibrations. The HEATER TEMPERATURE meter setting must be maintained throughout all tests until the furnace is recalibrated with the Radiometer.

WARNING: USE INSULATED GLOVES AND/OR SUITABLE TONGS TO AVOID DIRECT CONTACT WITH HEATED SURFACES.

10. Slide Radiometer from front of furnace.

11. Close RADIOMETER AIR toggle valve (down).

12. Disconnect Radiometer air hose and electrical cable and remove Radiometer from chamber.

13. Place Radiometer in a dust/corrosive-free container.

14. Replace cap on Radiometer electrical connector on chamber floor.

15. The Smoke Density Chamber is now ready to test samples. For no flaming exposure tests (with burner removed), perform the test procedure described in the following paragraph. For flaming exposure tests, first perform steps 16 through 19 then perform the "Test Procedure".

16. Install and ignite burner as follows:

WARNING: DO NOT TOUCH FURNACE, SUPPORT ROD ASSEMBLY OR SAMPLE HOLDERS. KEEP HANDS AWAY FROM AREA DIRECTLY IN FRONT OF FURNACE HEATER.

A. Center a sample holder directly in front of the furnace.

B. Connect burner into the air/propane outlet receptacle on the chamber floor and tighten the gland nut finger tight, Dwg. #BROCH4.

C. Check the alignment of the burner to ensure that the two (2) outer tips are ¼ inch above the bottom opening in the face of the sample holder and that both tips are located ¼ inch away from the face of the holder (refer to Dwg. #BROCH18). Tighten the gland nut.

D. Open the FLAME GAS Toggle switch (up position).

E. Rotate needle-valve control on the FLAME GAS flow meter counterclockwise until indicator is between ten (10) and fifteen (15) then immediately ignite burner with a match.

17. Allow burner to flame for one (1) minute and then adjust needle-valve control on the FLAME gas flow meter until the indication equals the value shown in the Gas Flame Calibration Curve supplied with the Smoke Density Chamber to ensure a gas flow of 50 cc per minute.

18. Open the FLAME AIR toggle switch (up position) and adjust needle-valve on the FLAME AIR flow meter until ball indicates the value shown in the Flame Air Flow Meter Calibration Curve supplied with the Smoke Density Chamber to ensure an air flow of 500 cc per minute.

    The flame tiplets, when properly adjusted, will be blue in color and will just impinge on the surface of the sample holder face. Where difficulties are encountered or where flow meters have been replaced, the calibration of the flow meters may have to be checked by performing the "Burner Gas/Air Flow" paragraph in Section VI.

19. The Smoke Density Chamber is now ready to obtain data from a flaming exposure test in the presence of supporting radiation. Perform the "Test Procedure" in the following paragraph.

TEST PROCEDURE

The following procedure assumes that:

- The Chamber has reached a steady state condition.
- The Furnace is calibrated and if a burner is used, that the air/gas flow rate is set per Calibration Curves supplied with the Smoke Density Chamber.
- The Samples are properly prepared and mounted in sample holders.

1. Ensure that the PM tube shutter is closed, the ND-2 filter is in the light path (both rods on the filter-shutter assembly are in the out position), and the LAMP switch is set to ON.

2. Turn the Microphotometer power switch ON. Set the MULTIPLIER switch to 0.1. Set the DISPLAY switch to RELATIVE INTENSITY. Turn the SENSITIVITY knob full clockwise. The PM tube, though completely shielded from the light beam, will generate a small current called dark current. Dark current is most evident during high sensitivity (gain) measurements and is effectively cancelled when 0 %T is established on the Microphotometer display.

3. Adjust the ZERO control until the display indicates 0 RELATIVE INTENSITY units (0% Transmittance). If a recorder is used, set the recorder pen to the 0% line on chart (with Microphotometer indicating 0% Transmittance).

NOTE: DO NOT ADJUST THE DARK CURRENT CONTROL WITHOUT REPEATING STEPS 1 THROUGH 3.

4. Set the MULTIPLIER switch to 100.

5. Open PM tube shutter (lower shutter rod in).

6. Rotate the SENSITIVITY control until the display indicates 100% Transmittance. If a recorder is used, set recorder pen to the 100% line on the chart (with Microphotometer indicating 100% Transmittance). If unable to match recorder span to Microphotometer span, adjust the RECORD ADJUST control on the rear panel of the Microphotometer until spans correspond, or a span adjust on the recorder if it is so equipped. Set recorder chart speed to one (1) inch per minute.

7. Ensure that the chamber exhaust vent/blower is off by turning the exhaust VENT now to the CLOSE position. ("Close" pilot light will turn on.)

8. Ensure that the inlet vent is partially closed. The inlet vent is completely closed only when the Microphotometer indicates the presence of smoke. However, during a test if negative pressure develops (usually after an intense sample flaming reaction) partially open the inlet vent to equalize the pressure. Normally, the chamber pressure as observed with the manometer is positive (4 ± 2 inches). As a result of the pressure rise, the FLAME AIR and GAS flow meters indications may change. Readjust indications until they match the calibrated values to maintain proper flow rate. Many users provide inlet venting by leaving the chamber door slightly open, with the handles against the face of the door rather than against the latch surface. The inlet vent is then used for relief of negative pressure only.

9. Mount the loaded sample holder on the support rods, next to the empty holder.

10. Push loaded sample holder directly in front of the furnace (empty holder will be against the back stop of the support rod).

11. Immediately start the recorder chart drive and close chamber door (or leave slightly open if being used for venting).

12 Complete close the inlet vent (or the chamber door) when the Microphotometer indicates a decrease in % Transmittance.

13. Record any observation pertinent to the burning and smoke generating properties of the materials under test. As the % Transmittance of the light beam decreases, increase the Microphotometer sensitivity by the multiplier switch to the next range. For each range, allow the meter indication to decrease to 10% or slightly less before selecting the next range, i.e., with MULTIPLIER switch set to 100, reset to 10 when indication falls to 10% Transmittance.

14. Cover the chamber door window with window cover P/N 68086035800 if the light level decreases into the 4^{th} decade to avoid possible light scattering effects from room light. The window cover is easily installed by bowing it into the clips.

15. The .1 range is the highest sensitivity range of the Microphotometer. To measure % Transmittance below this range perform the following:
    - With MULTIPLIER switch set to .1 allow meter indication to decrease to 10% of full range. If the ND-2 filter has a value greater than two (2), allow indication to decrease to below 10%.
    - Reset MULTIPLIER switch to one (1).
    - Remove the ND-2 filter from the light path by pushing upper filter rod in the turning rod to lock. When meter indication decreases to 10% of full scale, reset MULTIPLIER switch to .1. The removal of the ND-2 filter provides an additional two (2) decades of sensitivity (see Table 4).

16. Continue test for a period of three (3) minutes after a minimum light transmittance value is obtained or after an exposure of twenty (20) minutes, whichever occurs first. If desired, the test may be extended beyond twenty (20) minutes if the minimum light transmittance level has not been reached. Some test periods may be specified for periods of less than twenty (20) minutes.

17. Terminate the test as follows:

    A. Immediately displace sample holder from front of furnace by pulling the sample-positioning rod.

    B. Set recorder chart speed to a slower chart speed to conserve paper.

    C. If ND-2 Filter was removed in step 16, reinsert filter into light path (upper filter rod out).

D. Set Microphotometer MULTIPLIER switch to 100. Purge chamber within one (1) minute after terminating the test by rotating exhaust VENT control to OPEN and then opening the inlet vent (or by slightly opening the chamber door). When purging, always open floor vent to start the blower before opening the inlet vent (or chamber door). "Open" pilot light will turn on.

18. **WARNING: THE PRODUCTS PRODUCED BY PYROLYSIS AND BURNING OF THE MATERIALS UNDER TEST MAY BE CARCINOGENIC, TOXIC, IRRITATING OR OTHERWISE HAZARDOUS. AN AUXILIARY BREATHING DEVICE AND PROTECTIVE GLASS MAY HAVE TO BE WORN BEFORE OPENING CHAMBER DOOR. USE GLOVES AND/OR SUITABLE TONGS TO AVOID CONTACT WITH HAZARDOUS RESIDUES. BUTYL GLOVES HAVE BEEN FOUND SUITABLE FOR HIGHLY CORROSIVE RESIDUES.**

When maximum % Transmittance is obtained, open chamber door. Remove loaded sample holder and place under an exhaust hood to cool.

19. Continue exhausting the chamber for one (1) minute to ensure that the ultimate maximum % Transmittance has been reached. Record this value as T_c (Clear beam).

20. Close PM tube shutter (lower shutter rod out) or set Microphotometer POWER switch to OFF.

21. Clean the lower and upper optical windows with alcohol or an ammoniated cleaner. Wipe dry using soft tissue paper.

22. To obtain smoke measurements of the other samples, repeat procedures from step 1.

TEST RESULTS

The results of the test may be reported as follows (refer to Table 5 for a suggested format of the report):

1. For each sample test run, tabulate the %T/Minute data from the recorder chart paper. Normally three (3) test runs are made and the data tabulated in three (3) tables.

2. Obtain and tabulate the equivalent specific optical density (D_S) for each %T Value. Any value of %T can be directly converted to its equivalent D_S value by using Table 4. For example:

   At twelve (12) minutes a value of 0.036 %T (36×10^{-3} %T) is reported. To measure this level, the MULTIPLIER is set to .1 and the ND-2 filter is in the optical path. The %T vertical and horizontal columns in Table 4 establish that a 36×10^{-3} %T value is equal to a D_s value of 455.

3. Average the D_s value tabulated for each minute of the test. Use this average value of D_s for the remaining computations.

4. At the "Results" section of the report:

   A. Record the lowest %T obtained and the time for the smoke to reach this value.

   B. Record the maximum specific optical density (D_m) by converting the average lowest %T obtained to its equivalent D_s from Table 4. If the ND-2 Filter was removed for this measurement, and higher accuracy is required, it may be necessary to add a correcting factor to this D_s value. Refer to Table 3.

   C. Record the time for the smoke to reach 90% D_m.

   D. Record the clear beam transmittance T_c value. This value was obtained in step 20 of the "Test Procedure" paragraph.

   F. Obtain and record D_s equivalent of the T_c value from Table 4. This value is designated D_c and is used to correct the maximum specific density value (D_m) as follows:

$$D_m \text{ (corr)} = D_m - D_c$$

5. At the "Optional Presentation of Results" section of the report:

   A. Record the time for the smoke to reach a D_s value of 16 (%T=75.). This value may have to be obtained from the recorder data.

   B. Find the greatest change of D_s (D_s) over any two (2) minute interval test. Divide this D_s value by two (2) to obtain the maximum rate R per minute for the interval.

$$R = \frac{D_s}{2}$$

   Record this rate.

   C. If running aerospace type samples, an average of D_m value should be calculated at ninety (90) seconds after the start of the test.

SYSTEM SHUTDOWN PROCEDURE

1. If burner is ignited, close the FLAME GAS and AIR toggle valves (down) and shut off propane supply at the tanks.

2. If sample tests are not conducted daily, turn of the furnace by setting HEATER switch to OFF. If tests are run daily, allow the chamber wall to remain heated by either using an auxiliary 500 watts heater placed in the chamber or by reducing the temperature to the furnace by 50% with the HEATER TEMPERATURE ADJUST control.

PRECAUTION: LEAVING THE FURNACE TURNED ON AT ITS NORMAL OPERATING TEMPERATURE WILL PRODUCE PREMATURE FAILURE OF THE HEATER COIL.

3. Set LAMP switch to OFF.

4. Set Microphotometer POWER switch to OFF.

5. Ensure PM tube shutter is closed (lower shutter rod out).

6. Ensure that the chamber is free from contaminants, especially the lower and upper optical windows. If necessary clean the chamber by performing the "Test Chamber Cleaning" procedure in Section VIII., Maintenance.

REPORT (from ASTM E-662-79)

The Report shall include the following (refer to Table 5):

1. Complete description of the material tested including type, manufacturer, shape, thickness, or other appropriate dimensions, weight or density, coloring, etc.

2. Complete description of the test specimen, including substrate or core, special preparation, mounting, specimen orientation, etc.

3. Information regarding the test specimen, conditioning procedure, and the duration of conditioning.

4. Number of specimens tested.

5. Test conditions: type of exposure, the exposure period, and temperature of chamber wall.

6. Observations of the behavior of the specimen during the test exposure, such as delamination, sagging, shrinkage, melting, collapse, etc., including the time of such occurrence. The time of any change exposure mode should be noted.

7. Observations of the smoke-generating properties of the specimens during exposure, such as color of the smoke, nature of the settled particulate matter, etc.

8. A tabulation or curve of time versus either percent transmittance or D_s (rounded to two (2) significant figures) for each run of the three (3) test specimens.

9. Test results rounded to two (2) significant figures as described including the average and range on each set of specimens for D_m with time of occurrence, and D_m (corr).

***NOTE: PRIOR TO THE ADOPTION OF THIS TEST METHOD, IT WAS CUSTOMARY TO REPORT THE MAXIMUM SMOKE ACCUMULATED AS D_m (CORR), AND FOR THAT REASON IT HAS BEEN INCLUDED AS A PART OF THE TEST REPORT. SUBSEQUENTLY, A STATISTICAL ANALYSIS OF THE ROUND ROBIN DATA UPON WHICH THE PRECISION STATEMENT IS BASED, SHOWED THAT THE D_m VALUES WERE MORE UNIFORM. THEREFORE, IT IS REQUIRED THAT BOTH Dm AND D_m (CORR) BE REPORTED.**

VI. CALIBRATION PROCEDURES

This section contains the procedures and guidelines for calibrating the optical system, burner air/gas flow, and radiometer of the Smoke Density Chamber. The overall calibration of the Smoke Density Chamber can be performed using SRM 1006 Alpha-Cellulose for non-flaming and SRM 1007 ABS plastic for the flaming mode. These materials can be purchased from the Office of Standard Reference Materials, National Institute of Standards and Technology, Gaithersburg, Maryland 20760.

OPTICAL SYSTEM

The 529 through 924 specific optical density (D_s) values in Table 4 were derived using an ND filter with optical density of 2.00. Since the optical density of this filter may vary from unit to unit, these D_s values may have to be corrected for filter deviation (refer to Table 6-1 for the correction factors). However, even if the optical density deviates by as much as 5 percent from the 2.00 value (2.1 to 1.9), the maximum D_s error would be equal to thirteen (13). Therefore, the margin of error for the 529 to 924 D_s range would only be from 2.4 to 1.4 percent. Since in any flammability test procedure, accuracies greater than 90 percent are questionable, correcting for filter deviation may not be required. The optical density of the ND filter supplied with this Smoke Density Chamber is given in the attached inspection report. Performing the following procedure may recheck the optical density of this filter:

1. Ensure that the PM shutter is closed and that the ND-2 filter is in the light path (both rods of the filter-shutter assembly in the out position).

2. At the Microphotometer, set:

   - Multiplier switch to 100
   - POWER switch to ON

3. Place several thin tissues on the lower optical window or use a neutral density filter of approximately 2.5 ND value in place of the tissues.

