U. S. DEPARTMENT OF COMMERCE
JESSE H. JONES, Secretary
NATIONAL BUREAU OF STANDARDS
LYMAN J. BRIGGS, Director

SOLID-FUEL-BURNING FORCED-AIR FURNACES

COMMERCIAL STANDARD CS109-44

Effective Date for New Production From March 10, 1944

A RECORDED VOLUNTARY STANDARD OF THE TRADE

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PROMULGATION

of

COMMERCIAL STANDARD CS109-44

for

SOLID-FUEL-BURNING FORCED-AIR FURNACES

Pursuant to a request dated April 20, 1942, from the Federal Housing Administration, there was developed with the aid of interested agencies and laboratories, including the National Warm Air Heating & Air Conditioning Association and the Anthracite Industries Laboratory, a proposed commercial standard for coal-burning furnaces.

A draft was circulated November 11 and 12, 1942, to leading distributors, testing laboratories, manufacturers, and users for comment. Following adjustment on February 22 and 23, 1943, in the light of that comment and after special consideration by the NWAHACA, a revised draft of the proposed commercial standard was circulated on August 16, 1943, to the entire trade for written acceptance.

Those concerned have since accepted and approved the standard as shown herein for promulgation by the United States Department of Commerce, through the National Bureau of Standards.

The standard is effective for new production from March 10, 1944.

Promulgation recommended.

I. J. Fairchild,
Chief, Division of Trade Standards.

Promulgated.

Lyman J. Briggs,
Director, National Bureau of Standards.

Promulgation approved.

Jesse H. Jones,
Secretary of Commerce.

SOLID-FUEL-BURNING FORCED-AIR FURNACES

COMMERCIAL STANDARD CS109-44

PURPOSE

1.0. This standard is provided as a basis for guaranteeing the construction and performance of solid-fuel-burning forced-air furnaces for the guidance of manufacturers, testing laboratories, distributors, installers, contractors, and purchasers.

SCOPE

1.1. This standard covers surface-fired and magazine-feed, solid-fuel-burning warm-air furnaces with forced-air circulation in sizes up to 80,000-Btu output, when using chestnut-size anthracite as a test fuel, and is composed of the following sections:

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DEFINITIONS

1.20. *Furnace.*—A warm-air furnace is a device for the transfer of heat generated by the combustion of fuel within the device to air that flows between the combustion chamber and an outer enclosing jacket to pipes or ducts that carry the heated air to the desired locations.

1.21. *Gravity furnace.*—A gravity furnace is defined as one which depends primarily upon the difference between the weight of the heated air and the return cold air to produce circulation.

1.22. *Forced-air furnace*.—Forced-air furnaces are defined as those which depend upon power-driven fans or blowers to produce circulation of the heated air.

1.30. *Standard air* is air weighing 0.075 lb/cu ft. (This weight corresponds to dry air at 70° F or air with 50-percent relative humidity at a dry-bulb temperature of 68° F when the barometric pressure is 29.92 in. mercury.) Specific heat is taken as 0.243.

1.31. *Air delivery* (cfm) is the quantity of standard air, in cubic feet per minute, discharging from the bonnet.

1.40. *Heat input* is the total gross heating value of the coal supplied to the furnace, expressed in Btu/hr.

1.50. *Bonnet output* is the heat delivered at the bonnet of the heater, expressed in Btu/hr.

1.60. *Bonnet efficiency* is the ratio of the bonnet output to the heat input expressed in percentage.

1.70. *Stack loss* is the percentage of the heat value of the fuel carried in the flue gases in the flue pipe, as arrived at by the graphic method, figure 4, and explained in appendix II. It includes the sensible heat in the dry gases, the heat of the steam in the flue gases, and the superheat of the moisture in the combustion air.

1.80. *Maximum rating* is the average bonnet output developed by the furnace during the test cycle when complying with the provisions set forth under paragraphs 4.10 to 4.20, inclusive.

1.81. *Minimum rating* of a furnace is defined as three times the output as measured in the banking test described in paragraph 5.71.

1.82. *The range of rating* of a furnace is that range of output between the maximum rating and the minimum rating. A given furnace may be used to supply any house with a design heat loss falling within that range.

GENERAL REQUIREMENTS

2.0. *Dependability*.—The furnace shall be capable of functioning satisfactorily when installed and adjusted in accordance with the manufacturer's instructions.

2.1. *Durability*.—The design and construction of the furnace shall be such as to insure its durability in service as outlined in section 3. The outer casing or jacket shall be constructed of steel or other suitable material and of such design that it is not readily damaged or dented in use.

2.2. *Efficiency*.—The furnace shall be capable of meeting the minimum efficiency requirements as outlined in paragraph 4.10.

2.3. *Operating instructions.*—Each furnace shall be accompanied by a complete set of instructions covering essential points with respect to installation, operation with the various fuels and general upkeep.

2.4. *Draft regulator.*—The furnace shall be equipped with an automatic draft regulator so located and permanently set as to limit the burning rate to the maximum rated output of the furnace. The draft regulator, if of the barometric type, shall be set by the installer according to the furnace manufacturer's instructions for the fuel used, so as to limit the burning rate to the maximum rated output of the furnace.

2.5. *Fan switch.*—An adjustable, bonnet-installed, fan switch having an approximate range of 70° to 200° F shall be supplied with each furnace.

2.6. *Filters.*—If filters are supplied, they should be 1 in. or more in thickness and of one of the following sizes: 16 by 20, 20 by 20, 16 by 25, or 20 by 25 in.

CONSTRUCTION REQUIREMENTS

3.0. *Combustion chamber.*—If of steel, the combustion chamber shall be constructed of not lighter than No. 10 gage.

3.1. *Flue collar* shall be constructed of cast iron, or of sheet steel of suitable thickness, but not less than No. 16 gage, and shall be rigidly attached at the flue outlet of the furnace. It shall afford convenient suitable means for attaching the flue pipe securely to the furnace.

3.2. *Radiators* or economizers when used shall be constructed of not lighter than No. 16 gage steel or other suitable material, and the construction shall be such as to insure strength, rigidity, and durability. All horizontal surfaces in radiators shall have access for cleaning without removing casing panels.

3.3. *Doors.*—Joints between all doors and access opening covers and their frames shall be fitted so that a piece of paper of the width and thickness of United States paper currency, placed at any point around the perimeter of the opening, cannot be withdrawn when the door is closed. The fire door of surface-fired furnaces shall be protected from direct radiation by means of a suitable liner.

3.31. *Handles.*—All handles for firing doors and dampers shall be so designed as to minimize the danger of burns from personal contact.

3.4. *Grates.*—Grates shall be of such materials and construction as to provide a reasonable life under normal operating conditions and shall be of the shaking type and may be of the shaking and dumping type.

3.5. *Finish.*—Outside surfaces of furnace casings, grilles, and accessories shall be adequately protected against rust or corrosion and against damage during manufacture, shipment, and reasonable conditions of storage.

3.6. *Sheet-steel gages*.—All sheet-steel gages specified in this standard shall be interpreted as follows:

Manufacturers' standard practice gage numbers	Thickness (inch) plus or minus mill tolerance
10	0.1345
12	.1046
14	.0747
16	.0598

3.7. *Electrical equipment*.—All electrical parts supplied by the furnace manufacturer, including electric controls and electric motors, shall meet such safety requirements of the Underwriters' Laboratories, Inc. as are applicable to such equipment.

3.71. *Motor*.—The motor shall conform to NEMA specifications for general purpose motors, and its name-plate rating shall equal or exceed the load occurring when the fan is operated in place in the furnace with all the duct work and air filters removed. General purpose motors with a service factor as defined by NEMA standards shall be considered as meeting the above requirements when provided with suitable integral overtemperature protection.

3.8. *Air filters* when used must be so located that no point on the filter will reach a temperature in excess of 90° F above room temperature when the furnace is being operated at maximum output with the forced-air equipment either operating or not operating. Average velocity through filters shall not exceed 300 fpm on nominal external dimensions of the filter, during maximum rating test.

PERFORMANCE REQUIREMENTS UNDER TEST

4.00. *A stock model* of the furnace as offered for general sale shall, when tested as described under section 5, meet the following performance requirements:

4.10. *Efficiency*.—The average bonnet efficiency from three consecutive test cycles shall be at least 55 percent for forced-air circulation furnaces.

4.11. *Stack temperature*.—The flue-gas temperature, measured as hereinafter specified, shall not exceed 830° F above laboratory temperature.

4.12. *Draft*.—The draft used, measured as hereinafter specified, shall not exceed 0.06 in. water gage.

4.13. *Attention period*.—The period between attentions shall be at least 8 hours for surface-fired and 12 hours for magazine-feed furnaces. Attention shall be considered firing, poking, or shaking grates. Adjustment of dampers at any time is permissible attention.

4.14. *Heat-exchanger-surface temperature.*—The temperature of the metal serving as heat-exchanger surface shall not exceed that of the inlet air temperature by more than 930° F as measured by the thermocouples. The average for the entire test as indicated by thermocouple readings taken at the selected spots on the heat-exchanger surface shall not exceed 830° F above inlet air temperature.

4.15. *Surface temperature.*—The surface temperature of the jacket when operating at maximum rating shall not exceed 230° F above laboratory temperature except at points above the firing door or within 6 in. of the sides of the door frame or within 6 in. of the flue pipe.

4.16. *Bonnet pressure.*—The pressure of delivered air in the bonnet shall be maintained at 0.20 in. water gage.

4.17. *Air-temperature rise.*—With a bonnet pressure of 0.20 in. water gage, the blower shall deliver a flow of such volume that the average air-temperature rise shall not exceed 100° F or be less than 70° F.

4.18. *Laboratory temperature.*—The laboratory temperature shall be taken as that of the inlet air. (T_2, fig. 1)

4.19. *Fan operation.*—The fan shall be operated continuously during all tests, except as otherwise specified.

4.20. *Air filters.*—Air filters shall not be in place, except during air-filter temperature tests.

4.30. *Banking.*—With the furnace regulated in accordance with manufacturer's instructions for banking, and with the coaling doors closed, the furnace shall maintain a fire which will produce not more than 25 percent of the maximum output rating on the basis of fuel consumption, for a minimum of 12 hr for surface-fired furnaces and 24 hr for magazine-feed furnaces.

4.40. *Gassing.*—With the coaling doors closed and the furnace otherwise in accordance with the manufacturer's instructions, there shall be no noticeable gassing from the furnace at any time during the firing and banking cycle.

TEST CODE

5.0. The Btu input, output, efficiency, and cfm air delivery shall be determined in accordance with the following method, or its equivalent as approved by the standing committee. A list of data to be recorded and methods of calculation are shown in paragraphs 6.0 and 6.1.

5.10. *Furnace and filter.*—The furnace shall be erected in accordance with the manufacturer's instructions, omitting air filters, if any. Humidifiers, if provided, shall be in place but left dry. The furnace shall be provided with inlet and outlet ducts, as shown in figure 1. Connections shall be provided for measuring the static pressure at the points at which the outlet duct is connected to the furnace. The instruments for testing draft and static pressure, measuring stack temperature and temperatures of inlet and outlet air, and for sampling flue gas shall be installed as shown in figures 1, 1A, 1B, 5, 6, and 7.

5.11. *Source of draft.*—Means shall be provided capable of producing a draft of 0.06 in. of water at the smoke outlet with the furnace operating at its rated capacity.