4. Open the PM tube shutter (lower shutter rod in).

5. Place additional tissues on the lower optical window and reset the MULTIPLIER switch until the meter indicates approximately mid-scale when the MULTIPLIER switch is set to the one (1) range.

6. Adjust the ZERO control until an indication of exactly fifty (50) is obtained. Do not disturb the tissues or ZERO control setting after an indication of fifty (50) is obtained on the one (1) range.

7. Set MULTIPLIER switch to 100.

8. Remove the ND-2 filter (upper filter rod in) from optical path. If the ND-2 filter is exactly two (2), the meter will indicate exactly fifty (50). However, if an indication higher or lower than fifty (50) is obtained, a correction factor from Table 3 may be applied. For example:

Calibration procedure obtains a meter indication of fifty-five (55). Therefore, actual optical density rating of the ND filter is 1.96 (refer to Table 3). Correction factor for this filter is -6 (refer to Table 3).

Record the correction factor for the future reference. Use this correction factor whenever smoke density measurements are made without the ND filter in the optical path. For example, a value of 0.00045 %T (45×10^{-5} %T) is reported.

This measurement was obtained with the MULTIPLIER switch set to .1 and the ND filter removed.

Table 4 establishes that a 45×10^{-5} %T is equal to 706 D_s.

With a correlation factor of -6 this D_s value becomes 700. This D_s value would be recorded for the 0.00045 %T indication.

3. Remove the tissues or neutral density filter from optical window and restore Smoke Density Chamber per procedures in Section V., Operation.

BURNER GAS/AIR FLOW

A certified wet or dry gas meter may be used to measure the individual gas flows at the gas and air inlets on the rear panel. A voltmeter may be used in constructing a manifold and connecting its inlet to all six (6) of the burner tiplets.

All flow meter calibrations or checks of flow meter calibration must be performed with the burner in place and with both the air and gas flowing. The total flow must be adjusted to assure 550 cc/min, assuring that the air flow differentials, setting the propane flow alone without the air and with the burner in place will produce an error in the propane flow (usually about 10 to 15% low).

RADIOMETER

The radiometer calibration must be checked periodically. A standby calibrated radiometer P/N 4-5801 is recommended to check the radiometer. Contact us if your radiometer needs to be calibrated. The user may purchase the P/N 4-5803 Radiometer Calorimeter for calibration verification or recalibration by the user.

VII. PRECAUTIONS, LIMITATIONS, AND HAZARDS

WARNINGS

Assure that all gaseous products are completely and safely vented. The products produced by these tests may be carcinogenic, toxic, irritating, or otherwise hazardous. An auxiliary breathing device and protective glasses may have to be worn before opening chamber door. Use butyl gloves and/or suitable tongs to avoid contact with hazardous residues.

The power outlet must be properly grounded and polarized to prevent a shock hazard.

Use insulated gloves and/or suitable tongs to avoid touching heated surfaces. Keep hands away from the front of the furnace or burner.

Wear butyl rubber or other suitable gloves and protective clothing when cleaning the chamber to avoid contact with toxic and irritating residues.

PRECAUTIONS

Do not touch glass envelope of the PM tube. Fingerprints on this glass will degrade the PM tube operation or cause erratic indications.

Exposing the PM tube to room light when high voltage is applied could permanently damage the PM tube.

Do not handle radiometer by its cable or touch the front, black surface.

Do not leave the furnace turned on at its normal operating temperature for any extended period, as this will produce premature failure of the heater coil. To protect the chamber sidewall from excessive heat, always place a sample holder with a Marinite I block directly in front of the furnace.

Do not use Windex[6] glass cleaner or other wax-containing products when cleaning the optical windows in the chamber.

LIMITATIONS

The chamber should be tested for leakage at installation and periodically to verify proper seal.

Handle compensating filters only by the edge to prevent changing optical density value with fingerprints.

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[6]Drackett Company

VIII. MAINTENANCE

Operator performed maintenance of the Smoke Density Chamber is limited to periodic cleaning, light beam adjustment, and to replacing the radiometer, PM tube, and fuse. Our service representative should perform all other maintenance. A schematic (see Dwg. #68086020800W) and replacement part list is contained in this section.

PERIODIC MAINTENANCE

TEST CHAMBER CLEANING

The chamber must be kept clean to ensure correct smoke density measurements. After running a series of tests, the inner walls of the chamber, the optical windows, and the sample holders may accumulate residues. The following cleaning procedure will be more effective if the chamber walls are kept warm.

WARNING: USE BUTYL RUBBER OR OTHER SUITABLE GLOVES AND PROTECTIVE CLOTHING DURING CLEANING TO AVOID CONTACT WITH TOXIC AND IRRITATIVE RESIDUES.

1. Use ethyl alcohol or a non-wax, non-abrasive glass cleaner to clean the optical windows in the chamber.

   PRECAUTION: DO NOT USE WINDEX GLASS CLEANER OR OTHER WAX CONTAINING PRODUCTS.

2. Use ethyl alcohol or ammoniated cleaner to clean the chamber door window.

3. Remove any charred residues on the sample holder, support rods and chamber walls. Ammoniated spray detergents and soft non-metallic scouring pads can be used.

LIGHT BEAM ALIGNMENT

The light source provides a collimated light beam inside the chamber, which is centered within the upper window facing the PM tube. The alignment of the light beam should be checked periodically or whenever the lamp is replaced.

1. Construct a paper alignment guide using the dimensions given in Dwg. #BROCH13.

2. Attach and center guide to upper optical window in chamber using transparent tape.

3. Set the Chamber LINE Switch to ON. Ensure that the PM tube shutter is closed (lower shutter rod is in the out position) and that the Microphotometer POWER switch is OFF.

4. Set LAMP switch to ON. Light beam should enter chamber from lower optical window on chamber floor. The light beam will not be exactly circular but will spread out and should completely fill the inner two (2) inch circle of the guide.

5. If necessary, adjust light beam as follows:

   Remove cover from lower lens housing (lower rear of cabinet). Loosen lens mount screws. Adjust lens assembly by moving assembly until light beam completely fills the 2-inch circle. In extreme cases, adjust the lamp socket by loosening the securing screw through the floor of the housing. Tighten the lens mount screws. Replace cover.

6. Remove guide.

7. Remove front cover from the PM tube and lens housing, Dwg. #BROCH14.

8. Remove compensating filter from holder from the lens bracket. Loosen the lens mount screws and adjust the lens mount until the light beam converges to a point at the disc aperture of the PM tube housing projecting into the top of the lens housing.

9. Retighten the lens mount screws and reinsert the compensating filter holder into the lens bracket.

10. Replace the front cover.

11. Realignment may require changing the compensating filter. Perform the "Compensating Filter Selection" procedure to determine which filters should be used.

COMPENSATING FILTER SELECTION

This procedure is used to select the proper compensating filter whenever 100% Transmittance cannot be obtained on the Microphotometer. Wratten filters or screens (obtained from industrial photographic supply sources) rated from 0.1 to 0.9 ND can also be used to obtain 100% Transmittance. The procedure is usually performed after a PM tube is replaced.

NOTE: HANDLE FILTERS BY THEIR EDGES. FINGERPRINTS WILL PRODUCE ADDITIONAL OBSCURATION BY AS MUCH AS ND = 1.

1. At the Microphotometer, set:
   - MULTIPLIER switch to 100.
   - POWER switch to ON.

2. Ensure that the PM tube shutter is open (lower shutter rod in) and ND-2 filter is in the light path (upper filter rod out).

3. Ensure that the light beam is on and that both optical windows in chamber are clean.

4. Rotate the SENSITIVITY control until the display indicates 100 %T. If 100% T is obtained, the compensating filter in the PM tube housing is the correct one. Terminate this procedure. If however, an indication of 100 %T is unattainable, go to step 5.

5. Close the PM tube shutter (lower shutter rod out).

6. Remove the front cover of the PM tube and lens housing, Dwg. #BROCH14.

7. Remove holder containing the compensating filter from the lens bracket.

8. Replace cover and secure with the retaining screws to prevent light leaks.

9. Open the PM tube shutter (lower rod in).

10. Select filter rated above and below the original filter value. Alternately place each filter over the optical window in the chamber floor until 100 %T is obtained by adjusting the SENSITIVITY control. (If indication is above 100 %T for all the filters, use a combination of two (2) filters at a time.)

11. Close the PM tube shutter (lower shutter rod out).

12. Remove the front cover of the PM tube and lens housing and place filter (s) that obtained 100 %T into holder. Reinsert holder in the lens bracket and replace cover, ensuring that the cover is light tight.

13. Open the PM tube shutter (lower shutter rod in). Recheck to see if 100 %T can be obtained.

14. Close the PM tube shutter and set POWER switch to OFF.

15. Store remaining compensating filters.

CORRECTIVE MAINTENANCE

RADIOMETER MAINTENANCE

If loss of radiometer signal or erratic signals occurs, an internal ground connection may be loose. Gentle turning of the cable connector at the rear of the radiometer may correct this problem. After obtaining a steady signal, tighten side screw securing the connector.

If the black, front surface of the radiometer is blistered or badly scratched the radiometer may need to be replaced. Contact us for instructions in returning the unit for replacement. A standby-calibrated radiometer is recommended to recheck the calibration of the standard radiometer.

The optional P/N 4-5803 Calorimeter provides means for verification or recalibration by the user.

PM TUBE REPLACEMENT

The P/N 47-16216 PM tube is specifically for the Smoke Density Chamber. The use of a PM tube obtained from a source other than Newport Scientific, Inc., even though the PM tube is of the same make and model, may not give the stability and compensation required for proper photometric measurements.

1. Set power switch on Microphotometer to OFF.

   PRECAUTION: THE HIGH VOLTAGE MUST BE OFF TO ENSURE THAT THE HIGH VOLTAGE IS NOT APPLIED TO THE PM TUBE WHILE IT IS OUT OF ITS HOLDER. EXPOSING THE PM TUBE TO ROOM LIGHT WITH THE HIGH VOLTAGE APPLIED COULD PERMANENTLY DAMAGE THE NEW PM TUBE.

2. Hold the protruding base of the PM tube while loosening PM tube side retaining screw. Remove PM tube from housing.

3. Ensure that the glass envelope of the new P/N 47-16216 PM tube is clean and free of fingerprints. Insert new PM tube carefully into PM tube holder. Insert PM tube holder into the PM tube housing ensuring that the pin on the holder enters the slot in the housing. Tighten the side screw to lock the PM tube holder into the housing.

4. Perform the "Compensating Filter Selection" procedure to ascertain if a different filter is needed to compensate for the characteristics of the new PM tube. (See note below *.)

5. Close the PM tube shutter (lower shutter rod out) and set POWER switch to OFF.

CHAMBER BLOWOUT PANEL REPLACEMENT

1. Remove all foil and tape from chamber floor area.

2. Thoroughly de-grease and wipe area around floor opening.

   ***NOTE: ALLOW ONE (1) TO TWO (2) HOURS FOR "BURNING IN" OF PM TUBE FROM HV APPLIED. SOME TUBES MAY REQUIRE ONE (1) OR TWO (2) DAYS TO STABILIZE.**

3. Cover opening with heavy-duty aluminum foil (0.0015 $\pm$ 0.0005 inch thick) ensuring that foil is wrinkle free.

4. Secure foil to floor with 2-inch wide Mylar or cloth adhesive backed tape. Allow tape to overlap foil one (1) inch, with remaining one (1) inch adhering to the floor.

LAMP REPLACEMENT

To minimize corrosive effects of the test effluents, the lamp leads are soldered directly to the lamp base. When replacing the lamp, the lamp and its leads must be disconnected and removed as one unit. The procedure follows:

1. Set LAMP switch to OFF.

2. Remove cover from lower lens housing (lower rear or cabinet).

3. Trace leads from lamp base to the main terminal board.

4. Tag terminal board connectors and then disconnect leads from terminal board.

5. Twist lamp to unlock from socket. Remove lamp by pulling leads through rear of socket.

6. Insert leads from new lamp through the opening at rear of lamp socket.

7. Secure lamp by twisting it in lamp socket.

8. Connect lamp leads to terminal board.

9. Remove dust by carefully wiping lamp, lens, and lower optical window with lens brush or tissue.

10. Check lamp alignment by performing the "Light Beam Alignment" procedure.

HEATER FUSE REPLACEMENT

1. Set HEATER switch to OFF.

2. Remove back cover on CONTROL PANEL. Remove fuse from inside CONTROL PANEL, left side.

3. Check for continuity across fuse. If open, replace fuse 16A ampere, Farraz A050f020 or equivalent.

4. Place fuse in fuse holder. Restore power to heater.

HEATER METER SETUP

1. Press and hold for three (3) seconds UP key and DOWN key.

2. Press "M" key until "In" appears. Set to "H" (UP & DOWN keys).

3. Press "M" key until "C_F" appears. Set to "F".

4. Press "M" key until "rL" appears. Set to "0" (zero).

5. Press "M" key until "rH" appears. Set to "1600".

6. Press "M" key until "0t1" appears. Set to "hT".

7. Press "M" key until "HSC" appears. Set to "3".

8. Press "M" key until "0t2" appears. Set to "prA".

9. Press "M" key until "HSA" appears. Set to "2".

10. Press "M" key until "LAt" appears. Set to "nLA".

11. Press "M" key until "rP" appears. Set to "off".

12. Press "M" key until "P L" appears. Set to "100".

13. Press "M" key until "dSP" appears. Set to "nor".

14. Press "M" key to return to Control Set Point.

15. Press "M" key until "Pb1" appears. Set to "68".

16. Press "M" key until "rE1" appears. Set to "1.71".

17. Press "M" key until "rA1" appears. Set to 0.02".

18. Press "M" key until "ALO" appears. Set to "0" (zero).

19. Press "M" key until "rH1" appears. Set to "1600".

20. Press "M" key until "AUt" appears. Set to "0" (zero).

21. Press "M" key to return to Control Set Point.

TROUBLESHOOTING

Only an Electronics Technician should do troubleshooting. Refer to Dwg. #68086020800S and Dwg. #68086020800W for Component and Schematic location. For maintenance information on the Microphotometer and other accessories, refer to the appropriate instruction manual.

TABLE 1 - ITEMS SUPPLIED WITH CHAMBER		
QUANTITY	**PART NUMBER**	**DESCRIPTION**
1	68086019100	Compensating Filters Graded set of nine
1	68086035600	Container Assembly
1	68086009100	Furnace Alignment Tool
1	68086038800	Furnace Assembly with Thermocouple
1	68086031000	Flange Adapter Exhaust Fan
1	68086004500	Drip Pan
5	68086017200	Sample Holder with Drip Retainer
1	68086017000	Trough Burner Assembly
1	4-5807	Microphotometer
1	4-5801	Radiometer
1	68086022000	Radiometer Cable
1	47-16216	Photomultiplier Tube and Cable
1	P1869002300	Hex Wrench
1	68086018700	Filter Assembly
1	P1020021600	U-Tube Manometer
1	68086035400	Burner Positioner
1	68086035800	Window Cover
1	---	Instruction Manual, Smoke Chamber
1	---	Instruction Manual, Microphotometer
1	---	Microphotometer Schematic
2	---	Calibration Sheets, 2 Flow Meters
1	---	Calibration Sheet, Radiometer
1	---	Pressure Test - Cabinet Assembly

TABLE 2: PROPANE TANK CAPACITIES			
CAPACITY (LBS)	**APPROXIMATE TESTS PER FILLING***	**DIAMETER (INCHES)**	**HEIGHT (INCHES)**
6	450	9	14
10	750	9	18
20	1500	11	20-1/2
30	2250	11	26-1/2
40 (ALUM.)	3000	11	34-1/2
100/200	NONPORTABLE INSTALLATIONS		

* Based on a required propane flow of 50 cc/minute during flaming test, a minimum time of 20 minutes per test sample and the usual three (3) replicate tests specified. These tanks are sold and refilled by bottled gas companies.

TABLE 3

ND-2 FILTER REMOVAL FACTORS		
Meter Indicator	Optical Density Of the ND Filter Log $P_0P=D$	Correction Factor* to be Added to Table A-1 or Fig. A-1 529 to 924 D_s Values
31	2.21	+27
32	2.19	+25
33	2.18	+24
34	2.17	+22
35	2.16	+20
36	2.14	+19
37	2.13	+17
38	2.12	+15
39	2.11	+14
40	2.10	+13
41	2.09	+11
42	2.08	+10
43	2.07	+8
44	2.06	+7
45	2.05	+6
46	2.04	+5
47	2.03	+3
48	2.02	+2
49	2.01	+1
50	2.00	+0
51	1.99	-1
52	1.98	-3
53	1.97	-4
54	1.965	-5
55	1.96	-6
56	1.95	-7
57	1.94	-8
58	1.934	-9
59	1.93	-10
60	1.92	-11
61	1.91	-12
62	1.905	-13
63	1.90	-14
64	1.90	-14
65	1.89	-15
66	1.88	-16
67	1.87	-17
68	1.865	-18
69	1.86	-19
70	1.85	-20
*Corrections are to be applied to the D_s values equivalent to the 0.01 to 0.001 %T and 0.00001 %T values only.		

Table 4 converts the Microphotometer or recorder data (%T) to specific optical density (D_s) values for the Smoke Density Chamber. The conversion for the first six (6) decades are given in both tabular form.

1. Select the Transmittance Range row that has the %T value. For example, if value is 0.15 %T, use the 1 to 0.1 row.

2. Use the %T vertical row and horizontal column to find the D_s value. For this example, 0.15 %T (15 x 10^{-2} %T) equals 373 D_s.

CONVERSION OF % TRANSMITTANCE TO SPECIFIC OPTICAL DENSITY

PARAMETERS AND TRANSMITTANCE RANGE	%T	0	1	2	3	4	5	6	7	8	9
		SPECIFIC OPTICAL DENSITY (D_S)									
	90	6	5	5	4	4	3	2	2	1	1
	80	13	12	11	11	10	9	9	8	7	7
MULTIPLIER:	70	20	20	19	18	17	16	16	15	14	14
100 WITH ND-2	60	29	28	27	26	26	25	24	23	22	21
FILTER	50	40	39	37	36	35	34	33	32	31	30
100 TO 10 %T	40	53	51	50	48	47	46	45	43	42	41
	30	69	67	65	64	62	60	59	57	55	54
	20	92	89	87	84	82	79	77	75	73	71
	10	132	127	122	117	113	109	105	102	98	95
	$90X10^{-1}$	138	137	137	136	136	135	134	134	133	133
	80	145	144	143	143	142	141	141	140	139	139
MULTIPLIER:	70	152	152	151	150	149	148	148	147	146	146
10 WITH ND-2	60	161	160	159	158	158	157	156	155	154	153
FILTER	50	172	171	169	168	167	166	165	164	163	162
	40	185	183	182	180	179	178	177	175	174	173
10 TO 1 %T	30	201	199	197	196	194	192	191	189	187	186
	20	224	221	219	216	214	211	209	207	205	203
	10	264	259	254	249	245	241	237	234	230	227
	$90X10^{-2}$	270	269	269	268	268	267	266	266	265	265
	80	277	276	275	275	274	273	273	272	271	271
MULTIPLIER:	70	284	284	283	282	281	280	280	279	278	278
WITH ND-2	60	293	292	291	290	290	289	288	287	286	285
FILTER	50	304	303	301	300	299	298	297	296	295	294
	40	317	315	314	312	311	310	309	307	306	305
1 TO 0.1 %T	30	333	331	329	328	326	324	323	321	319	318
	20	356	353	351	348	346	343	341	339	337	335
	10	396	391	386	381	377	373	369	366	362	359

TABLE 4 Page 1 of 2

CONVERSION OF % TRANSMITTANCE TO SPECIFIC OPTICAL GRAVITY

PARAMETERS AND TRANSMITTANCE RANGE	%T	0	1	2	3	4	5	6	7	8	9
		SPECIFIC OPTICAL DENSITY (D_S)									
	$90X10^{-3}$	402	401	401	400	400	399	398	398	397	397
	80	409	408	407	407	406	405	405	404	403	403
MULTIPLIER:	70	416	416	415	414	413	412	412	411	410	410
.1 WITH ND-2	60	425	424	423	422	422	421	420	419	418	417
FILTER	50	436	435	433	432	431	430	429	428	427	426
0.1 TO 0.01 %T	40	449	447	446	444	443	442	441	439	438	437
	30	465	463	461	460	458	456	455	453	451	450
	20	488	485	483	480	478	475	473	471	469	467
	10	528	523	518	513	509	505	501	498	494	491
	$90X10^{-4}$	534	533	533	532	532	531	530	530	529	529
	80	541	540	539	539	538	537	537	536	535	535
MULTIPLIER:	70	548	548	547	546	545	544	544	543	542	542
1 WITHOUT	60	557	556	555	554	554	553	552	551	550	549
ND-2 FILTER	50	568	567	565	564	563	562	561	560	559	558
	40	581	579	578	576	575	574	573	571	570	569
0.01 TO 0.001	30	597	595	593	592	590	588	587	585	583	582
%T	20	620	617	615	612	610	607	605	603	601	599
	10	660	655	650	645	641	637	633	630	626	623
	$90X10^{-5}$	666	665	665	664	664	663	662	662	661	661
	80	673	672	671	671	670	669	669	668	667	667
MULTIPLIER:	70	680	680	679	678	677	676	676	675	674	674
.1 WITHOUT	60	689	688	687	686	686	685	684	683	682	681
ND-2 FILTER	50	700	699	697	696	695	694	693	692	691	690
	40	713	711	710	708	707	706	705	703	702	701
0.001 TO	30	729	727	725	724	722	720	719	717	715	714
0.00001 %T	20	752	749	747	744	742	739	737	735	733	731
	10	792	787	782	777	773	769	765	762	758	755
	00	-	924	885	861	845	832	821	812	805	798

TABLE 4 Page 2 of 2

SUGGESTED REPORT FORM FOR SMOKE DENSITY CHAMBER

Sample Description _____

Test No. _____ Operator _____ Date _____

Time, Min.	%T	DS	Time, Min.	%T	DS	Time, Min.	%T	DS
0.5			7.5			14.5		
1.0			8.0			15.0		
1.5			8.5			15.5		
2.0			9.0			16.0		
2.5			9.5			16.5		
3.0			10.0			17.0		
3.5			10.5			17.5		
4.0			11.0			18.0		
4.5			11.5			18.5		
5.0			12.0			19.0		
5.5			12.5			19.5		
6.0			13.0			20.0		
6.5			13.5					
7.0			14.0					

Operating Condition

Radiometer Reading _____ Mv.@ _____ W/CM^2 Date & Time _____

Furnace Temperature _____ Test Mode _____ Pyrolysis _____ w/flaming _____

Flow meter Settings Propane @ 50 cm^3/min. _____ Air at 500 cm^3/min. _____

Chamber Temperature _____ Pressure _____ in water

Chamber Surface Condition _____

Sample

Manufacturer, etc. _____

Preconditioning: Oven @ _____ °C _____ h Conditioner @ _____ °C _____ RH ___ h

Thickness _____ mm. Density _____ g/cm^3

Weight: Initial _____ g Final _____ g Wt. Loss _____ g _____ %

Test Result

Minimum Transmittance _____ %T, _____ Maximum Dm _____ Time to Dm _____ min ___

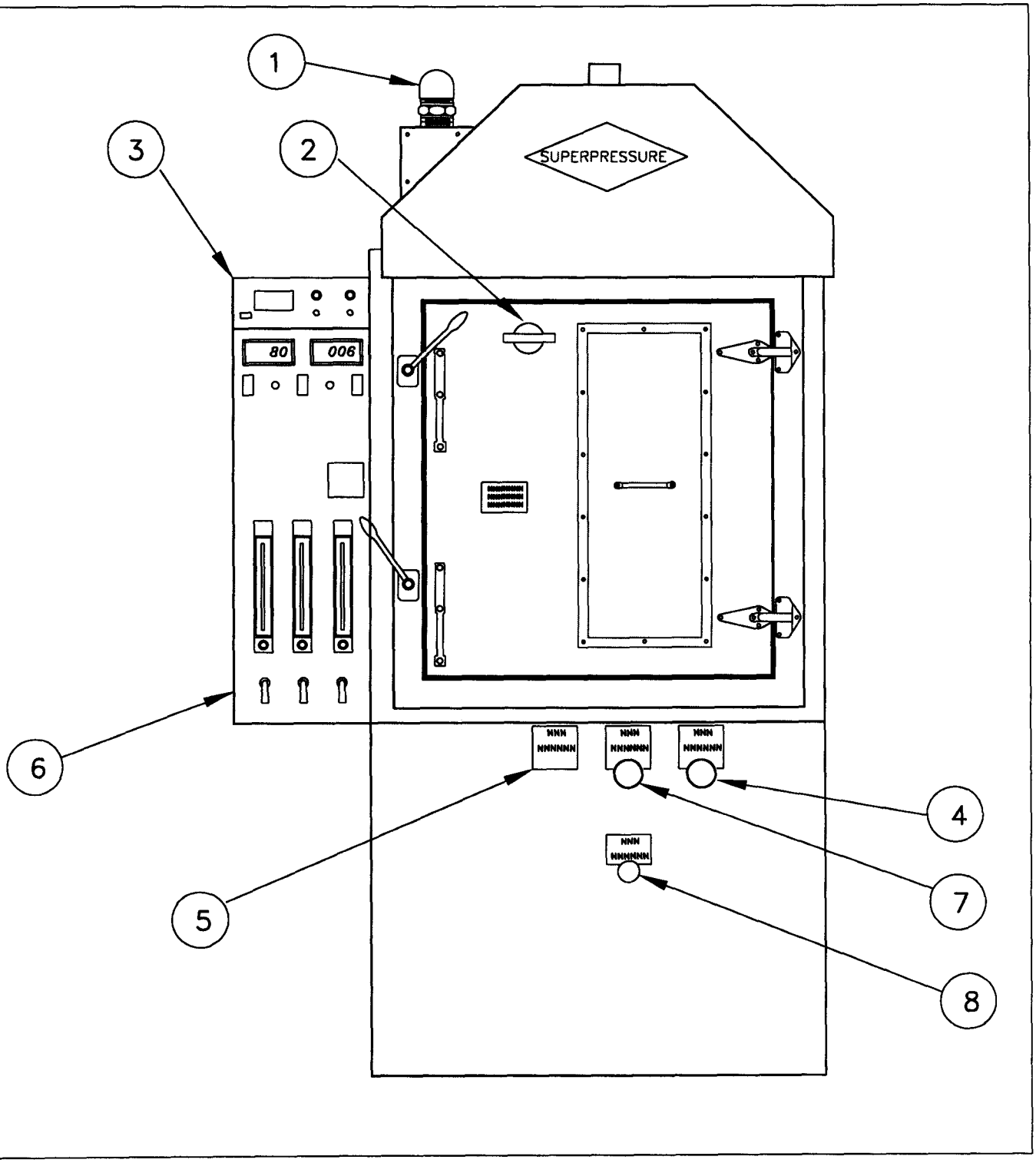
Clear Beam Reading _____ %T, Dc _____ Dm corr (Dm-Dc) _____

Optional Presentation

Max Rate of Ds min _____ Time to Reach Ds 16 _____ min.

Remarks _____

TABLE 5



1. PM FILTER–SHUTTER ASSEMBLY
2. INLET VENT CONTROL
3. PM MICROPHOTOMETER
4. SAMPLE POSITION CONTROL
5. EXHAUST VENT CONTROL
6. CONTROL PANEL
7. BURNER IGNITOR
8. BURNER CONTROL VALVE

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE THIS DRAWING

BY	NAME	DATE
PREPARED		
CHECKED		
ENGR/DSGN		
APPROVED		

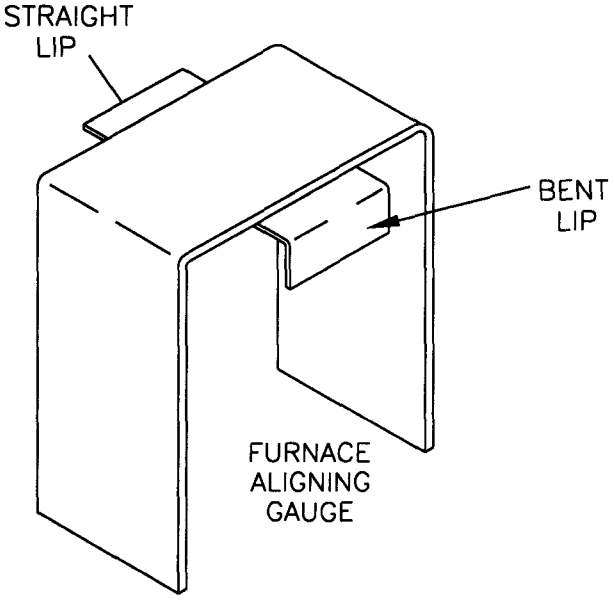
FINISH:

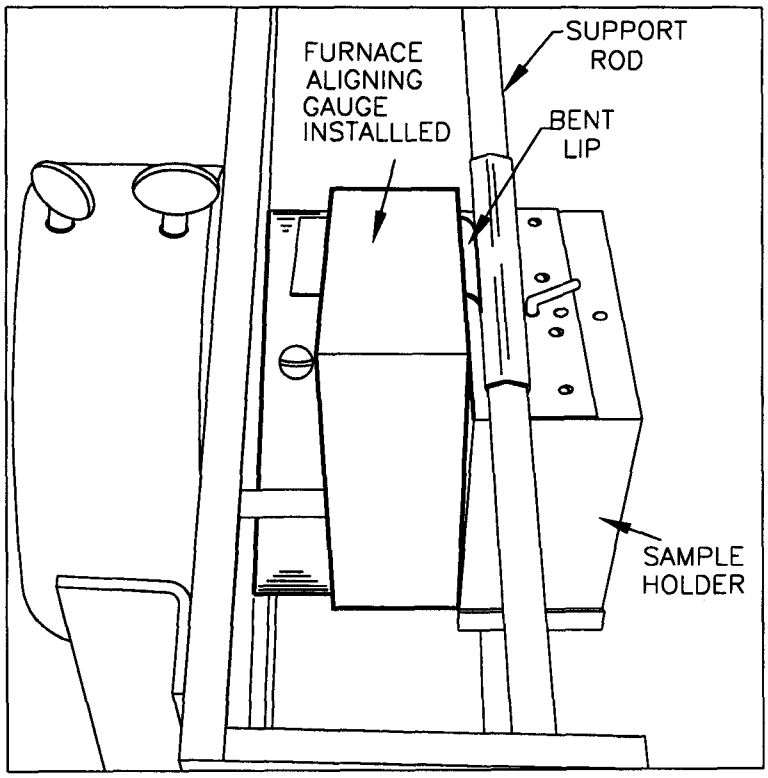
MATERIAL

SUPERPRESSURE ® NEWPORT SCIENTIFIC INC.