5.20. *Thermocouples.*—Thermocouples of not larger than No. 20 AWG wire with a maximum diameter of twisted junction of 0.07 in., as shown in figure 7, shall be used for measurement of the flue-gas and heat-exchanger-surface temperatures. For measurement of heat-exchanger-surface temperature, arrange the temperature-sensitive end of the thermocouple, so that the junction and at least 1 in. of the wires back from the junction are in contact with the hot surface of the heater and secure them with the minimum amount of furnace cement required for mechanical support. The furnace cement adheres to the metal better if applied when the furnace is cold. It may be hardened quickly at the time of application by a gas flame or blow torch.

5.201. *Thermocouple grid.*—The thermocouple grid for measuring outlet air temperature is constructed as shown in figure 1B and located as indicated in figure 1. The arrangement shown provides one thermocouple junction for each one-twelfth of the air flow meter throat area, and makes available a mean temperature value correctly weighted as to area and volume, provided the velocity is uniform at all points in the throat section.

5.202. *Thermocouple wire.*—The materials for thermocouple wires shown on figures 1B and 7 were selected as being generally the most suitable for the purpose. Laboratories using thermocouples of junction materials other than those shown in figures 1B and 7 shall submit, with each test report, a statement that the thermocouples used have been calibrated through the range of temperatures involved.

5.21. *Damper or draft regulator.*—If the furnace is equipped with dampers in such position as to interfere with the flue-gas sampling or temperature-measuring arrangement described above, such dampers shall be either removed or sealed during the tests. See also paragraph 2.4 and figure 5.

5.22. *Weighing scales.*—Scales reading to 0.5 lb shall be provided for weighing fuel.

5.23. *Draft gages.*—Measurements of the chimney draft shall be made with gages graduated in divisions representing 0.01 in. of water. Gages shall be checked for zero readings at the beginning and the end of each test. A draft gage with an accuracy of plus or minus 0.005 in. of water column shall be used.

5.24. *Pressure gage.*—An inclined draft gage shall be provided and arranged as shown in figure 1 to determine the pressure loss in the connected duct system external to the casing. The static-pressure connections shall consist of a 1/4-in.-diameter nipple soldered to the surface of the duct and centered over a hole one-sixteenth of an inch in diameter drilled through the sheet-metal duct. The inner surface of the duct adjacent to the hole shall be free from burrs and irregularities.

5.25. *Air-flow meter.*—Arrangements shall be made for measuring the air flow through the unit under test as shown in figure 1. A general calibration curve for the 9-in. measuring section is shown in figures 2A and 2B, for the case in which the Pitot tube is located in the center position. The gage used in connection with the Pitot tube shall have an accuracy of ±0.002 in. of water column.

5.26. *Bonnet output.*—The bonnet output shall be computed from the quantity of air delivered, as determined in 5.25, and its observed temperature rise. (See figs. 2, 2A, 2B, and 3; also Report of Data and Method of Calculation, par. 6.0 and 6.1.)

5.27. *Fan measurements.*—A wattmeter shall be placed in the electric circuit of the fan motor to measure the power consumption. A determination shall be made of the speed of the fan under test conditions.

5.28. *Temperature measurement.*—Accurately calibrated instruments shall be provided for all temperature measurements. A mercury thermometer may be used at the air inlet, but a thermocouple is preferable. The instruments shall be shielded against radiation from the firepot and radiator (if installed) of the furnace.

5.29. *Flue-gas analysis.*—The flue-gas sample for analysis shall be taken as indicated in figures 5 and 6 and measured by an Orsat or equivalent gas analyzer equipped for determination of CO_2, O_2, and CO.

5.30. *Fuel for test.*—The fuel used for these tests shall be anthracite with the following characteristics: Volatile matter 4 to 6 percent; ash content not to exceed 12 percent; heating value (dry basis) 13,000 Btu/lb or above; size, chestnut, according to Standard Anthracite Sizing Specifications adopted by the Anthracite Committee of the Production Control Plan for the Anthracite Industry, Harrisburg, Pa., effective December 15, 1941. (See p. 12, 7th edition, Mac's Directory and Handbook of Anthracite, published by National Coal Publications. Mimeographed copies of the sizing specifications may be obtained on request from the Anthracite Committee, State Street Building, Harrisburg, Pa.)

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5.31. *Fuel sampling.*— A gross sample of fuel shall be collected, crushed, mixed, and divided until reduced to a laboratory sample. This sample shall then be placed in a sealed container for transportation to the laboratory. The sampling procedure shall be strictly in accordance with Tentative Method of Sampling Coals Classed According to Ash Content, American Society for Testing Materials Designation D 492-40 T, or later revision. (Adherence to ASTM procedure is necessary to obtain a sample which accurately represents the coal.)

5.32. *Lot sampling.*—When a number of tests are to be conducted with the same lot of fuel, it shall be permissible to sample the entire lot for proximate analysis and calorific value as specified in ASTM Designation D 492-40 T, or later revision. When this method is used, samples shall be collected on arrival and the coal stored in a dry place until used.

5.40. *Observation test.*—In order to determine the proper location of thermocouples used to register maximum temperature of heat-exchanger surface, a separate observation test shall be made as follows: (a) The furnace shall be examined to determine whether all parts of the heat-exchanger surface will be visible through air intake or other openings while the furnace is under test. If such is not the case, suitable provision shall be made for observing directly all portions of the heat-exchanger surface or for sampling temperatures upon it by means of a thermocouple. Observations may be made or temperatures sampled through small holes drilled in the furnace jacket. These holes shall be tightly closed with wooden plugs or by other suitable means except when used, one at a time, for observation or temperature measurement. Plugs should not protrude into the warm-air spaces more than one-quarter of an inch. (b) Fire shall be kindled and test fuel fired with amount sufficient to fill the firepot to the level of the firing door, or according to the manufacturer's instructions for both surface-fired and magazine-feed units. (c) With warm-air circulating fan operating at specified bonnet pressure, the draft shall be so adjusted, by means other than the automatic draft regulator and not to exceed 0.06 in. water gage, as to raise the flue-gas temperature 830° F above laboratory temperature, if attainable. If this temperature is not attainable, test shall be run with a stack draft of 0.06 in. water gage, except that in no case shall the test be run with a value of draft such as to cause severe overheating of any part of the heat-exchanger surface. Observations and notations shall be made of location and sequence of appearance of visibly glowing areas of heat-exchanger surfaces. If no glowing spots are observed, areas of maximum temperature shall be located with a contact thermocouple. (d) At the end of 4 hr, grates shall be dumped and all ash and unburned fuel removed, the furnace allowed to cool, and thermocouples attached to the heat-exchanger surface in three separate places, as indicated by the test, preference being given to points first attaining high temperatures.

5.41. *Preliminary cycle.*—(a) A preliminary cycle, with a full charge of fuel as described below, shall be run to determine whether the temperature of the heat-exchanger surface (par. 4.14), of the jacket surface (par. 4.15), or of the stack is the limiting temperature. Fire shall be kindled with a weighed quantity of wood or charcoal on which shall be fired a weighed amount of test fuel filling the fire pot to the level of the firing door, or according to the manufacturer's instructions for both surface-fired units and magazine-feed units. No further attention shall be given the fuel bed. (b) The draft shall be so adjusted by means other than the automatic draft regulator and not to exceed 0.06 in. water gage, as to raise the flue-gas temperature as quickly as possible to 830° F above laboratory temperature, if attainable, or to the maximum temperature permitting compliance with paragraphs 4.14 and 4.15, whichever is the lower, and shall then be so adjusted as to maintain this flue-gas temperature. (c) If, with 0.06-in. draft, the flue-gas temperature fails to reach 830° F above laboratory temperature, or such temperature as would permit compliance with the limitations specified in paragraphs 4.14 and 4.15, the test shall be run at the highest flue-gas temperature attainable with 0.06-in. draft. (d) If the preliminary cycle reveals that the automatic draft regulator is not set as to limit the burning rate to the maximum rated output, it shall be so readjusted, set, and left without change for the remaining test cycles.

5.42. *Flue-gas test temperature.*—The maximum flue-gas temperature arrived at under the conditions specified for the preliminary cycle, paragraph 5.41, (b) or (c), shall be the maximum temperature used to control the three subsequent test cycles and shall be called the *flue-gas test temperature.*

5.43. *End of cycle.*—The preliminary cycle shall be considered to have ended when the difference between the flue-gas temperature and the laboratory temperature drops to 75 percent of the difference between the flue-gas test temperature and the laboratory temperature, or in the case of magazine-feed furnaces, at any time after a 12-hr attention period, according to the instructions of the manufacturer, provided that the first temperature difference mentioned above has not dropped below 75 percent of the second temperature difference. For a surface-fired furnace, if the preliminary cycle test shows that the fuel bed at the cycle end point, determined by the temperature difference method described above, will not kindle the new charge, the cycle shall be considered to have ended at any time after the 8-hr attention interval, according to the instructions of the manufacturer.

5.44. If there is no glow in the ash pit, the grates shall be shaken until a glow appears in the ash pit and the ashes removed. The furnace shall then be filled with a weighed amount of test fuel to the level of the firing door, or according to the manufacturer's instructions.

5.50. *Test cycles.*

5.51. Three consecutive test cycles shall then be run with the automatic draft-regulator setting and within the limit of the flue-gas test temperature obtained from the preliminary cycle, paragraphs 5.41 and 5.42.

5.52. The end of each cycle shall be determined as described in paragraph 5.43. The grates shall then be shaken until a glow appears in the ashpit and the ashes removed. The furnace shall then be filled with a weighed amount of test fuel to the level of the firing door, or according to the manufacturer's instructions.

5.53. If the conditions specified in paragraphs 4.11 to 4.15, inclusive, have been met, no further tests except banking and pickup (par. 4.30, 5.71, and 5.72) and temperature of air filter (par. 3.8 and 5.80) will be required. If the specified conditions have not been met, the test cycles shall be repeated at one or more lower stack temperatures until the requirements have been met. Results may then be interpolated as illustrated in appendix I.

5.60. *Frequency of observations.*

5.61. Observations of stack drafts and temperatures and of the temperature and velocity of the heated air shall be made at regular intervals of 20 min during test cycles other than the banking test. Test recordings shall start 10 min after firing is completed.

5.62. Instantaneous samples of flue gas shall be taken at intervals not to exceed 20 min or, as an alternate, the flue gas may be continuously sampled and collected in bottles for analysis.

5.70. *Banking test.*

5.71. The banking test shall immediately follow a test cycle. The primary air damper shall be closed and the draft reduced to a minimum consistent with the maintenance of combustion by the means provided with the furnace by the manufacturer. The fan shall be operated by the automatic fan switch, set according to the manufacturer's recommendations. Under those conditions the furnace shall operate as described in paragraph 4.30. During the banking test, only weight of fuel charged, and time of start and finish, need be recorded.

5.72. At the end of the banking period, the grates shall be shaken until a glow appears in the ashpit, a weighed fresh charge of fuel shall be added to the level of the bottom of the firing door or according to the manufacturer's instructions. The primary air damper shall be opened and the draft increased to 0.06 in. water gage, or to the value arrived at during the preliminary cycle, paragraph 5.41 (b) and (c). The stack temperature shall rise to 830° F above laboratory temperature or to the flue-gas test temperature in not more than 1 hour.

5.80. *Air-filter temperature test.*— Where provision is made in the furnace for the use of an air filter, a stock filter shall be provided by the furnace manufacturer for use in the air-filter temperature test. A thermocouple shall be attached to the center of that face of the filter exposed to the more severe direct radiation, and when, at the end of the test for pickup after banking, the flue gas has attained the flue-gas test temperature, the filter shall be inserted. With the fan operating, air filter temperatures shall be recorded at 5-min intervals until constant temperature is attained, as indicated by three consecutive readings. The fan shall then be turned off and readings to constant temperature taken as before.

5.90. *Maximum rating.*— The maximum rating of the furnace, to meet the requirements of paragraphs 4.10 to 4.20, inclusive, shall be determined as described in paragraphs 5.51 to 5.53, inclusive.

5.91. *Minimum rating.*— The minimum rating need not be established by test but shall be computed on the following assumptions:

(a) A fuel-burning rate of not less than three times that observed during the banking test.
(b) An efficiency equal to that observed during the test for maximum rating.

6.0. SOLID-FUEL-BURNING FORCED-AIR FURNACES
DATA AND REPORT SHEET

Complete information is required for purposes of checking the data and for permanent records. *Fill in all spaces.* If additional space is required, use separate pages and attach to the data sheets. NOTE.—Suggested log data sheets for recording running data are contained in appendix III.

General information:

1. Manufacturer's name____________________
2. Address____________________
3. Laboratory test No.____________
4. Date of test__________________5. Test conducted by______________

Furnace data:

6. Identification__________a. Steel or cast iron______________
   b. Type______________________________
   c. Catalog designation______________
7. Metal thickness_________a. Combustion chamber: head_____, sides____
   b. Flue collar_________________
   c. Radiator___________________
   d. Casing_____________________
8. Casing__________________a. Shape: Round___Square___Rect.___________
   Elliptical________
   b. Size:
   Plan view dimensions___in.; Height___in.
9. Air inlet to casing_____a. Top, side, or bottom_____________
   b. Dimensions: Diam_____in.; Width_____in.;
   Length_____in.
10. Air outlet from casing__a. Dimensions: Diam_____in.; Width_____in.;
   Length_____in.
11. Air filters specified, but not installed in capacity tests.__a. Make_________________________
   b. Number used_________________
   c. Size: Width_______in.; Length_______in.;
   Thick._______in.
12. Blower__________________a. Make______________Catalog No.___________
   b. Wheel size: Width____in.; O.D.________in.
   c. Outlet: Diam_______in.; Height______in.;
   Width______in.
   d. Pulley size__________in.
   e. Fan rating for 3/8 in. s.p.__________cfm.
   _________rpm.
   _________bhp.
13. Blower motor____________a. Make______________Catalog No.___________
   b. Type______________________rpm__________
   c. Horsepower rating_________
   d. Pulley size (nominal)_____in.

Fuel data:

14. Coal used_________________a. Kind______________b. Size______________
15. Proximate analysis (as received).________a. Volatile matter_________%_____________
   b. Fixed carbon___________%_____________
   c. Moisture_______________%_____________
   d. Ash____________________%_____________
   e. Calorific value____Btu/lb_____________

16. Analysis (as fired, if stored exposed to weather).
    a. Moisture ---------------- % ----------------
    b. Ash ---------------- % ----------------

Limiting temperatures derived from preliminary cycle:

17. Temperature rise of heat-exchanger surface.
    Maximum ---------------- °F ----------------
    Average ---------------- °F ----------------
18. Temperature rise of jacket ---------------- Maximum ---------------- °F ----------------
19. Flue-gas test temperature ---------------- °F ----------------

Duration of test:	Prelim. cycle	First cycle	Second cycle	Third cycle	Total for 3 cycles
20. Time of firing of coal----	------	------	------	------	
21. Time at end of cycles-----	------	------	------	------	
22. Duration of cycles,-----hr	------	------	------	------	--------
Fuel input:					
Kindling,-------lb------					
Initial charge,--------lb------					
23. Fuel fired at end of test cycles-----------lb	------	------	------	------	--------

	Prelim. cycle	First cycle	Second cycle	Third cycle	Avg for 3 cycles
24. Rate of fuel consumption---------lb/hr	------	------	------	------	--------
25. Calorific value of coal (as fired)----Btu/lb	------	------	------	------	
26. Rate of heat input--Btu/hr	------	------	------	------	--------
Combustion data (average for each cycle):					
27. Draft at smoke outlet-----------in. water	------	------	------	------	--------
28. Flue-gas temperature rise above laboratory temperature:					
a. Maximum-------------°F	------	------	------	------	--------
b. Average-------------°F	------	------	------	------	--------
29. Temperature of combustion air---------°F	------	------	------	------	
30. Flue gas analysis:					
a. CO_2-----------------%	------	------	------	------	
b. O_2-----------------%	------	------	------	------	
c. CO-----------------%	------	------	------	------	
Air circulation and blower data:					
31. Barometric pressure, average------------in. Hg	------	------	------	------	
32. Air temp at outlet, average, (T_1)----------°F	------	------	------	------	
33. Air temp at inlet, average, (T_2)----------°F	------	------	------	------	
34. Temperature rise, average, (T_1-T_2)-------°F	------	------	------	------	

	Prelim. cycle	First cycle	Second cycle	Third cycle	Avg for 3 cycles
35. Density of air at outlet, average----------lb/cu ft	------	------	------	------	
36. Velocity pressure at flow meter, average----------in. water	------	------	------	------	
37. Volume of air at outlet----------------cfm	------	------	------	------	
38. Weight of circulated air, average-------lb/min	------	------	------	------	
39. Static pressure at outlet duct, average----in. water	------	------	------	------	
40. Blower speed-----------rpm	------	------	------	------	
41. Electric input to blower motor---------------watts	------	------	------	------	
42. Air delivery (standard cond.)---------------cfm	------	------	------	------	-------

Capacities and efficiencies:					Total for 3 cycles
43. Bonnet output (maximum rating)-----------Btu/hr		------	------	------	-------
44. Stack loss (from curve)--%	------	------	------	------	
45. Radiation and unaccounted-for loss---------------%		------	------	------	
46. Bonnet efficiency (direct)---------------%		------	------	------	-------
47. Indirect efficiency (optional)-------------%		------	------	------	-------

Banking test:

48. Weight of coal charged at end of banking test-------------------lb --------------
49. Length of banking test--hr --------------
50. Rate of fuel consumption---------lb/hr --------------
51. Ratio of banking rate to test rate-------------------------------
52. Minimum rating------Btu/hr --------------

Pickup test:

53. Time for pickup to flue-gas test temperature-----------min --------------

54. Air filter temperature	Fan on	Fan off
a. Actual--------------°F	------	------
b. Rise above laboratory temp---------------°F	------	------

55. Air velocity through filter-------------ft/min average-------------

6.1 *Method of calculation:*

Item 24 = Rate of fuel consumption, lb/hr

$$= \frac{\text{Fuel fired at end of test cycle, lb}}{\text{Total duration of test cycle, hr}} = \frac{\text{Item 23}}{\text{Item 22}}.$$

Item 25 = Calorific value of coal (as fired) Btu/lb.

$$= \frac{100 - (\text{ash} + \text{moisture})\ (\text{as fired})}{100 - (\text{ash} + \text{moisture})\ (\text{as recd.})} \times \text{Btu (as recd.)}.$$

Item 26 = Rate of heat input, Btu/hr.
= Rate of fuel consumption, lb/hr $\times$ calorific value of coal.
= Item 24 $\times$ item 25.

Item 39 = Static pressure at outlet duct, average, in. water.

NOTE.—Air-outlet duct static-pressure adjustment.

At the start of the preliminary cycle adjust the air damper to produce a static pressure at the air outlet duct of 0.20 in. water. When flue-gas test temperature is attained, readjust air damper as required to bring air outlet duct pressure to 0.20 in. water. Leave damper in this position for the remainder of the tests.

$$\text{Item } 42 = \text{Air delivery, cfm (standard condition)} = \frac{\text{Avg wt circulated air (lb/min)}}{\text{Density of std. air}}$$

$$= \frac{\text{Item } 38}{0.075}.$$

NOTE.—Obtain outlet air density in lb/ft^3 from figure 2, volume in cfm at the "obtained" density from figures 2A or 2B and calculate the weight of circulated air in lb/min as the product of the air volume times its density. Air delivery may be obtained for each cycle, using the average per cycle of outlet air densities and Pitot tube pressure readings, and the values for the three test cycles then averaged, or it may be obtained by using a three test cycle average of the above mentioned air densities and Pitot tube pressures.

Under usual conditions of humidity and atmospheric pressure and aside from errors due to setup and recording, the outlet air density taken from figure 2, which does not take into account the variant weights of water vapor in the air or the added air pressure due to the fan, will be a close approximation of the true density.

For small variations, not to exceed 5 sq in. in area, from nominal areas of the 9- and 12-in. air-flow-meter throats, air-volume corrections shall be made by multiplying the values obtained from figures 2A or 2B by a correction factor obtained as follows:

9-in. throat | 12-in. throat

$$\text{Correction factor} = \frac{\text{Actual area}}{\text{Nominal area}} = \frac{\text{actual area, sq. in.}}{63.62} = \frac{\text{actual area, sq. in.}}{113.098}$$

Item 43 = Bonnet output (maximum rating), Btu/hr
= Average temperature rise $\times$ air delivery $\times$ 60 $\times$ 0.018.
= Item 34 $\times$ item 42 $\times$ 1.08.

NOTE.—Output may be calculated for each test cycle on the basis of average temperature rise per cycle and the three test cycle results averaged or it may be calculated on the basis of the three test cycle average rise.

Alternately, the average weight of circulated air in lb/min may be converted to weight in lb/hr and the bonnet output, for each cycle or for the average of the three test cycles, taken from the curves on figure 3.

Item 45 = Radiation and unaccounted-for loss, %.
= Indirect efficiency − direct efficiency = item 47 − item 46.

Item 46 = Bonnet efficiency (direct), %.

$$= \frac{\text{Heat output}}{\text{Heat input}} \times 100 = \frac{\text{item 43}}{\text{item 26}} \times 100.$$

Item 47 = Indirect efficiency, %.

$= 100 - \text{losses} = 100 - \text{item 44}$

NOTE.—Loss obtained from figure 4 is taken as the total combustion loss. For explanation of the method, see appendix II.

Item 52 = Minimum rating, Btu/hr.