ITEMS SUPPLIED WITH
SMOKE DENSITY CHAMBER

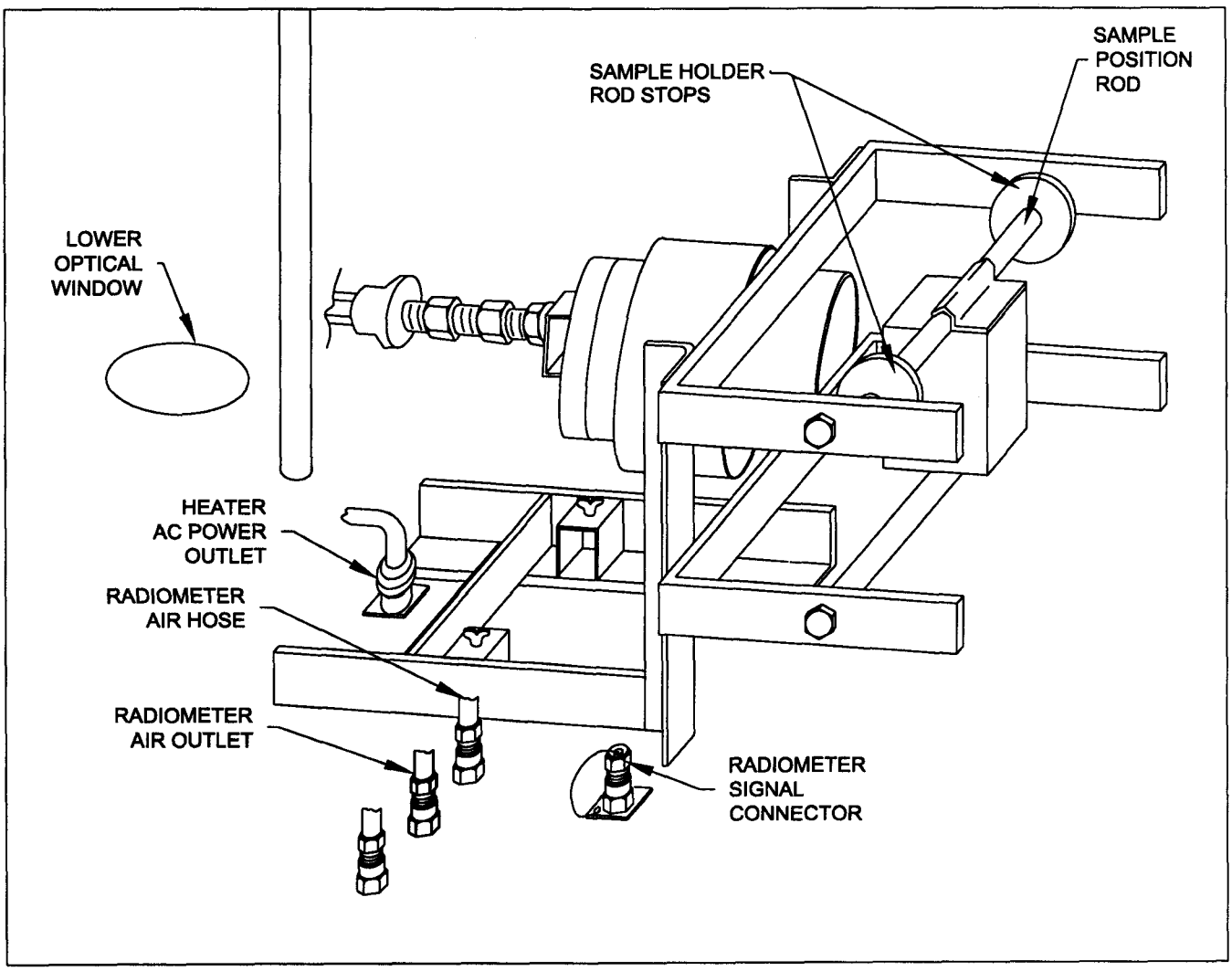
CODE IDENT. NO.	SIZE	PART NO.	DRAWING NO.
59505	B	BROCH1	BROCH1





GAUGE FOR OBTAINING CORRECT DISTANCE
BETWEEN FURNACE & SAMPLE HOLDER

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS ± DECIMALS ± ANGLES ± REMOVE ALL BURRS AND SHARP EDGES				PROPRIETARY This document is issued in strict confidence on condition that it is not copied, reprinted, or disclosed to a third party, wholly or in part, without written consent of Newport Scientific Inc.
DO NOT SCALE THIS DRAWING				SUPERPRESSURE® NEWPORT SCIENTIFIC INC.
BY	NAME	DATE	FINISH:	
PREPARED				
CHECKED				GAUGE FOR FURNACE AND SAMPLE HOLDER
ENGR/DSGN				
APPROVED				
MATERIAL			CODE IDENT. NO. 59505	SIZE
				PART NO. BROCH3
				DRAWING NO. BROCH3



INTERNAL TEST CHAMBER CONNECTIONS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS ± DECIMALS ± ANGLES ± REMOVE ALL BURRS AND SHARP EDGES				PROPRIETARY This document is issued in strict confidence on condition that it is not copied, reprinted, or disclosed to a third party, wholly or in part, without written consent of Newport Scientific Inc.
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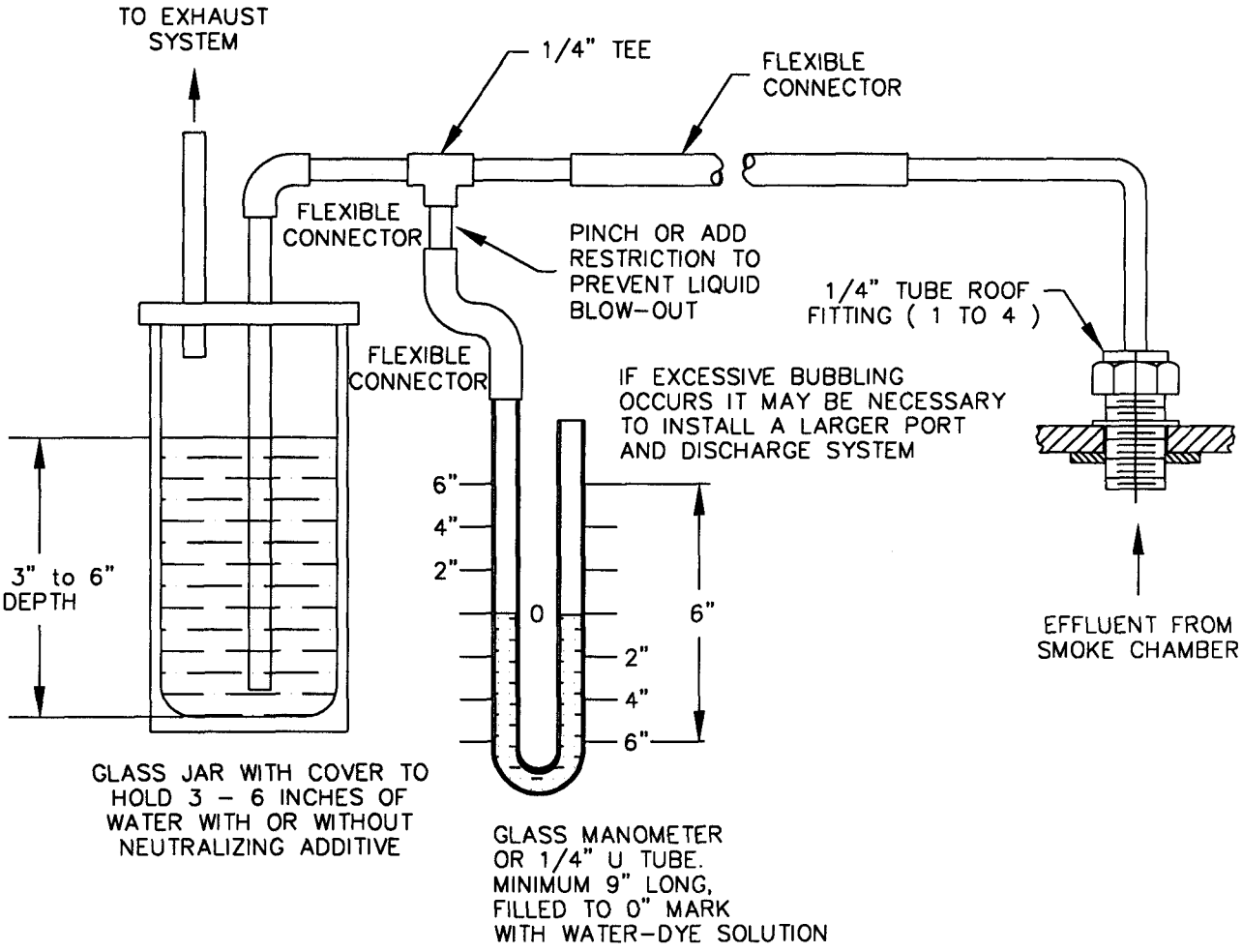
BY	NAME	DATE	FINISH:	
PREPARED				
CHECKED				INTERNAL TEST CHAMBER CONNECTIONS
ENGR/DSGN				
APPROVED				
MATERIAL			CODE IDENT. NO. 59505	SIZE B / PART NO. BROCH4 / DRAWING NO. BROCH4



UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

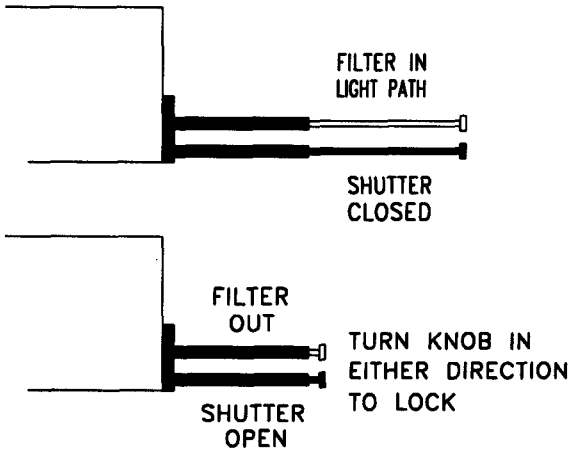
BY	NAME	DATE
PREPARED		
CHECKED		
ENGR/DSGN		
APPROVED		

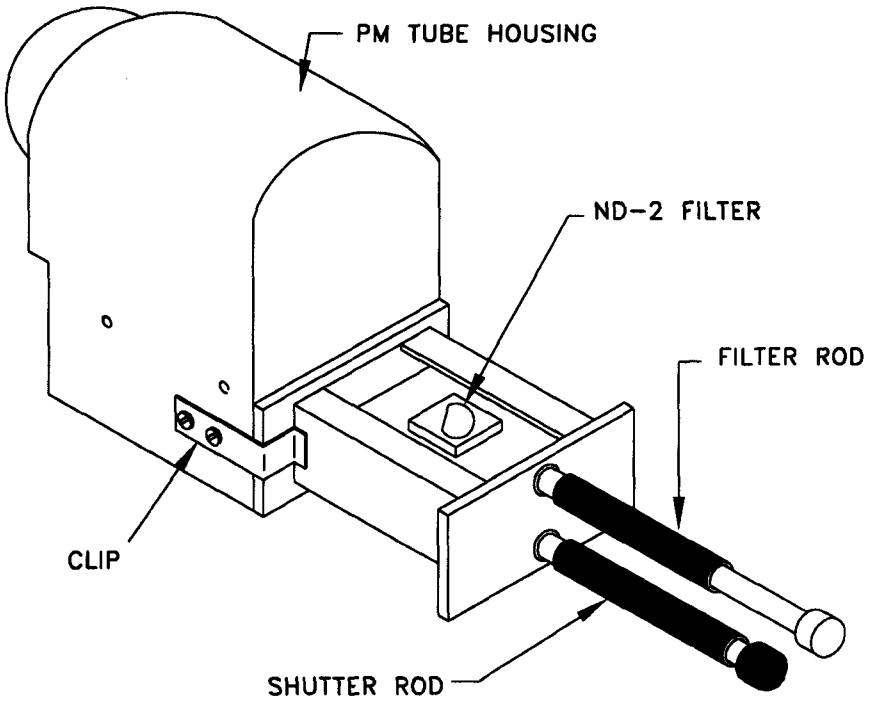
FINISH:
MATERIAL

SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

CHAMBER PRESSURE RELIEF AND MANOMETER

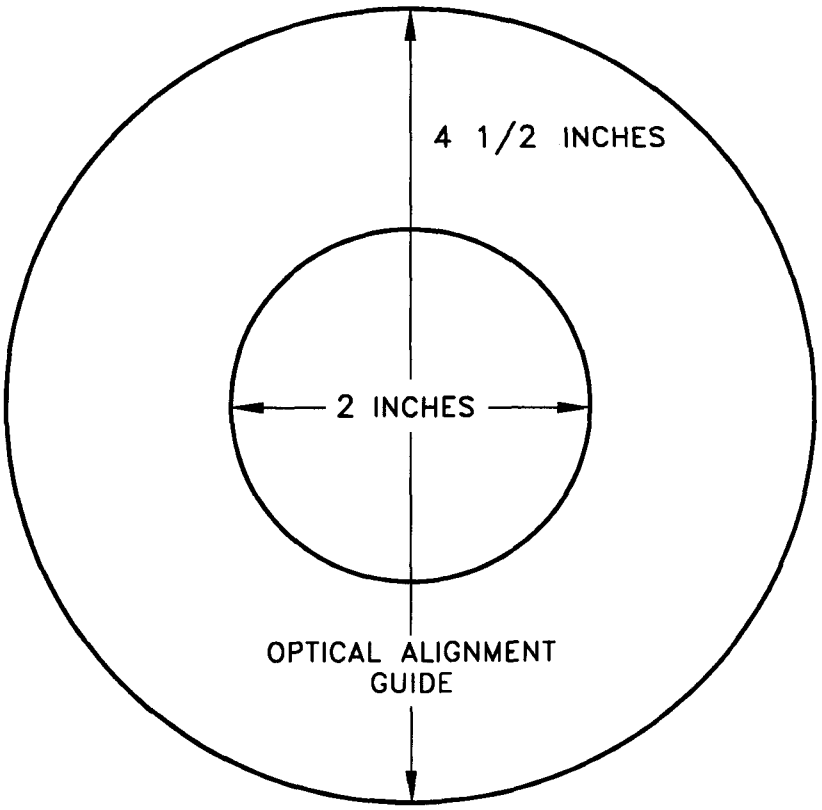
CODE IDENT. NO.	SIZE	PART NO.	DRAWING NO
59505	B	BROCH6	BROCH6



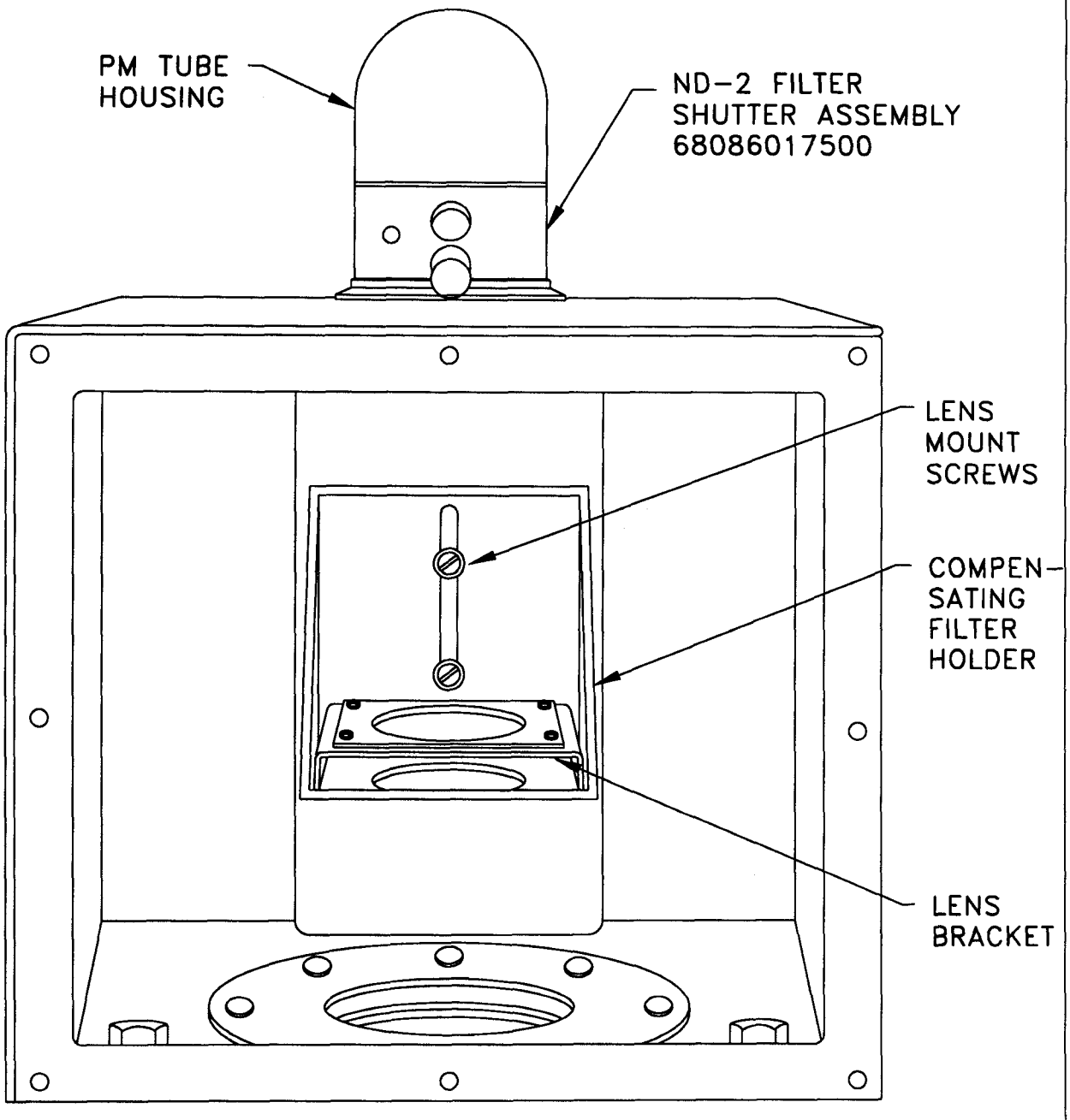


UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS ± DECIMALS ± ANGLES ± REMOVE ALL BURRS AND SHARP EDGES				PROPRIETARY This document is issued in strict confidence on condition that it is not copied, reprinted, or disclosed to a third party, wholly or in part, without written consent of Newport Scientific Inc.	
DO NOT SCALE THIS DRAWING				SUPERPRESSURE® NEWPORT SCIENTIFIC INC.	
BY	NAME	DATE	FINISH:		
PREPARED					
CHECKED				FILTER–SHUTTER ASSEMBLY	
ENGR/DSGN					
APPROVED					
MATERIAL			CODE IDENT. NO. 59505	SIZE B	PART NO. BROCH9 DRAWING NO. BROCH9

NOTE: OPTICAL ALIGNMENT GUIDE INNER CIRCLE IS 2 INCHES DIAMETER. OUTER CIRCLE IS 4 1/2 INCHES DIAMETER TO FIT OVER UPPER OPTICAL WINDOW.



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS ± DECIMALS ± ANGLES ± REMOVE ALL BURRS AND SHARP EDGES				PROPRIETARY This document is issued in strict confidence on condition that it is not copied, reprinted, or disclosed to a third party, wholly or in part, without written consent of Newport Scientific Inc.
DO NOT SCALE THIS DRAWING			FINISH:	SUPERPRESSURE® NEWPORT SCIENTIFIC INC.
BY	NAME	DATE		
PREPARED				
CHECKED				
ENGR/DSGN				OPTICAL ALIGNMENT GUIDE
APPROVED				
MATERIAL			CODE IDENT. NO. 59505	SIZE B
				PART NO. BROCH13
				DRAWING NO. BROCH13



UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

BY	NAME	DATE
PREPARED		
CHECKED		
ENGR/DSGN		
APPROVED		

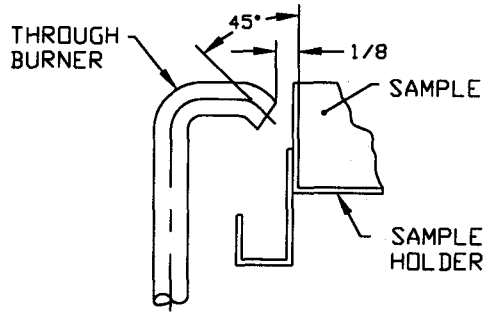
FINISH:

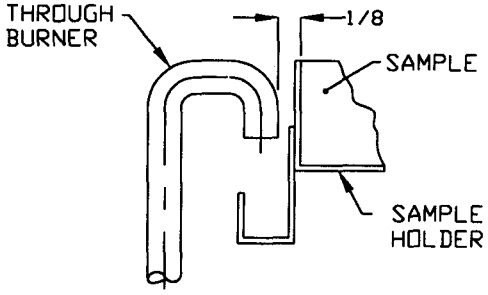
MATERIAL

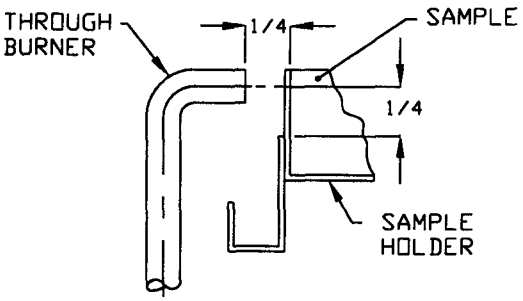
SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

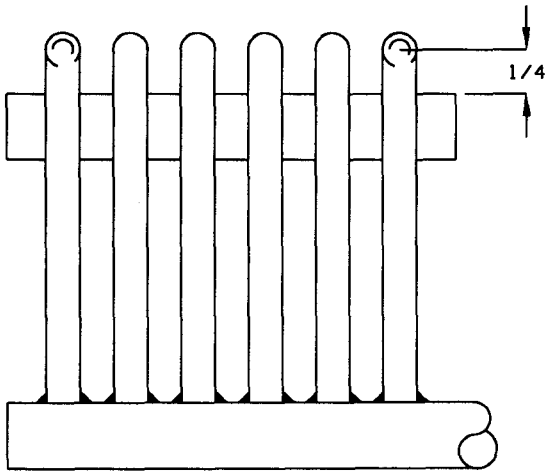
PM TUBE AND LENS HOUSING, (COVER REMOVED)

CODE IDENT. NO.	SIZE	PART NO.	DRAWING NO.
59505	B	BROCH14	BROCH14





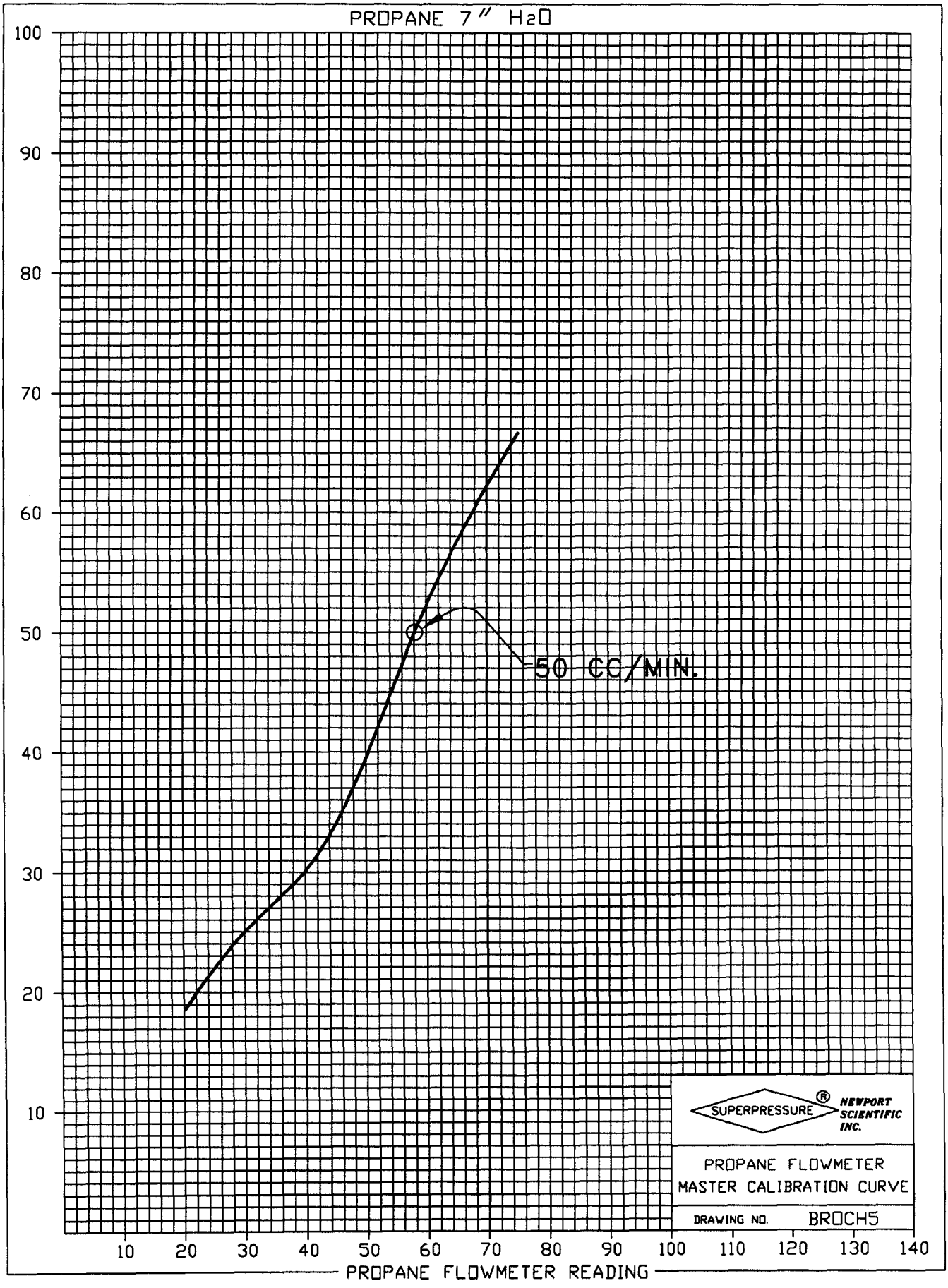


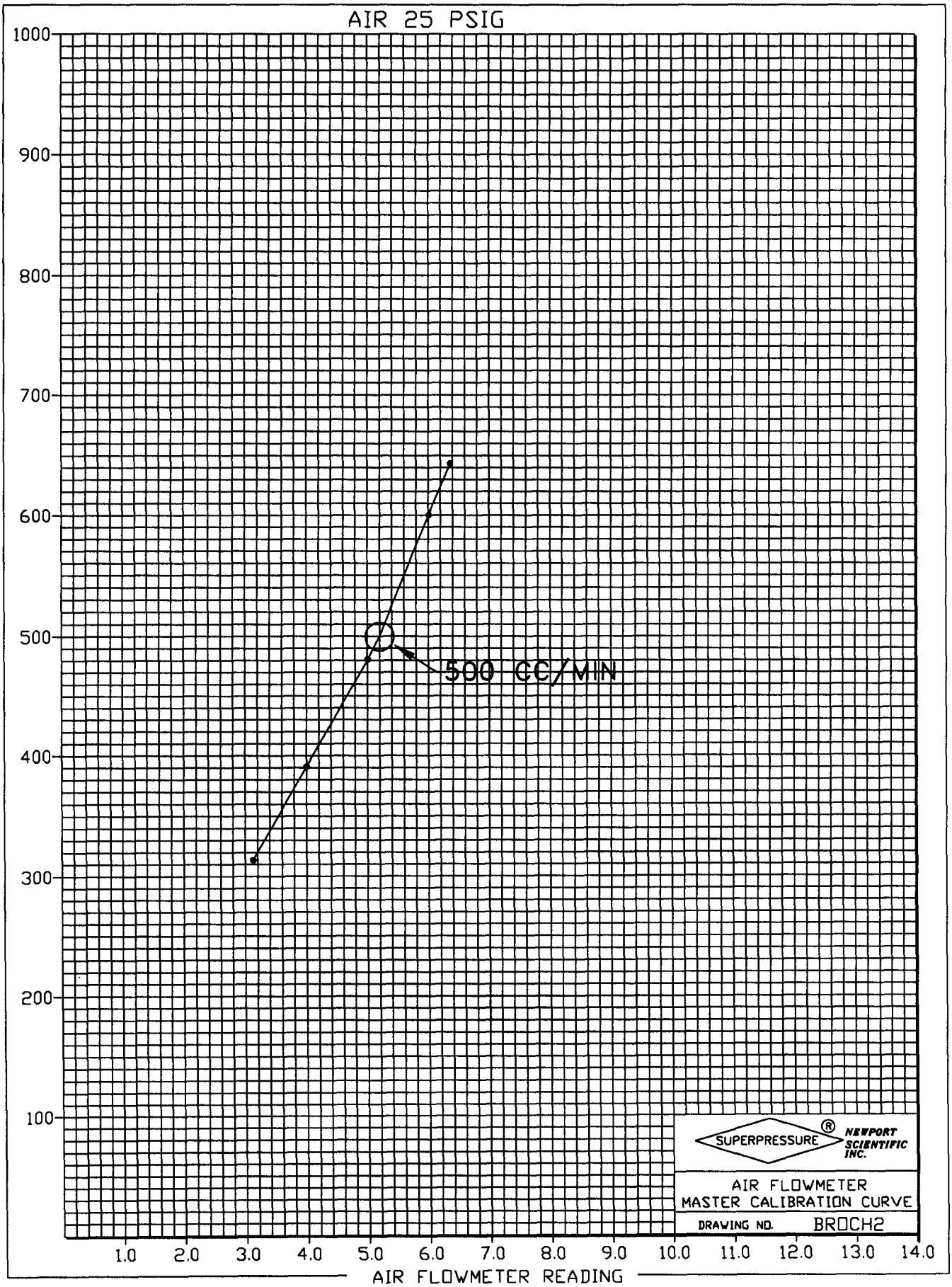


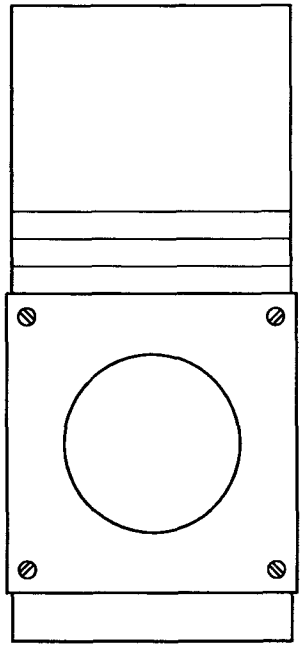
MULTI-DIRECTIONAL BURNER
68086017000

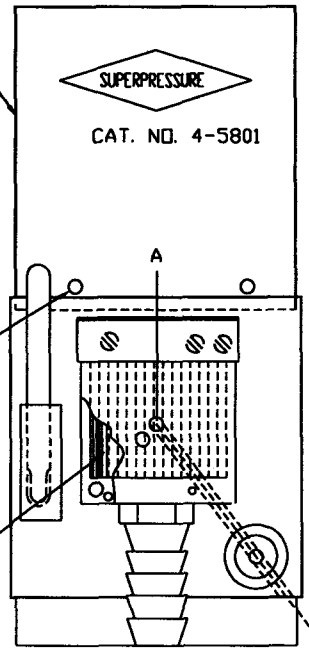
STRAIGHT BURNER
680860167000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS ± DECIMALS ± ANGLES ± REMOVE ALL BURRS AND SHARP EDGES				PROPRIETARY This document is issued in strict confidence on condition that it is not copied, reprinted, or disclosed to a third party, wholly or in part, without written consent of Newport Scientific Inc.
DO NOT SCALE THIS DRAWING				SUPERPRESSURE® NEWPORT SCIENTIFIC INC.
BY	NAME	DATE	FINISH:	
PREPARED				
CHECKED				BURNER ALIGNMENT
ENGR/DSGN				
APPROVED				
MATERIAL			CODE IDENT. NO. 59505	SIZE B
				PART NO. BRDCH18
				DRAWING NO. BRDCH18


PROPANE 7″ H2O
CC/MIN.
100
90
80
70
60
50
40
30
20
10
50 CC/MIN.
10
20
30
40
50
60
70
80
90
100
110
120
130
140
PROPANE FLOWMETER READING
SUPERPRESSURE
NEWPORT SCIENTIFIC INC.
PROPANE FLOWMETER
MASTER CALIBRATION CURVE
DRAWING NO. BROCH5


AIR 25 PSIG
1000
900
800
700
600
500
400
300
200
100
CC/MIN
500 CC/MIN
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
AIR FLOWMETER READING
SUPERPRESSURE
NEWPORT SCIENTIFIC INC.
AIR FLOWMETER
MASTER CALIBRATION CURVE
DRAWING NO. BROCH2





CONVECTION SHIELD
DWG 17-68086

#6 32 UNC 2A MACH. SCR
BD. HD. BRASS N.P. 1/4LG
10-REQ'D #Q0706011911
#6 L'WASHER PH. BR. N.P.
INTER TEETH 8 REQ'D
R 1060 54

FINNED COOLER ASS'Y
DWG 32-68086 APPLY
SILCONE HEAT SINK
COMPOUND RADIO SHACK,
CAT. #276-1372 BETWEEN
COOLER AND THERMOCOUPLE ASSY
(FOR CONDUCTION) BEFORE ASSY.

REAR

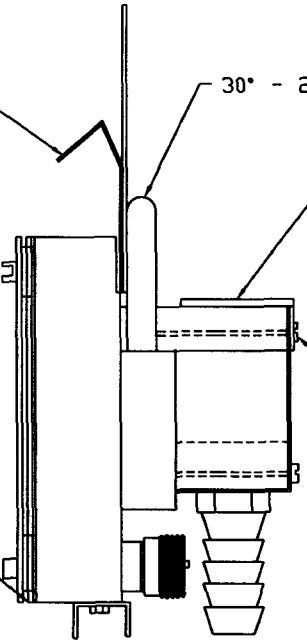
HANGER DWG 21-68086

30° - 200° THERMOMETER P1636-504 SEE NOTE 3

COOLER COVER DWG 33-68086

4-40 UNC-2A MACH. SCR.
PAN HD. ST. STL. 1 3/4 LG CUT
NO Q0821001538 TO 1 5/8 LG 4-REQ'D
#4 L'WASHER PH. BR. SPLIT TYPE
4-REQ'D P.N. R 1061 2

#6 FLAT WASHER BR. N.P.
147 X 3/8 X .032 P.N.
R 1066 177 8-REQ'D.



SIDE

#4-40 UNC 2A
MACH. SCR. RD. HD. BR. N.P.
3/8 LG 4-REQ'D P.N.
Q070 601 1515 #4
L'WASHER PH. BR. SPLIT
TYPE 4-REQ'D. P.N. R1061 2

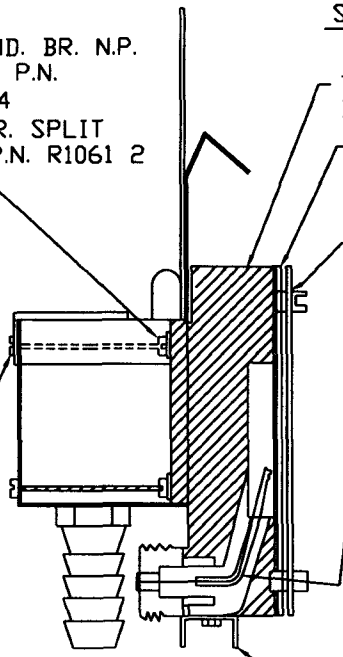
THERMOCOUPLS ASSY
DWG 34-68086

ALUMINUM SHIELD
DWG 23-68086

HEAT SHIELD
DWG 18-68086

.027 I.D. X .039 O.D. P.N. 1868-110
TEFLON TUBING OVER COPPER WIRE

COOLER COVER
TOP B47-68086



GUIDE

SECTION AOB
DWG A20-68086

NOTES:

1. ALL RADIOMETER ASSEMBLIES TO BE COMPARED WITH A RADIOMETER CALIBRATED BY THE NATIONAL BUREAU OF STANDARD.
2. PACK EACH ASSEMBLY WITH ITS CALIBRATION CURVE.
3. THERMOMETER SHIPPED LOOSE.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

BY	NAME	DATE
PREPARED		
CHECKED		
ENGR/DSGN		
APPROVED		

MATERIAL

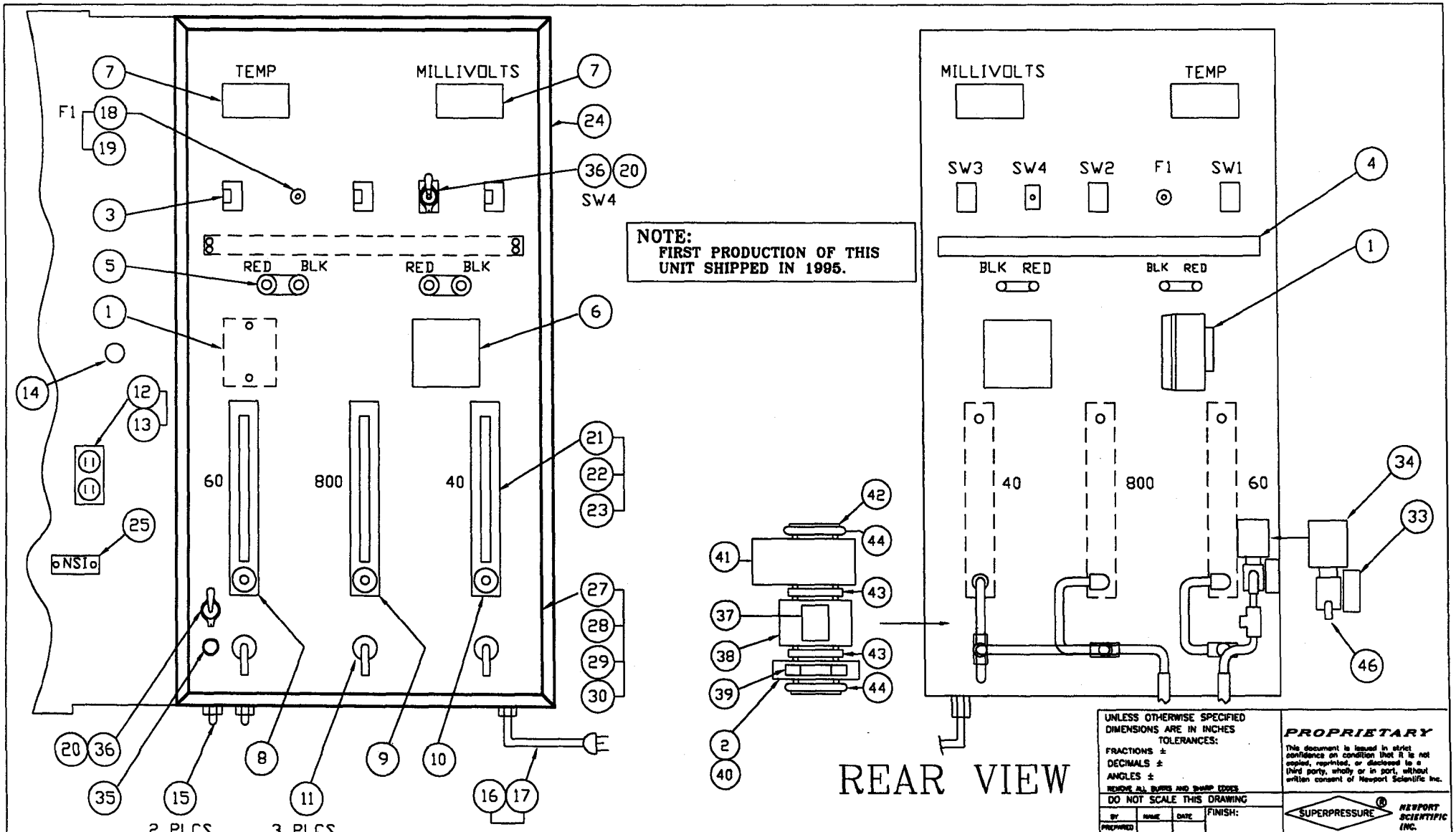
FINISH:

SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

SMOKE DENSITY CHAMBER
RADIOMETER ASSEMBLY

CODE IDENT. NO.	SIZE	PART NO.
59505	D	4-5801
		DRAWING NO. 4-5801

SCALE NONE | WEIGHT | SHEET 1 OF 1



FRONT VIEW

REAR VIEW

NOTE:
FIRST PRODUCTION OF THIS UNIT SHIPPED IN 1995.

NOTES:

1. ITEM 26 TO BE ASSEMBLED TO ITEM 3.
2. 68086020800W WIRING DIAGRAM SHOULD BE GIVEN WITH THIS ASSY.

4-5800-230V	
4-5800-115V	
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

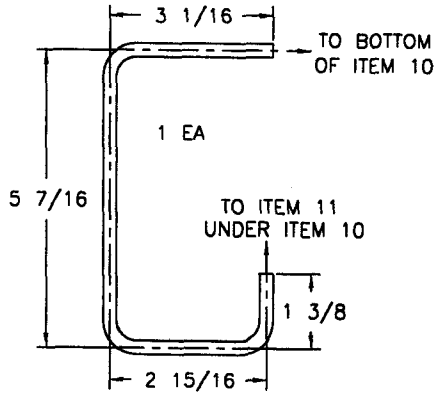
	NAME	DATE
PREPARED		
CHECKED	P.Z.	10/2
DSGN/DRGN		
APPROVED		
MATERIAL		

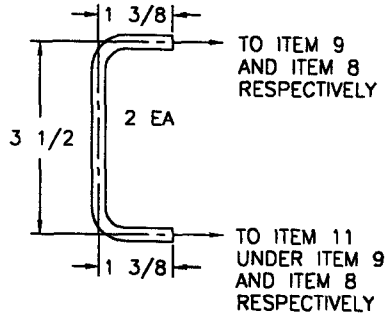
FINISH:

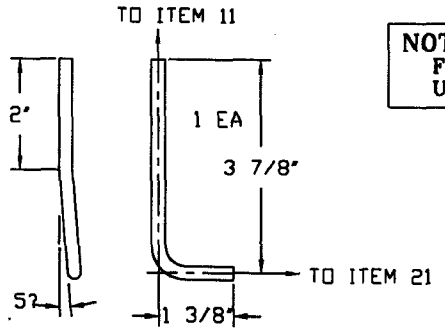
SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

TITLE: PANEL ASSEMBLY ASTM

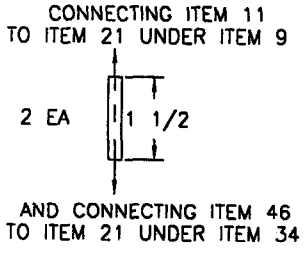
CODE IDENT. NO. 59505	SIZE D	PART NO. 68086020800	
SCALE	WEIGHT	DRAWING NO. 2081995A	
		SHEET 1 OF 3	

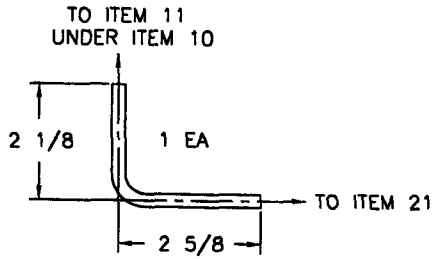


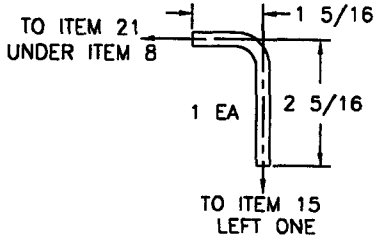


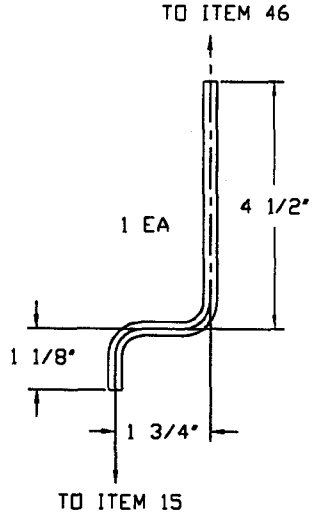


NOTE:
FIRST PRODUCTION OF THIS UNIT SHIPPED IN 1995.