$= 3 \times$ rate of fuel consumption during banking test $\times$ calorific value of coal (as fired) $\times$ direct efficiency/100.

$$= 3 \times \text{item 50} \times \text{item 25} \times \frac{\text{item 46}}{100}.$$

$$\text{Item 55} = \text{Air velocity through filter} = \frac{\text{Air delivery, cfm}}{\text{Filter area (external dimensions) ft}^2}.$$

INFORMATIVE LABELING

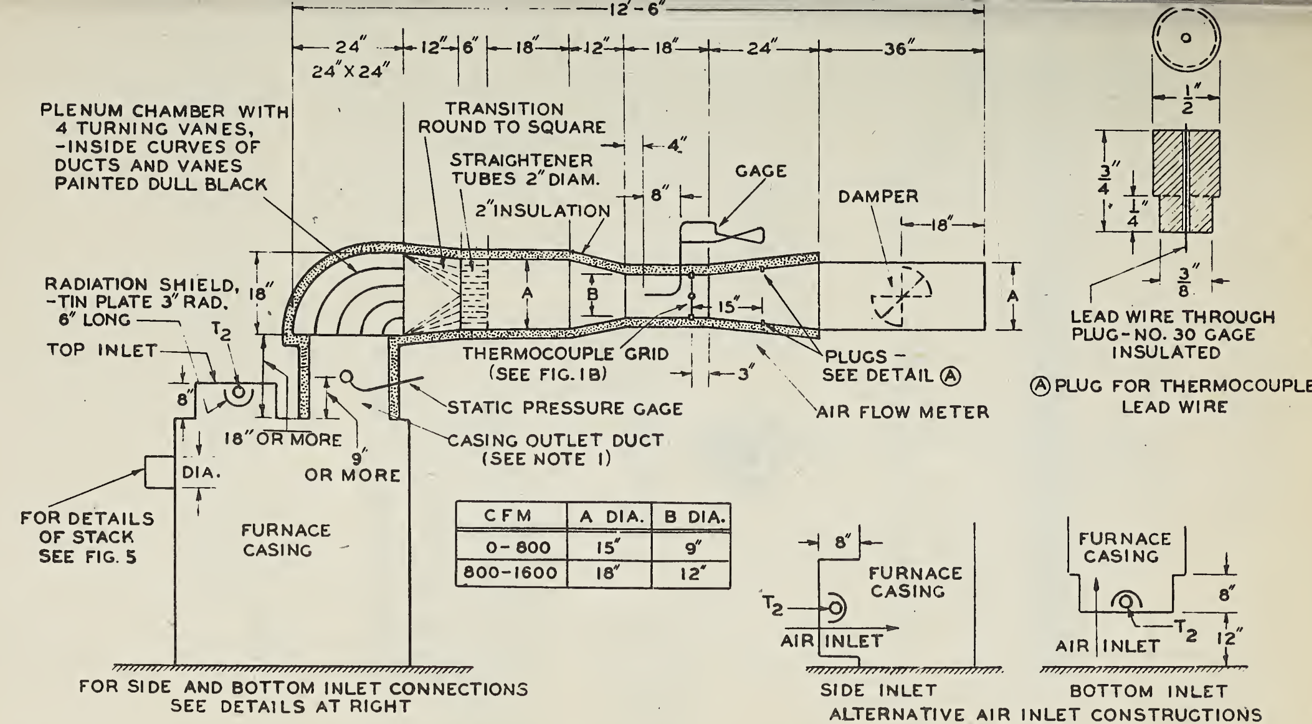
7.0. *Manufacturer's guarantee.*—A manufacturer's guarantee, worded as follows, shall accompany each furnace.

MANUFACTURER'S GUARANTEE

Solid-Fuel-Burning Forced-Air Furnace. Catalog Designation______

(Name of manufacturer) (Address)

This furnace is guaranteed to have an output range from______maximum rating to______minimum rating Btu per hour when tested, without air filters, according to CS109-44 for Solid-Fuel-Burning Forced-Air Furnaces as issued by the United States Department of Commerce.



CFM	A DIA.	B DIA.
0-800	15"	9"
800-1600	18"	12"

FIGURE 1.—*Schematic diagram of arrangement of apparatus for testing solid-fuel-burning forced-air furnaces.*

NOTE 1.—Dimensions of casing outlet duct to be the same as outlet opening in the casing. If either dimension of outlet at casing exceeds 24 in., a transition piece is to be provided so that neither dimension shall exceed 24 in. This transition piece is to be 6 in. high. The total distance from the top of the casing to the 24 by 24 in. bottom of the plenum chamber is to be 18 in. or more.

NOTE 2.—The air duct should be smooth on the inside and free from burrs and projections.

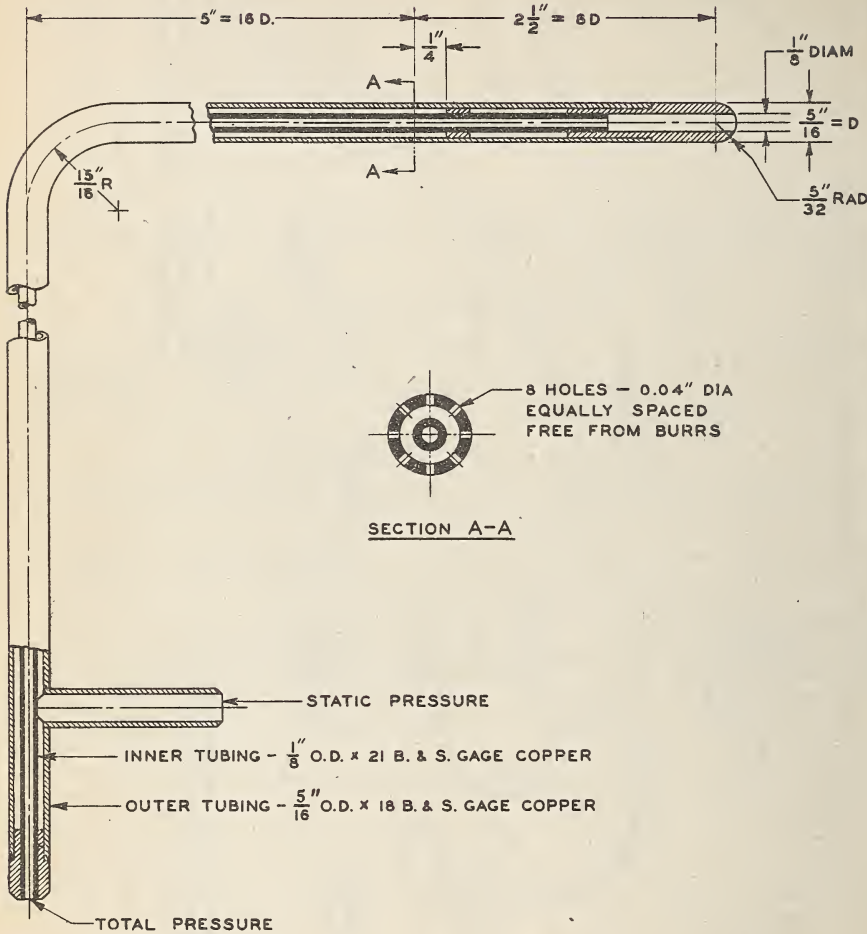
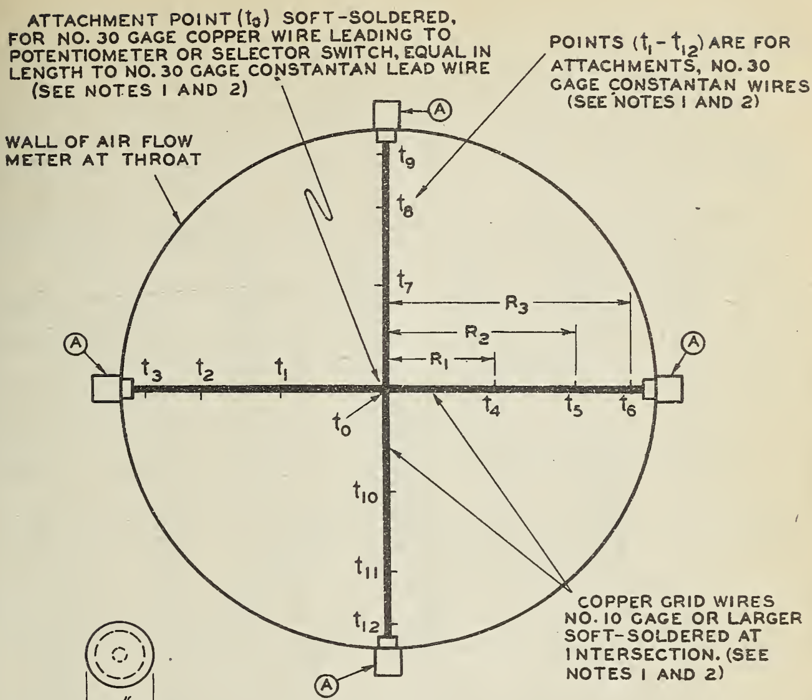
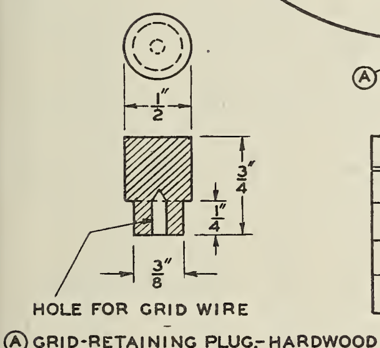


FIGURE 1A.—*Pitot tube.*





THERMOCOUPLE LOCATIONS		
RADIAL PROPORTIONS	9" PIPE	12" PIPE
$R_1 = 0.408\ R$	$1\frac{27}{32}$"	$2\frac{7}{16}$"
$R_2 = 0.707\ R$	$3\frac{3}{16}$"	$4\frac{1}{4}$"
$R_3 = 0.913\ R$	$4\frac{1}{8}$"	$5\frac{15}{32}$"

FIGURE 1B.—*Thermocouple grid for airflow meter.*

NOTE 1.—(t_1 - t_{12}) No. 30 gage constantan wires of equal length, soft-soldered to grid wires and soft-soldered together at other ends, one wire extended to cold junction of potentiometer.

NOTE 2.—Copper grid wires are bare. All lead wires to grid are electrically insulated their entire length.

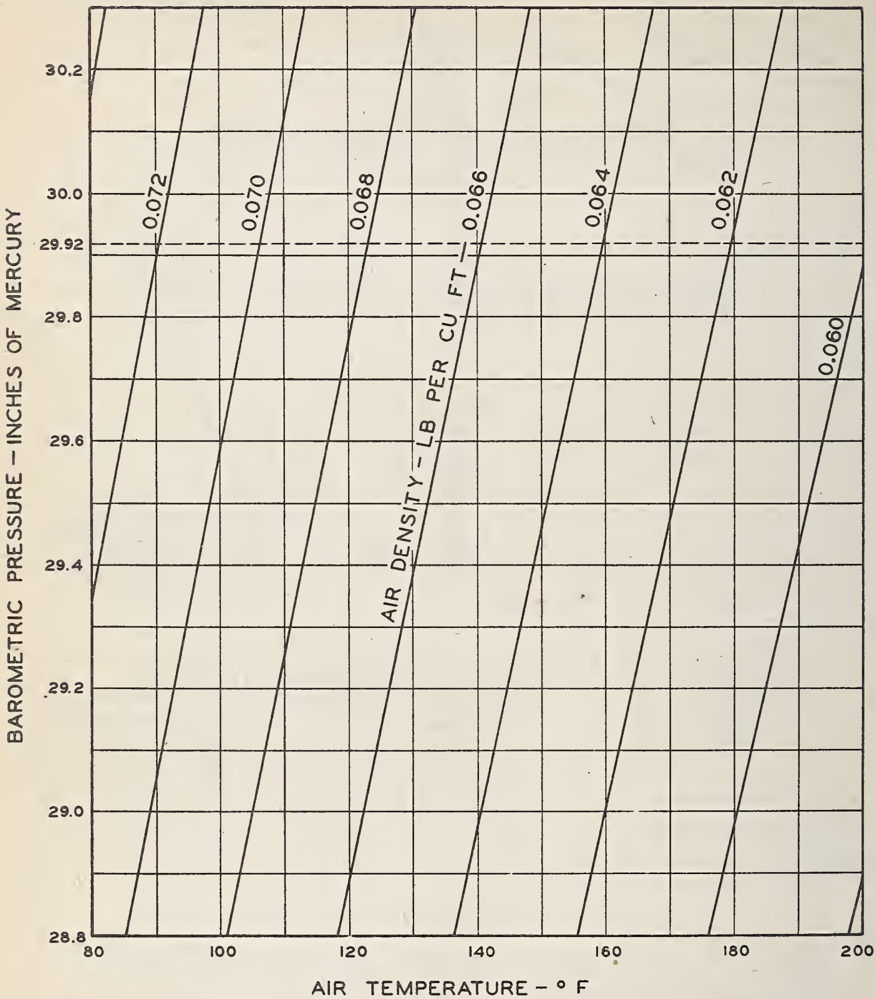


FIGURE 2.—*Air density for dry air* $= D = \dfrac{1.325B}{460+T}$.