NOTES:
1. ALL BENDS EQUAL 90°
2. 1/4" COPPER TUBING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

BY	NAME	DATE
PREPARED		
CHECKED	P.Z	10-C7
ENGR/DSGN		
APPROVED		
MATERIAL		

FINISH:

SUPERPRESSURE ® NEWPORT SCIENTIFIC INC.

TITLE: PANEL ASSEMBLY ASTM

CODE IDENT. NO.	SIZE	PART NO.
59505	C	68086020800
SCALE	WEIGHT	DRAWING NO. 2081995B
		SHEET 2 OF 3

ITEM NO.	QTY REQD	PART NO	DESCRIPTION
46	2	P0215025400	ELBOW CONNECTOR
45	10 ft	P0667002001	THERMOCOUPLE WIRE "K" TYPE
44	2	68086039200	RAIL MOUNT END CAP
43	2	68086039300	RAIL MOUNT SPACER
42	.5 ft	68086039400	RAIL
41	1	68086039500	SCR (DIN-A-MITE)
40	1	68086039600	FUSE HOLDER F 30A1b
39	1	68086039700	FUSE 20A
38	1	68086039800	RELAY MOUNT
37	1	68086039900	RELAY 10 AMP CONTACTOR 120/24
36	2	37-002-01	TOGGLE SWITCH
35	1	13-002-25	LIGHT
34	1	P0215090000	SOLENOID
33	1	68086037900	SPACER, SOLENOID
32	1	0800206	CABLE WRAP (NOT SHOWN)
31	4 ft	P1245000100	1/4 COPPER TUBING
30	1	68086036200	TOP PANEL
29	1	68086036400	BOTTOM PANEL
28	1	68086036300	BACK PANEL
27	1	68086036500	FRONT PANEL
26	7	P0215058400	DOUBLE MALETAB
25	1	63070005500	NSI NAME PLATE
24	7	S4847129050	ST.ST. 1/2 x 1/2 ANGLE
23	2	P0216051700	ELBOW FITTING (INSIDE BOX)
22	4	3300707	CONNECTOR (INSIDE BOX)
21	2	P0216051100	TEE (INSIDE BOX)
20	2	39-002-08	SWITCH PLATE
19	1	P0407098800	FUSE 15A
18	1	P0407095900	FUSE POST
17	1	P0403051000	POWER LINE
16	1	78024000927	LINE CLAMP
15	2	P0216051500	CONNECTOR BL HEAD
14	1	P0417023500	CAP PLUG
13	1	P0403030000	RECEPTACLE
12	1	P0407031100	RECEPTACLE COVER
11	3	P0208009000	VALVE
10	1	68086032900	FLOW METER, AIR
9	1	68086032800	FLOW METER, FLAME AIR
8	1	68086032700	FLOW METER, FLAME GAS
7	2	P1610010100	PYROMETER
6	1	68086040100	TEMP CONTROLLER 965 SERIES
5	2	03-011-21	BANANA JACK
4	1	P0405022900	TERMINAL BLOCK
3	3	P0421087000	SWITCH
2	2	68086040000	FUSE HOLDER ADAPTOR
1	1	68086019400	VOLTAGE STABILIZER ASSY
ITEM NO.	QTY REQD	PART NO	DESCRIPTION

PARTS LIST

NOTE:
FIRST PRODUCTION OF THIS UNIT SHIPPED IN 1995.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ± XX ±.XXX XXX ±.XXX
ANGLES ± X°
REMOVE ALL BURRS AND SHARP EDGES

DO NOT SCALE THIS DRAWING

	BY	NAME	DATE
PREPARED			
CHECKED			10-97
ENGR/DSGN			
APPROVED			

FINISH:

MATERIAL: NOTED

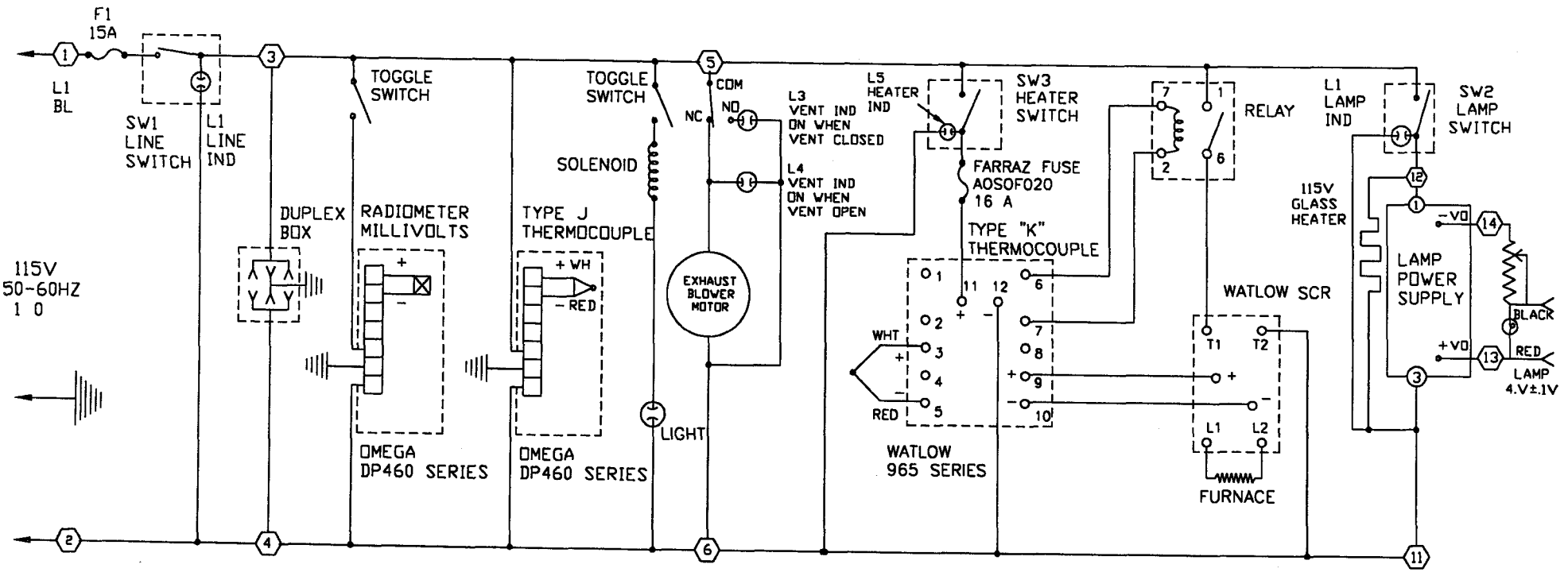
SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

TITLE: PANEL ASSEMBLY ASTM

CODE IDENT. NO.	SIZE	PART NO.
59505	B	6806020800

DRAWING NO. 2081995C

SCALE | WEIGHT | SHEET 3 OF 3



4-5800-115V	ASTM
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

BY	NAME	DATE
PREPARED		
CHECKED	D.Z	10-07
ENGR/DSGN		
APPROVED		
MATERIAL		

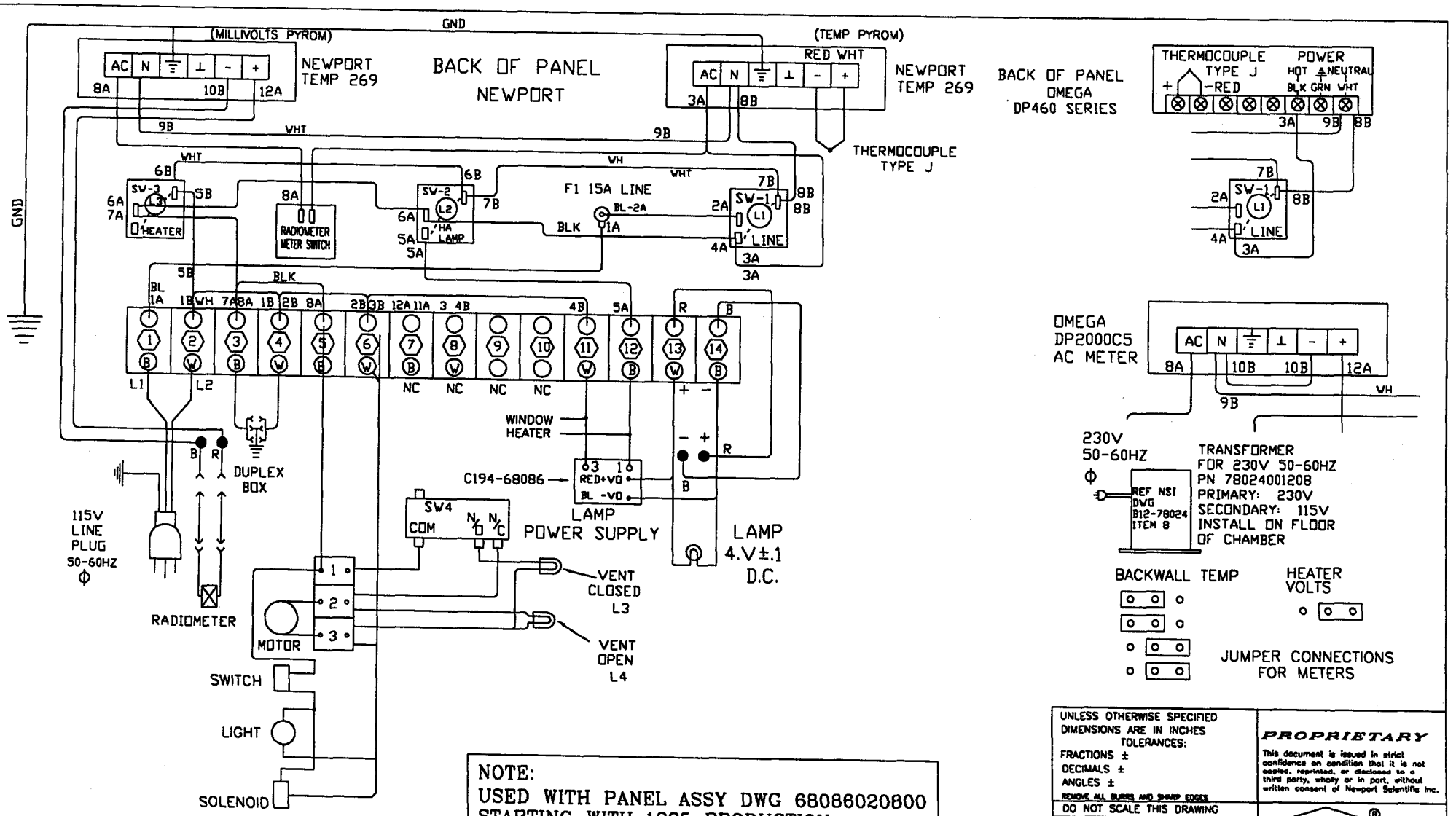
FINISH:

SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

TITLE: SMOKE DENSITY CHAMBER, ASTM
SCHEMATIC - PRODUCTION STARTING 1995

CODE IDENT. NO.	SIZE	PART NO.	DRAWING NO.
59505	—	68086020800S	6808620S

SCALE | WEIGHT | SHEET OF



NOTE:
USED WITH PANEL ASSY DWG 68086020800
STARTING WITH 1995 PRODUCTION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ±
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

	BY	NAME	DATE
PREPARED			
CHECKED	P.Z.		10-67
ENGR/DSGN			
APPROVED			

FINISH:

SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

TITLE SMOKE DENSITY CHAMBER
ASTM, PANEL WIRING DIAG.

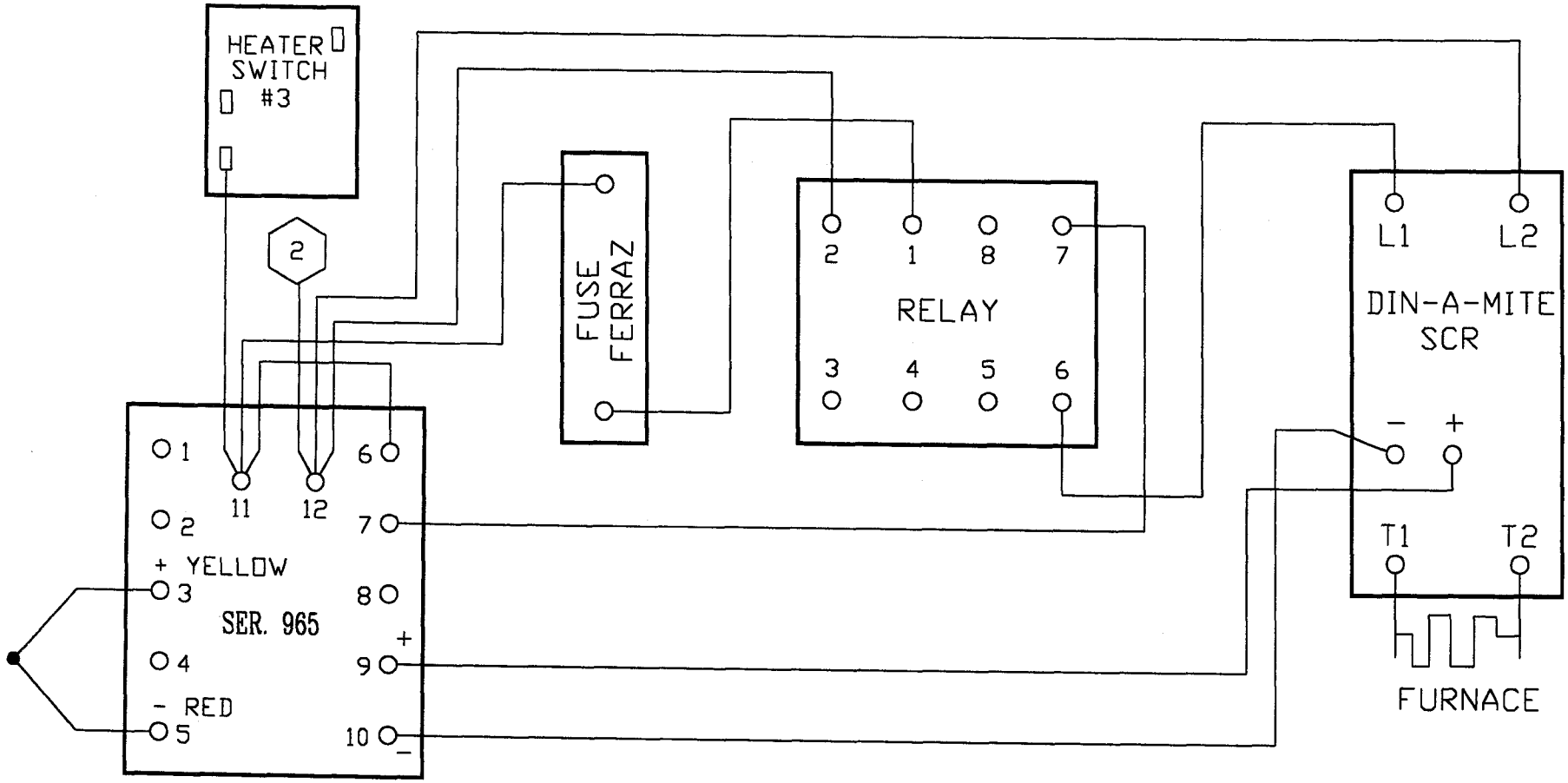
68086020800	4-5800 115V
NEXT ASSY	USED ON
APPLICATION	

MATERIAL

CODE IDENT. NO.	SIZE	PART NO.
59505	C	68086020800W

DRAWING NO. SDCWD1

SCALE | WEIGHT | SHEET 1 OF 2



TYPE "K"
THERMOCOUPLE

NOTE:
USED WITH PANEL ASSY DWG. 68086020800
STARTING WITH 1995 PRODUCTION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ± XX ±.XXX XXX ±.XXX
ANGLES ± X°
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

BY	NAME	DATE
PREPARED		
CHECKED	P.Z.	10 07
ENGR/DSGN		
APPROVED		

FINISH:

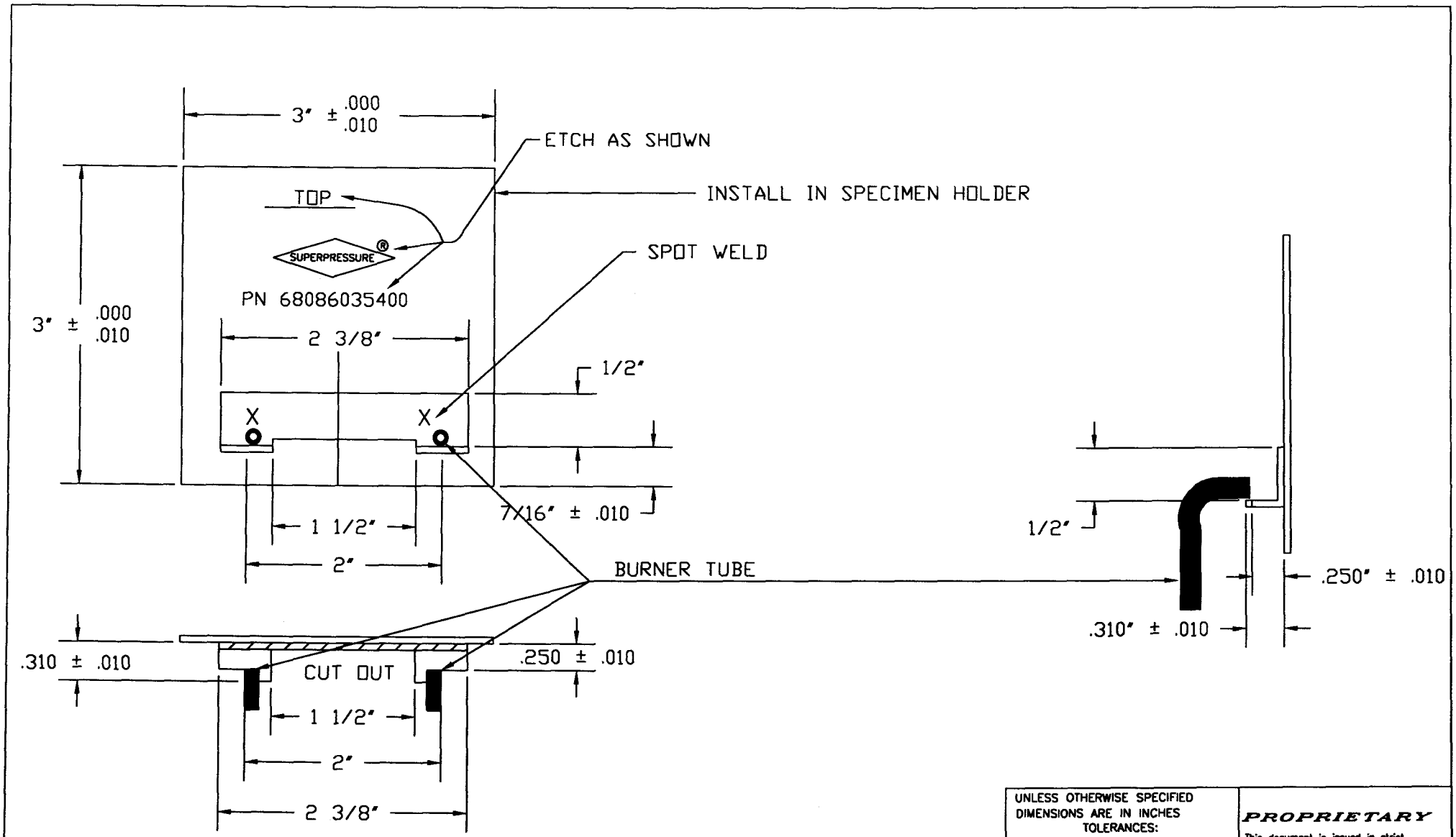
SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

SMOKE DENSITY CHAMBER
ASTM, PANEL WIRING DIAGRAM

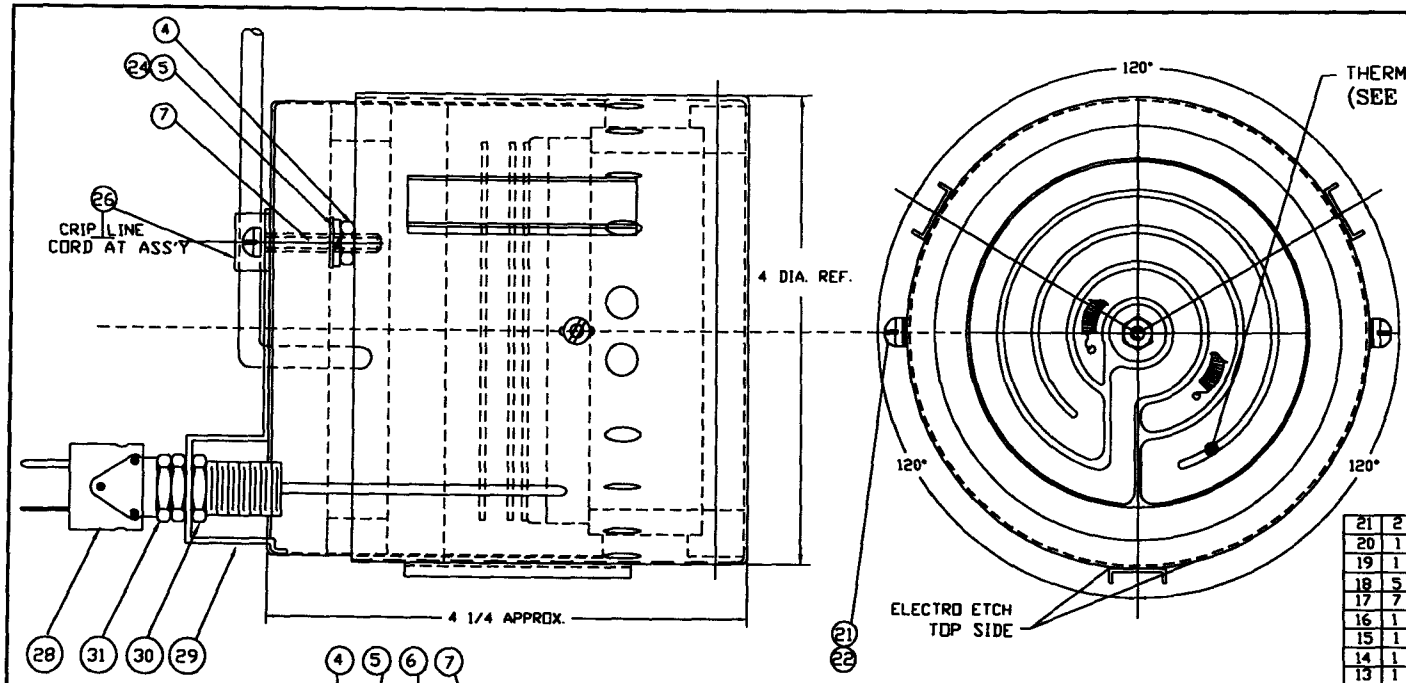
MATERIAL	CODE IDENT. NO.	SIZE	PART NO.
XXXXX	59505	B	68086020800W

DRAWING NO. SDCWD2

SCALE | WEIGHT | SHEET 2 OF 2



UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONS ± DECIMALS ± ANGLES ± REMOVE ALL BURRS AND SHARP EDGES			PROPRIETARY This document is issued in strict confidence on condition that it is not copied, reprinted, or disclosed to a third party, wholly or in part, without written consent of Newport Scientific Inc.
DO NOT SCALE THIS DRAWING			SUPERPRESSURE® NEWPORT SCIENTIFIC INC.
BY	NAME	DATE	FINISH:
PREPARED			
CHECKED			TITLE: BURNER POSITIONER
ENGR/DSGN			
APPROVED			
MATERIAL: 304 S/S 24 GA. (0.025)	CODE IDENT. NO. 59505	SIZE B	PART NO. 68086035400
			DRAWING NO. 354-68086
	SCALE 1=1	WEIGHT	SHEET 1 OF 1



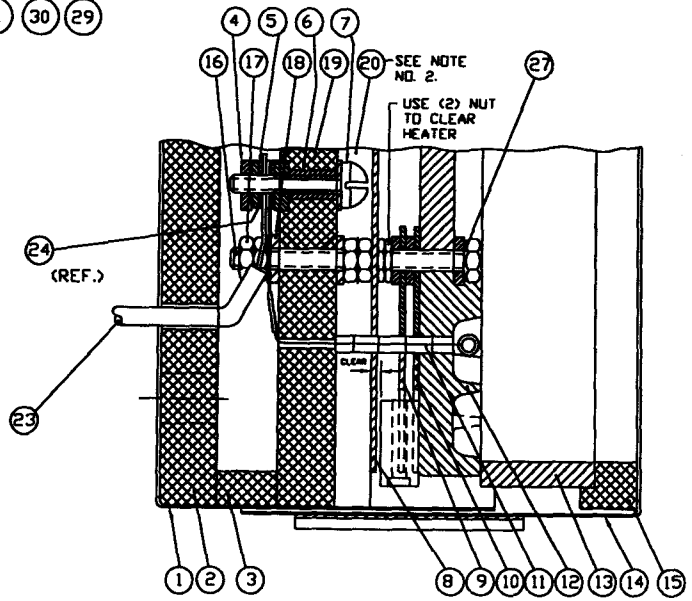
NOTE:
1 _ MOUNT FURNACE AS INDICATED BY ARROW.
2 _ FILL EMPTY SPACE BETWEEN ITEM NO. 8 AND 19. WITH FIBERFRAX INSULATION.
3 _ INSTALL AND ADJUST THERMOCOUPLE APPROX. 1/16" FROM HEATER ELEMENT BUT NOT TOUCHING ELEMENT.

ELECTRO ETCH/MARK

A. SUPERPRESSURE DIAMOND
B. CAT NO.
C. PRESSURE RATING (IF APPLICABLE)
D. LOT NO. (IF APPLICABLE)
E. D.O.M.
F. FLOW ARROW (IF APPLICABLE)

ITM	QTY	PART NO.	DESCRIPTION
21	2	02200031911	SCREW, TAPPING ROUND HEAD NO.6 X 1/4 LG ST. N.P.
20	1	A47-1824	INSULATION, FIBERFRAX, (FIT AS ASSEMBLY)
19	1	B39-68086	FURNACE HEATER SUPPORT DISC, MARINITE XL
18	5	R1065-155	WASHER, FLAT .203 I.D. X 438 O.D. X .063 ST.ST.
17	7	R1050-58	HEX. NUT NO. 10-32 ST.ST.
16	1	A6-76000	STUD. NO. 10-32 X 2 3/16 LONG ST.ST.
15	1	B37-68086	FURNACE, FRONT RING MARINITE XL
14	1	B258-68086	SHELL - OUTER HEATER ASSEMBLY
13	1	P418-516	PORCELAIN TUBE, 3" I.D. 3/16 WALL
12	1	B36-68086	FURNACE, HEATER
11	2	P404-203	BEADS - PORCELAIN
10	1	B40-68086	FURNACE HEATER INSULATING PLATE
9	1	B43-68086	FURNACE HEATER INNER REFLECTOR
8	1	B42-68086	FURNACE HEATER REFLECTOR ST.ST.
7	3	Q0701002226	BINDING HEAD SCREW NO. 8-32 X 1" LONG ST.ST.
6	2	P1636-174	RIVNUT NO. 8-32 ST.ST.
5	5	R1065-107	FLAT WASHER NO. 8 ST.ST.
4	5	R1050-056	HEX. NUT NO. 8-32 ST.ST.
3	1	B41-68086	FURNACE SPACER RING MARINITE XL
2	1	B9-76000	REAR INSULATING DISC MARINITE 36
1	1	B13-76000	SHELL INNER ASSEMBLY ST.ST.

LIST OF MATERIAL



SECTION SHOWING TERMINAL CONNECTIONS

UP

SEE NOTE NO. 1.

550 WATTS AT 115V, 5 amps

ITM	QTY	PART NO.	DESCRIPTION
31	1	68086039100	BULK HEAD FITTING (MODIFIED)
30	1	R1050021600	NUT,JAM 7/16-20 THDS 18-8SS
29	1	68086038900	THERMOCOUPLE BRACKET
28	1	390-68086	THERMOCOUPLE
27	1	R1061-35	LOCK WASHER, SPLIT NO. 10 ST.ST.
26	1	A8-76000	BRACKET, WIRE WRAP LINE CORD
25			
24	3	R1061-34	LOCK WASHER, SPLIT NO. 8 ST.ST.
23	1	B259-68086	CABLE ASSEMBLY
22	2	R1061-33	LOCKWASHER, NO. 6 ST.ST.

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONS ±
DECIMALS ±
ANGLES ± 0°-30'
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING

BY	NAME	DATE
PREPARED		
CHECKED		
ENGR/DSGN		
APPROVED		
MATERIAL		

FINISH

SUPERPRESSURE® NEWPORT SCIENTIFIC INC.

TITLE
FURNACE HEATER ASSEMBLY WITH THERMOCOUPLE

CODE IDENT. NO.	SIZE	PART NO. 68086038800
59505	D	DRAWING NO. 38868086
SCALE	WEIGHT	SHEET OF