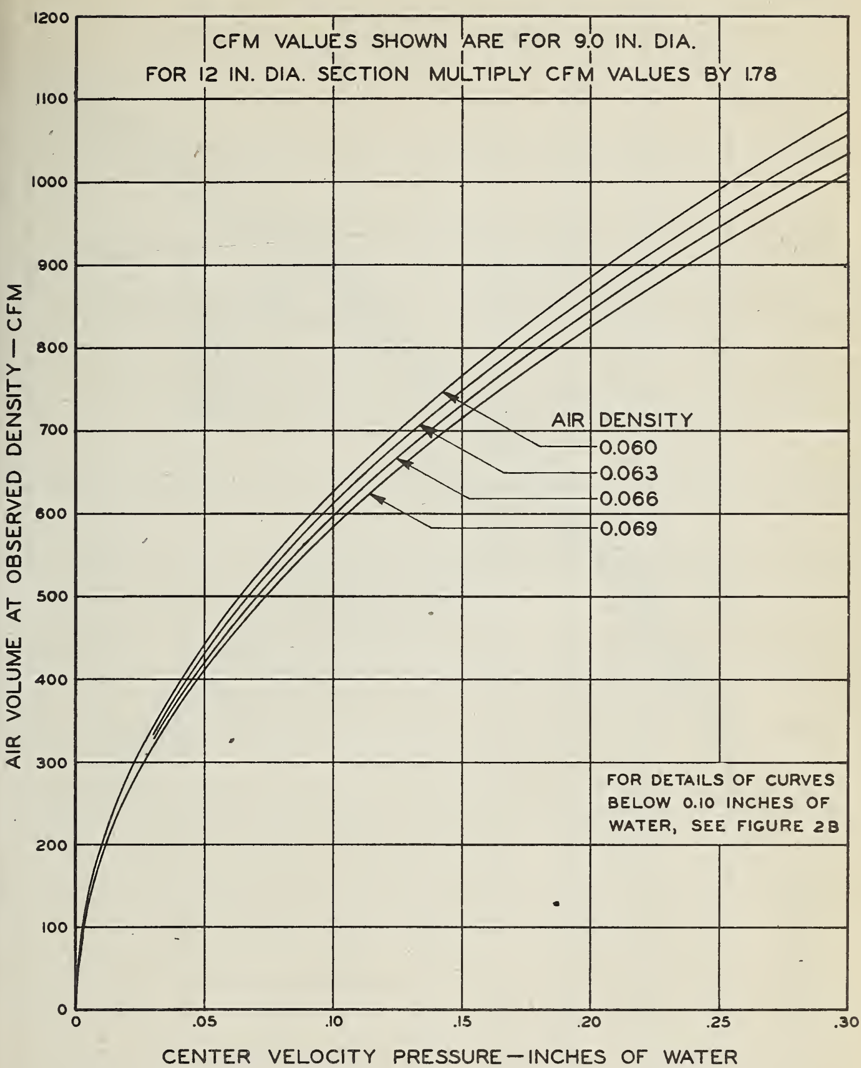


FIGURE 2A.—*Calibration curves for 9.0-in.-diam air-flow meter.*

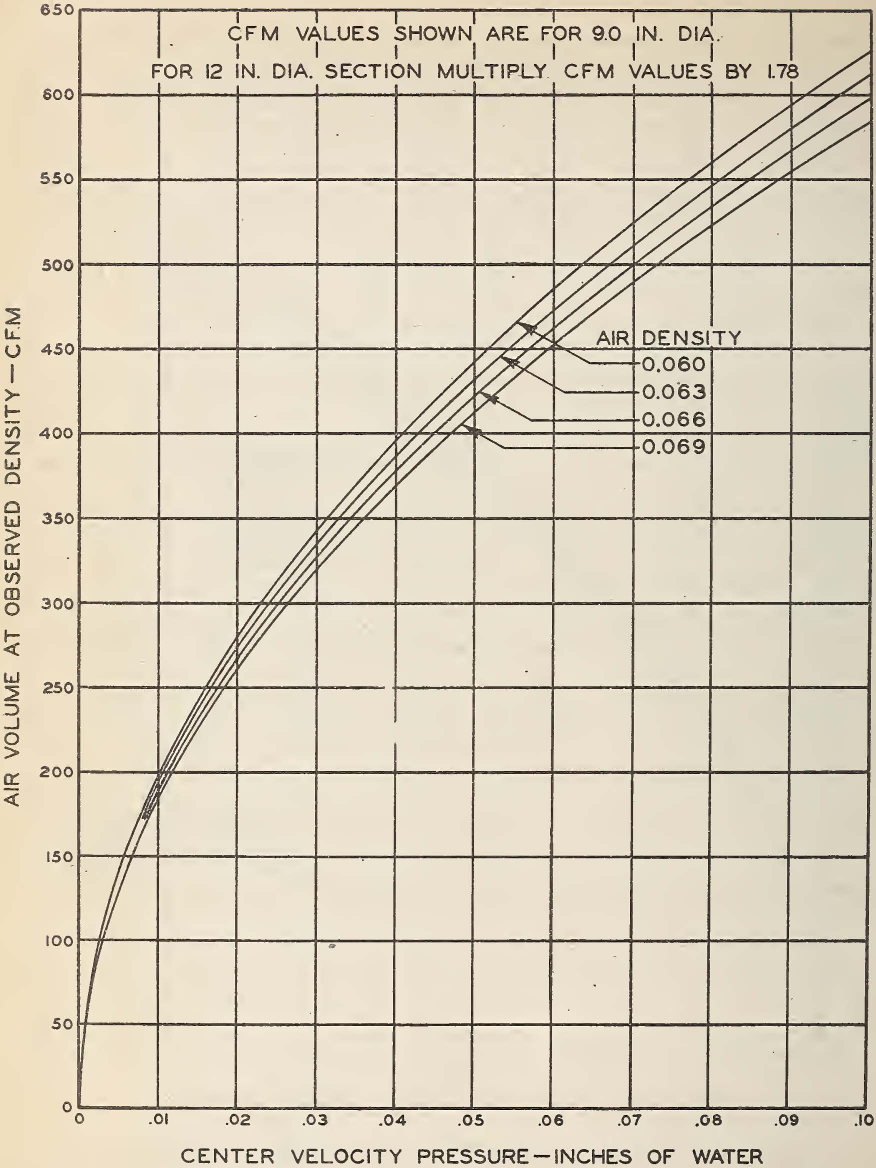


FIGURE 2B.—*Calibration curves (detail) for 9.0-in.-diam air-flow meter.*

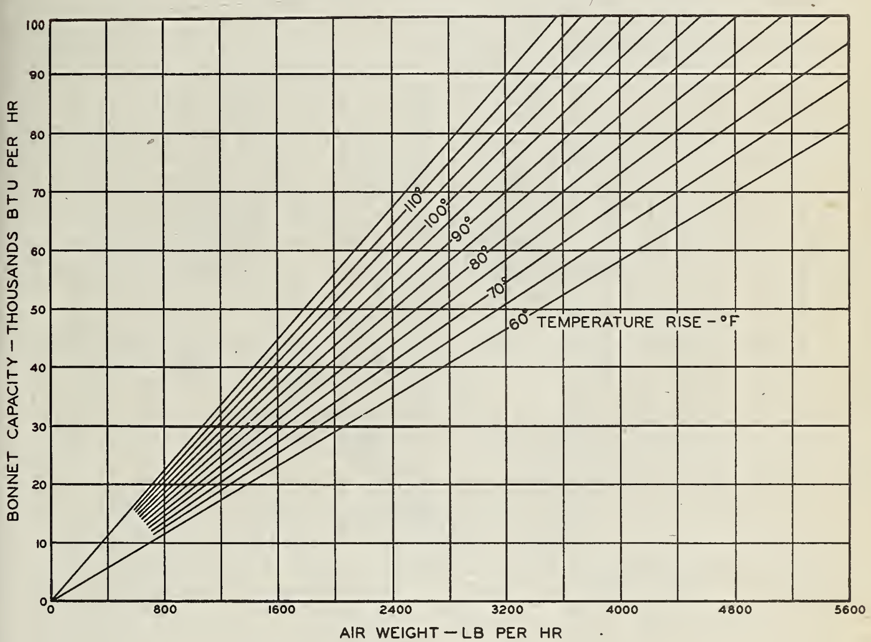


FIGURE 3.—*Capacity—air-weight relationships.*

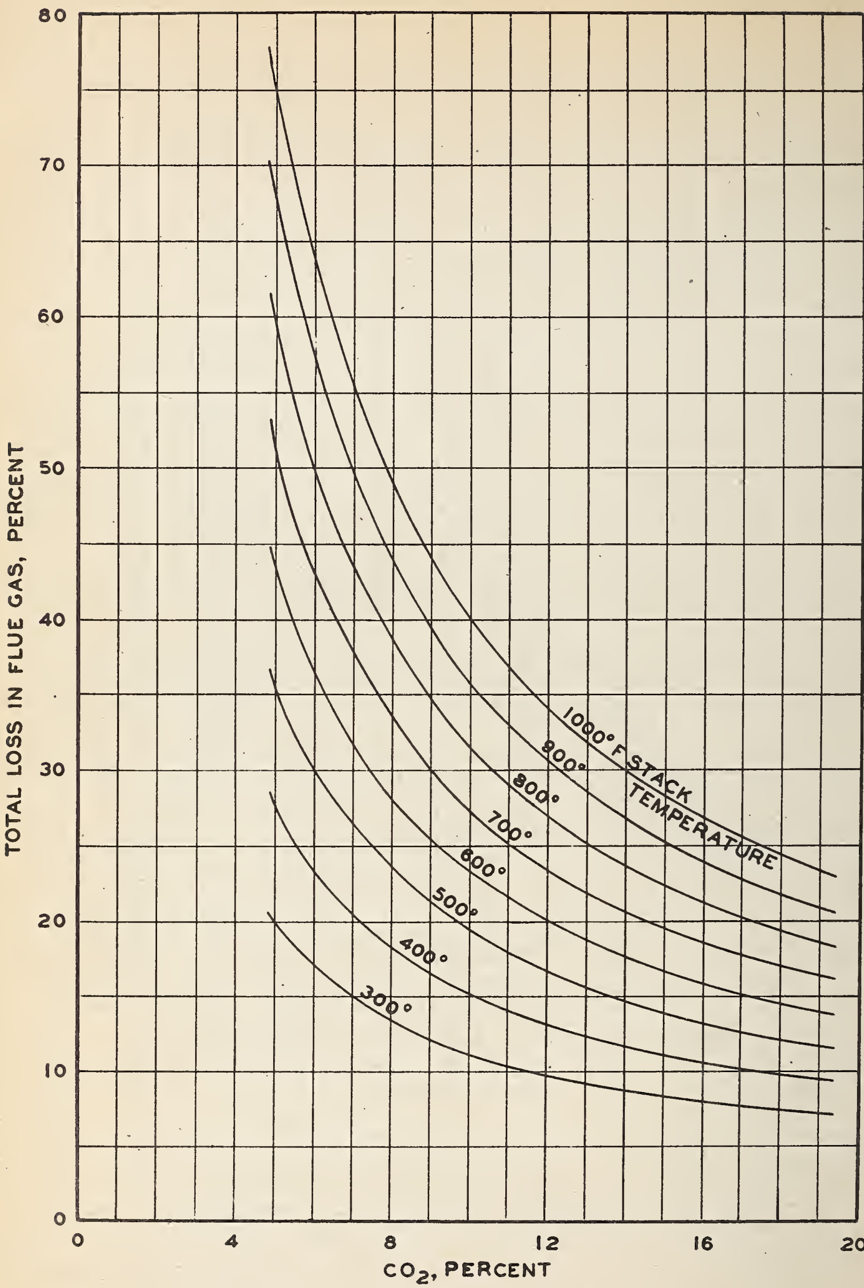


FIGURE 4.—*Flue-gas losses with anthracite as fuel.*

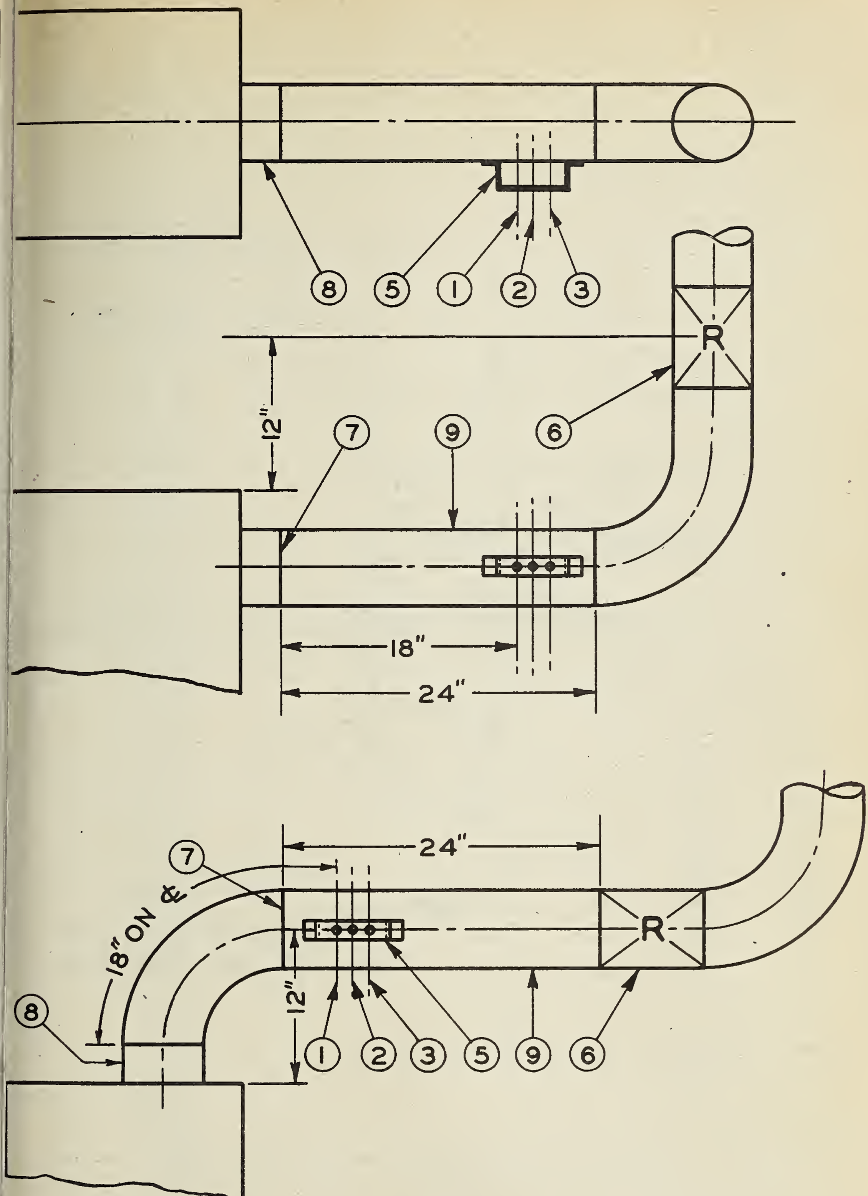


FIGURE 5.—*Flue connections.*

1, Center line of thermocouple—see figures 6 and 7; 2, gas-sampling tube—see figure 6; 3, draft tube—see figure 6; 5, support bracket—see figure 6; 6, draft regulator; 7, seal all openings in smoke pipe below gas-sampling tube; 8, flue collar; 9, section of smoke pipe, same nominal diameter as flue collar.

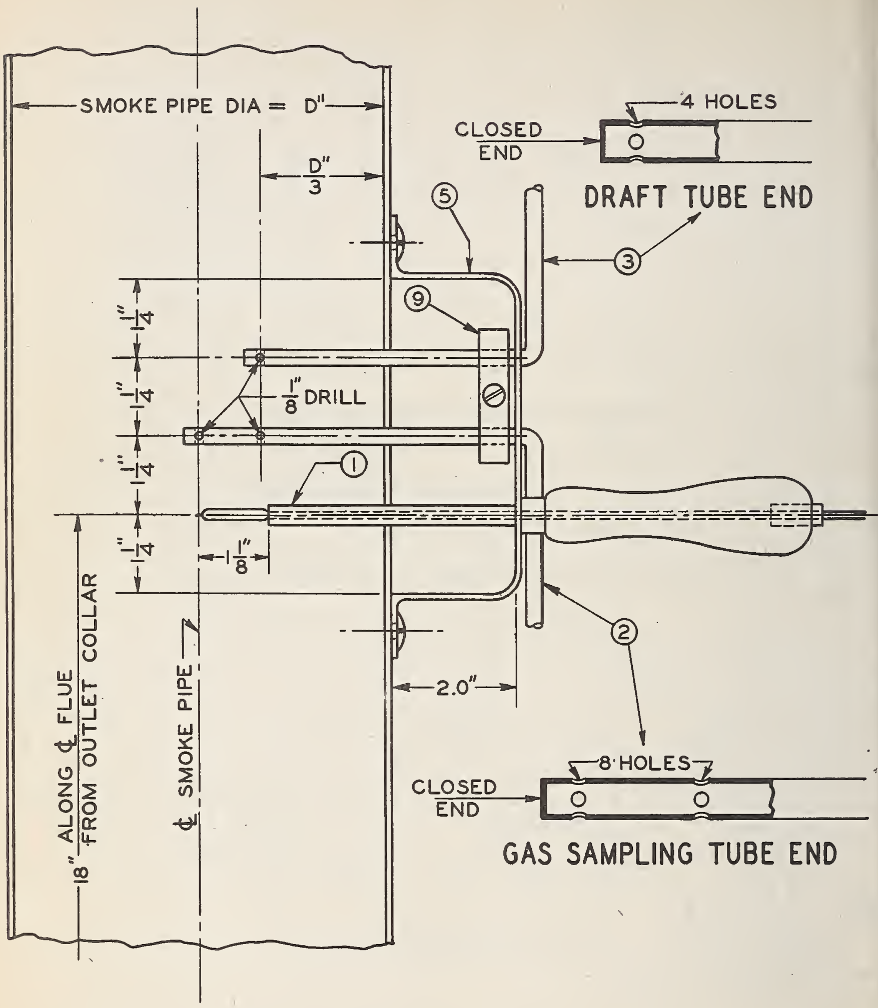


FIGURE 6.—*Gas-sampling and draft tubes, thermocouple, and support-bracket assembly.*

1, Thermocouple; 2 and 3, gas-sampling and draft tubes, (1/4-in. by approximately 0.032-in. wall); 5 and 9, support bracket and tube clamp, (1/2-in. by 0.093-in. half-hard flat steel wire).

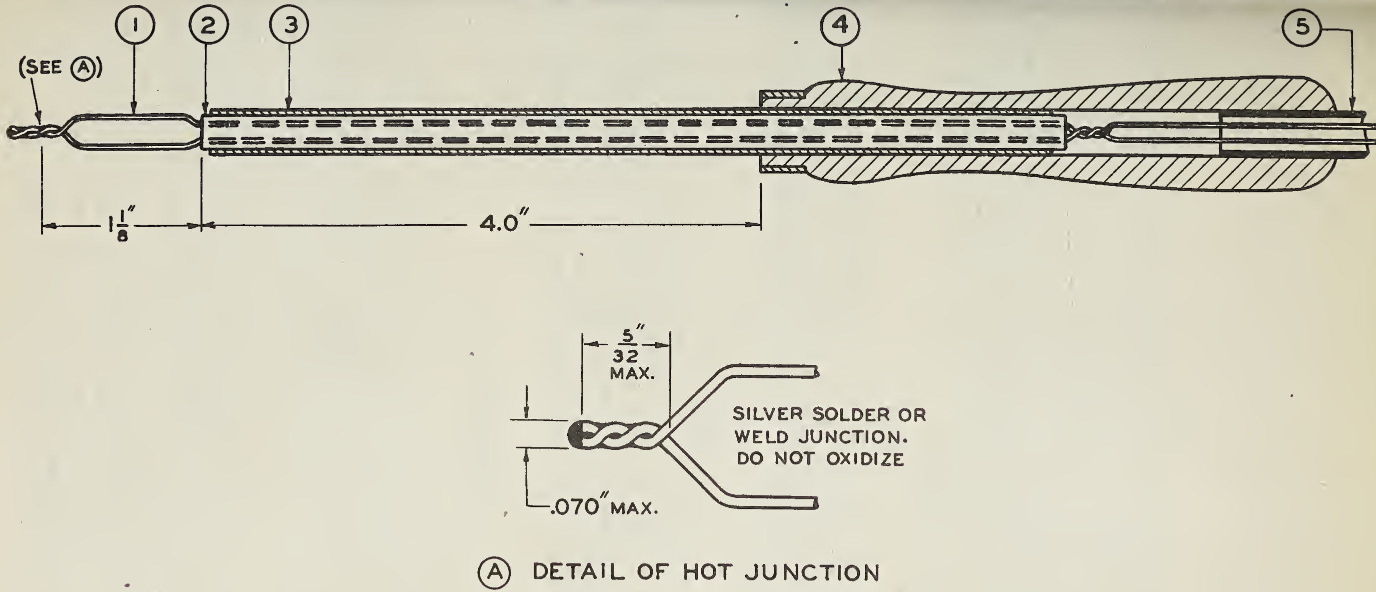


FIGURE 7.—*Standard thermocouple for flue-gas temperature measurement.*

1, Ten feet of No. 20 B&S gage iron-constantan, asbestos or woven glass covered thermocouple wires extending from hot junction to potentiometer or reference junction; 2, one Leeds & Northrup standard 714B, or equal, 1/4 in. O.D. two-hole porcelain insulator cut 6.0 in. long and ends beveled on two sides; 3, one 5/16 in. O.D. by 0.032-in. wall half-hard yellow-brass tubing cut 5 7/8 in. long. Ream, if necessary, to fit over insulator; then crimp ends over beveled ends of insulator; 4, one small wooden handle; 5, one piece of rubber tubing, 5/16 in. by 3/32 in. by 2 in. long.

APPENDIX I

Method of Interpolating Test Results

When one or more of the various limitations set forth in paragraphs 4.10 to 4.15 have been exceeded during a test for maximum output, a second test must be run and the results interpolated as shown by the following examples (refer to fig. 8, p. 29):

CASE A

Case A is a test on heater No. 1, in which none of the limitations were exceeded. Rated output in this case would be 70,000 Btu/hr.

CASE B

In the first test on this heater No. 2, the average draft was kept at 0.060 in. of water, and the furnace produced 65,000 Btu/hr. However, the maximum permissible stack temperature was exceeded. A second test at 0.040 in. of water draft gave 55,000 Btu, with none of the limitations exceeded. Straight-line interpolation between the points of these two tests produces a rating of 62,500.

CASE C

In the first test on heater No. 3, it produced 50,000 Btu/hr at an efficiency of 50 percent. Since this is less than the specified minimum, a second test was conducted at a lower draft. This produced 43,000 Btu/hr at an efficiency of 58 percent. Interpolation as shown gives a design rating of 46,000 Btu/hr.

CASE D

The first test on heater No. 4 showed 60 percent efficiency with 40,000 Btu/hr output. However, the casing temperature was in excess of the 300° F specified. A second test at 0.035 draft gave 30,000 Btu/hr and brought the jacket temperature down to 250° F. Interpolation between the two would establish a rating of 33,500 Btu/hr.

NOTE. In each case the inlet air temperature was considered to be 70° F.

APPENDIX II

Graphic Method of Determining Flue-Gas Loss

Curves used for obtaining flue-gas losses are taken from University of Illinois Engineering Experiment Station Circular Series No. 44, Combustion Efficiencies as Related to Performance of Domestic Heating Plants. The curves included in this standard, figure 4, are those obtained for anthracite. The method of calculation described in the circular is as set forth below.

The proximate and ultimate analyses of 54 different coals, ranging from anthracite to lignite, were selected at random from extensive lists given in publications of the U. S. Bureau of Mines, these lists being reprints from U. S. Bureau of Mines, R. I. 3296, Classification Chart of Typical Coals of the United States.

Using average values obtained from the ultimate analyses, the weights of the dry flue gases in lb/lb of fuel burned, the moisture formed by combustion, and the moisture contained in the combustion air, were calculated on the basis of complete combustion and for quantities of excess combustion air varying (by steps) from 0 to 300 percent.

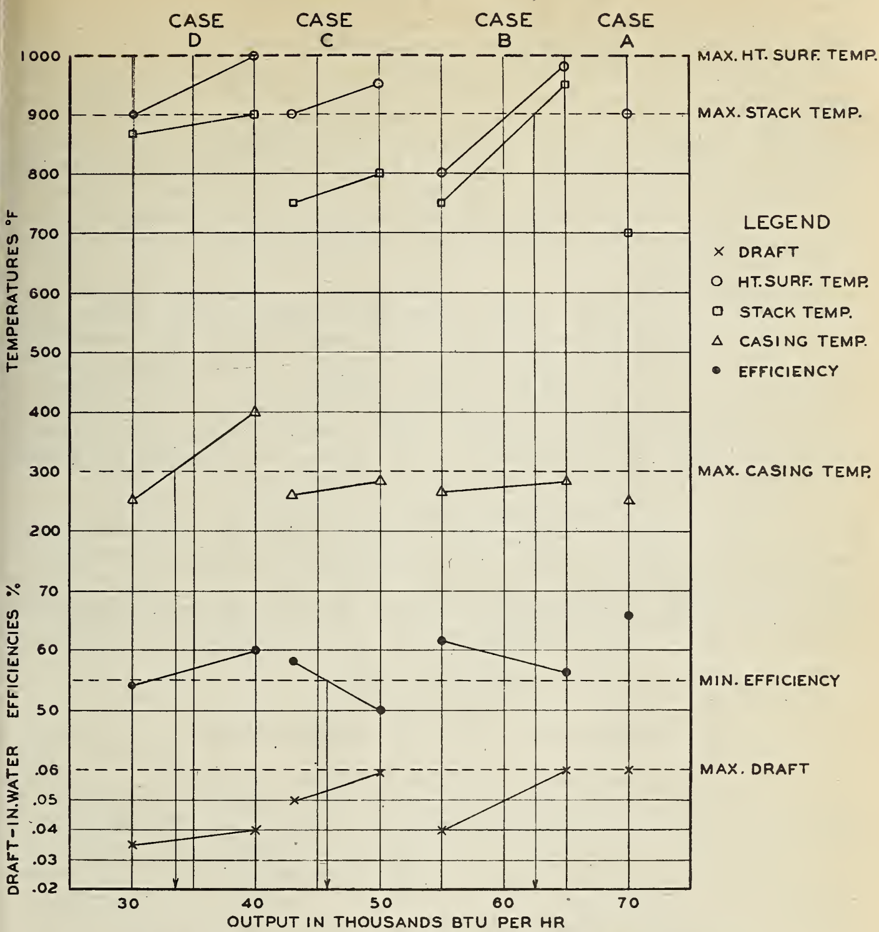


FIGURE 8. *Examples of interpolated maximum ratings.*

Assuming a temperature of 65° F for the combustion air, heat losses in Btu/lb of fuel burned were calculated on the basis of mean specific heats of the dry gases and enthalpy difference in the moisture for the three groups above at flue-gas temperatures varying by steps from 300° to 1,000° F. Using the average calorific value in Btu/lb of fuel, obtained from the proximate analyses, total flue-gas losses, in percentage of total heat evolved per pound of fuel burned, were obtained as the quotients (×100) of the total flue losses, for each percent of excess air and at each temperature, divided by the calorific value.

Using values of CO_2, in percentage by volume of dry flue gases, corresponding to percentages by volume of excess air, the curves reproduced in this standard were plotted to show heat loss in percentage of total heat value per pound of fuel burned against percentage by volume of CO_2 in stack.

Under the conditions of this determination, losses taken from the curves for various values of CO_2 are the losses based upon the complete burning of 1 lb of coal, these losses having been converted to percentages of the calorific value of 1 lb of coal. Stack loss, at any given value of CO_2, due to burning less than the total combustibles in 1 lb of coal, will be less than the value obtained from the curve.

In the case of combustibles remaining in the ash, the stack losses taken from the curves will be higher than the actual stack losses, the difference for the sensible loss being approximately in the ratio of weight of carbon per pound of coal from the ultimate analysis to the weight of carbon burned per pound of coal fired. Heat loss in the ash is, therefore, not entirely compensated for but for values of combustible in ash, of 25 percent or less, the values taken from the curves afford a measure of combined ashpit and stack loss within about 2 percent of the correct value.

In the case of unburned or incompletely burned flue gases (H_2 and CO), stack losses, in percent, taken from the curves will be higher than actual stack losses after subtracting the heat value of the combustible gases, approximately in the ratio of the sum of the percentages of $CO_2 + CO + H_2$ to the percentage of CO_2. Heat loss due to combustibles in the flue gas is, therefore, not entirely compensated for, but for values of these combustibles, not exceeding about 4 percent of the heating value of the fuel, the values taken from the curves afford a measure of the total stack loss within about 1 1/2 percent of the correct value.

In general, the stack losses determined from the curves are lower than the true losses existing when there are ashpit and incomplete combustion losses. For example, a 4 percent ashpit loss and 3.7 percent incomplete-combustion loss combine to produce an actual indirect efficiency 3.4 percent lower than the curves indicate is the case when the average CO_2 is 8 percent and the average stack temperature is 800° F.

APPENDIX III

Suggested form of log data sheets

LOG SHEET FOR SOLID-FUEL-BURNING FORCED-AIR FURNACES Sheet 1

Manufacturer------------------------Catalog designation--------------------------Test No.--------------

Date------------------------------Tested by------------------------Coal used: Kind--------Size--------

Barometric pressure---------------in. mercury Static pressure at outlet duct---------in. mercury

Blower speed----------------------rpm Fan input---------------watts

Item number on data and report sheets			23	27			28	30a	30b	30c		32		33	34
Time	Fuel fired, lb			Draft at smoke outlet	Flue-gas temp			Flue-gas anal., percent			Outlet air temp		Inlet air temp		Air temp rise
					Actual		Rise								
	Gross	Tare	Net		mv	°F	°F	CO_2	O_2	CO	mv	°F	mv	°F	°F

LOG SHEET FOR SOLID-FUEL-BURNING FORCED-AIR FURNACES Sheet 2

Item number on data and report sheets	36	Heat-exchanger temperature						Jacket temperature					
Time	Velocity pressure, in. WG	Location 1		Location 2		Location 3		Location 1		Location 2		Location 3	
		mv	°F	mv	°F	mv	°F	mv	°F	mv	°F	mv	°F

EFFECTIVE DATE

8.0. The standard is effective for new production from March 10, 1944.

STANDING COMMITTEE

9.0. The following individuals comprise the membership of the standing committee, which is to review, prior to circulation for acceptance, revisions proposed to keep the standard abreast of progress. Comment concerning the standard and suggestions for revision may be addressed to any member of the committee or to the Division of Trade Standards, National Bureau of Standards, which acts as secretary for the the committee.

H. WEYENBERG (chairman) Holland Furnace Co., Holland, Mich.
F. G. SEDGWICK, Waterman-Waterbury Co., Minneapolis, Minn.
A. L. RYBOLT, Rybolt Heater Co., Ashland, Ohio.
R. E. DALY, American Radiator & Standard Sanitary Corporation, Pittsburgh, Pa.
V. E. ISENHART, The Lennox Furnace Co., Marshalltown, Iowa.
JOHN W. INGOLD, Sears, Roebuck & Co., Chicago 7, Ill. (representing Mail Order Association of America).
E. E. ROBERTS, Roberts-Hamilton Co., 709 S. 3d St., Minneapolis 15, Minn. (representing Central Supply Association).
WILLARD A. NEIS, The Neis Co., 7943 W. National Ave., West Allis, Wis. (representing Heating, Piping & Air Conditioning Contractors National Association).
J. HARVEY MANNY, Robinson Furnace Co., 4600 W. Monroe St., Chicago, Ill. (representing Sheet Metal Contractors National Association, Inc.).
Associated General Contractors of America, Inc. (invited to name a representative).
R. K. THULMAN, Federal Housing Administration, Washington 25, D. C.
F. A. PECKHAM, Office, Chief of Engineers, War Department, Washington 25, D. C.
WALTER B. RUEVE, 600 Sunset Road, Louisville 6, Ky. (representing American Institute of Architects).
HENRY T. COATES, Dairymen's League Co-Op. Assn., Inc., 11 West 42nd St., New York 18, N. Y. (representing National Association of Purchasing Agents).

Hugh E. Keeler, 231 West Engineering Bldg., University of Michigan, Ann Arbor, Mich. (representing American Institute of Consulting Engineers).
R. C. Johnson, Anthracite Industries, Inc., Primos, Delaware County, Pa.
S. Konzo, University of Illinois, Urbana, Ill.
B. A. Landry, Battelle Memorial Institute, Columbus 1, Ohio.
C. C. Wright, Pennsylvania State College, State College, Pa.
R. S. Dill, Heat Transfer Section, National Bureau of Standards, Washington 25, D. C.

HISTORY OF PROJECT

10.0. As a result of informal conferences on April 3 and 14, 1942, between representatives of Anthracite Industries Laboratory and interested Government agencies, and following a specific request of April 20, 1942, from the Federal Housing Administration, there was developed by the industry in cooperation with Government agencies, a proposed commercial standard for solid-fuel-burning furnaces.

10.1. Conferences of interested individuals were held at the National Bureau of Standards on June 23, 1942, and October 15, 1942, as a result of which a second draft of the proposed standard was circulated November 11 and 12, 1942, to the industry for comment.

10.2. A special conference, held in Washington on February 22 and 23, 1943, revised the proposed standard in the light of comment, and this draft was circulated for further comment on May 15, 1943. Following subsequent adjustments to suit this comment, especially that of the National Warm Air Heating and Air Conditioning Association, a revised draft was circulated on August 16, 1943, to the entire trade for written acceptance, as there appeared to be no objections requiring adjustment at a general conference.

10.3. Following acceptance by a satisfactory majority, in the absence of active opposition, an announcement was issued on November 10, 1943, that the standard had been accepted as the recorded voluntary standard of the trade, effective for new production from March 10, 1944.

ACCEPTANCE OF COMMERCIAL STANDARD

If acceptance has not previously been filed, this sheet properly filled in, signed and returned, will provide for the recording of your organization as an acceptor of this commercial standard.

Date______________________

Division of Trade Standards,
National Bureau of Standards,
Washington, D. C.

Gentlemen:

Having considered the statements on the reverse side of this sheet, we accept the Commercial Standard CS109-44 as our standard of practice in the

Production[1] Distribution[1] Use[1] Testing[1]

of solid-fuel-burning forced-air furnaces.

We will assist in securing its general recognition and use, and will cooperate with the standing committee to effect revisions of the standard when necessary.

Signature of individual officer____________________________
(In ink)

(Kindly typewrite or print the following lines)

Name and title of above officer____________________________

Organization____
(Fill in exactly as it should be listed)

Street address____

City and State____

[1] Please designate which group you represent by drawing lines through the other three. Please file separate acceptances for all subsidiary companies and affiliates which should be listed separately as acceptors. In the case of related interests, trade papers, colleges, etc., desiring to record their general approval, the words "in principle" should be added after the signature.

TO THE ACCEPTOR

The following statements answer the usual questions arising in connection with the acceptance and its significance:

1. *Enforcement.*— Commercial standards are commodity specifications voluntarily established by mutual consent of those concerned. They present a common basis of understanding between the producer, distributor, and consumer and should not be confused with any plan of governmental regulation or control. The United States Department of Commerce has no regulatory power in the enforcement of their provisions, but since they represent the will of the interested groups as a whole, their provisions through usage soon become established as trade customs and are made effective through incorporation into sales contracts by means of labels, invoices and the like.

2. *The acceptor's responsibility.*— The purpose of commercial standards is to establish for specific commodities, nationally recognized grades or consumer criteria and the benefits therefrom will be measurable in direct proportion to their general recognition and actual use. Instances will occur when it may be necessary to deviate from the standard and the signing of an acceptance does not preclude such departures; however, such signature indicates an intention to follow the commercial standard where practicable, in the production, distribution, or consumption of the article in question.

3. *The Department's responsibility.*— The major function performed by the Department of Commerce in the voluntary establishment of commercial standards on a Nation-wide basis is fourfold: first, to act as an unbiased coordinator to bring all interested parties together for the mutually satisfactory adjustment of trade standards; second, to supply such assistance and advice as past experience with similar programs may suggest; third, to canvass and record the extent of acceptance and adherence to the standard on the part of producers, distributors, and users; and fourth, after acceptance, to publish and promulgate the standard for the information and guidance of buyers and sellers of the commodity.

4. *Announcement and promulgation.*— When the standard has been endorsed by a satisfactory majority of production or consumption in the absence of active, valid opposition, the success of the project is announced. If, however, in the opinion of the standing committee or the Department of Commerce, the support of any standard is inadequate, the right is reserved to withhold promulgation and publication.

ACCEPTORS

11.0. The organizations and individuals listed below have accepted this standard as their standard of practice in the production, distribution, and use of solid-fuel-burning forced-air furnaces. Such endorsement does not signify that they may not find it necessary to deviate from the standard, nor that producers so listed guarantee all of their products in this field to conform with the requirements of this standard. Therefore, specific evidence of conformity should be obtained where required.

ASSOCIATIONS

American Association of Engineers, Chicago, Ill.
American Specification Institute, Chicago, Ill.
Associated General Contractors of America, Inc., The, Washington, D. C.
Central Supply Association, Chicago, Ill.
Dairymen's League Co-operative Association, Inc., New York, N. Y.
Heating & Piping Contractors District of Columbia Association, Inc., Washington, D.C. (In principle.)
National Association of Purchasing Agents, New York, N. Y.
National Council of Women of the U. S., Inc., New York, N. Y.
National Warm Air Heating & Air Conditioning Association, Cleveland, Ohio. (In principle.)
Producers Council, Inc., The, Washington, D. C. (In principle.)
Southern Supply & Machinery Distributors' Association, Inc., Atlanta, Ga.
Southern Wholesalers Association, Atlanta, Ga.
Steam Heating Equipment Manufacturers Association, New York, N. Y. (In principle.)
Warm Air Furnace Manufacturers Council, Cleveland, Ohio.

FIRMS

Almirall & Co., Inc., New York, N. Y.
American Furnace Co., St. Louis, Mo.
American Furnace & Foundry Co., The, Milan, Mich.
American Houses, Inc., New York, N. Y.
Armstrong Furnace Co., Columbus, Ohio.
Baltimore, City of, Bureau of Plans & Surveys, Baltimore, Md.
Battelle Memorial Institute as Acting Research Laboratory for Bituminous Coal Research, Inc., Columbus, Ohio.
Bovee Furnace Works, Waterloo, Iowa.
Bowser Morner Testing Laboratories, Dayton, Ohio.
California Testing Laboratories, Inc., Los Angeles, Calif.
Case School of Applied Science, Cleveland, Ohio.
Central Co-operative Wholesale, Superior, Wis.
Chaney Hardware, Montpelier, Ind.
Chrysler Corporation, Airtemp Division, Dayton, Ohio.
Cincinnati, City of, Department of Purchasing, Cincinnati, Ohio.
Cleveland Heater Co., Air Controls, Inc., Division, Cleveland, Ohio.
Cleveland Steel Products Corporation, Cleveland, Ohio.
Coal-Heat (Magazine), Chicago, Ill. (In principle.)
Colladay Wholesale Hardware Co., The Frank, Hutchinson, Kans.
Consolidated Coal Co., Chicago, Ill.
Conwell & Co., E. L., Philadelphia, Pa.
Co-op. Community Builders, Inc., Wauwatosa, Wis.
Coroaire Heater Corporation, The, Cleveland, Ohio.
Corriveaux, F.—Home & Industrial Service, Schenectady, N. Y.
Dallman Supply Co., Sacramento, Calif.
Detroit Testing Laboratory, The, Detroit, Mich.
Enterprise Foundry Co., Inc., Rochester, N. Y.
Excelsior Steel Furnace Co., The, Chicago, Ill.
Farquhar Furnace Co., The, Wilmington, Ohio.
Fitzgibbons Boiler Co., Inc., New York, N. Y.
Forest City Foundries Co., The, Cleveland, Ohio.
Foster-Thornburg Hardware Co., Huntington, W. Va.
Froehling & Robertson, Inc., Richmond, Va.
Front Rank Furnace Co., St. Louis, Mo. (In principle.)
Gardner Hardware Co., Minneapolis, Minn.
Hall-Neal Furnace Co., Indianapolis, Ind.
Hanks, Inc., Abbot A., San Francisco, Calif.
Harrington & Associates, Joseph, Chicago, Ill.
Henkle & Joyce Hardware Co., Lincoln, Nebr.
Herlan-Patterson, Inc., Buffalo, N. Y.
Holland Furnace Co., Holland, Mich.
Home Furnace Co., Holland, Mich.
International Heater Co., Utica, N. Y.
Iowa, University of, Iowa City, Iowa.
Kalamazoo Stove & Furnace Co., Kalamazoo, Mich.
Kol-Master Corporation, Oregon, Ill.
Larson Hardware Co., Sioux Falls, S. Dak.
Lau Blower Co., The, Dayton, Ohio.
Lennox Furnace Co., Columbus, Ohio, and Marshalltown, Iowa.
Lennox Furnace Co., Inc., The, Syracuse, N. Y.
Majestic Co., The, Huntington, Ind.
Marshall Furnace Co., Marshall, Mich.
Martino Co., A. R., Waterbury, Conn.
Master Plumber & Heating Contractor, The, Brooklyn, N. Y.
May-Fiebeger Co., The, Newark, Ohio.
McGowin Lyons Hardware & Supply Co., Mobile, Ala.
McMahill Heating Service, Omaha, Nebr.
Mellish & Murray Co., Chicago, Ill.
Meyer Furnace Co., The Peoria, Ill.
Michigan Tank & Furnace Corporation, Detroit, Mich.
Midland Cooperative Wholesale, Minneapolis, Minn.
Minnesota Testing Laboratories, Inc., Duluth, Minn.
Modern Installation Co., Prospect Park, Paterson, N. J.
Morrisdale Coal Mining Co., The, New York, N. Y.
Mueller Furnace Co., L. J., Milwaukee, Wis.
Nebraska, University of, Mechanical Engineering Department, Lincoln, Nebr.
New England Coal & Coke Co., Boston, Mass. (In principle.)
New Orleans, Inc., Better Business Bureau of, New Orleans, La. (In principle.)
New York Coal Sales Co., Columbus, Ohio.
New York Testing Laboratories, Inc., New York, N. Y.
Newark College of Engineering, Newark, N. J.
North American Coal Corporation, The, Cleveland, Ohio.
North Carolina State College of Agriculture & Engineering of the University of North Carolina, Raleigh, N. C.
Northern Controlled Heat Co., Inc., Watertown, N. Y.
Northwest Stove & Furnace Works, Inc., Portland, Oreg.
Northwestern Hanna Fuel Co., St. Paul, Minn.
Notre Dame, University of, Testing Laboratory, Notre Dame, Ind.
O'Hair & Co., P. E., San Francisco, Calif.
Olsen Manufacturing Co., The C. A., Elyria, Ohio.
Patzig Testing Laboratories, Des Moines, Iowa.
Pennsylvania State College, The, State College, Pa. (In principle.)
Philadelphia & Reading Coal & Iron Co., Philadelphia, Pa.
Plumbing & Heating Selling Co., New Orleans, La.
Premier Furnace Co., Dowagiac, Mich.
Purdue University, Lafayette, Ind.
Rearick Bros. Automatic Heating, Gary, Ind.
Richmond Hardware Co., Richmond, Va.
Roberts-Hamilton Co., Minneapolis, Minn.
Rose Polytechnic Institute, Terre Haute, Ind.
Round Oak Co., Dowagiac, Mich.

Rudy Furnace Co., Dowagiac, Mich.
Rybolt Heater Co., Ashland, Ohio.
Sacramento, Better Business Bureau of, Sacramento, Calif. (In principle.)
St. Louis Furnace Manufacturing Co., St. Louis, Mo.
St. Louis Sampling & Testing Works, St. Louis, Mo.
Scranton Better Business Bureau, Scranton, Pa. (In principle.)
Sears, Robuck & Co., Chicago, Ill.
Swarthmore Heating Service, Swarthmore, Pa.
Thatcher Furnace Co., Garwood, N. J.
Twining Laboratories, The, Fresno, Calif.
U.S. Air Conditioning Corporation, Minneapolis, Minn.
Viking Air Conditioning Corporation, Cleveland, Ohio.
Viking Manufacturing Corporation, The, Dayton, Ohio.
Ward, Inc., Thomas E., Hanover, N. H.
Washington, University of, Seattle, Wash.
Waterman-Waterbury Co., The, Minneapolis, Minn.
Waverly Heating Supply Co., Boston, Mass.
Western Furnaces, Inc., Tacoma, Wash.
Westwick & Son., John, Galena, Ill.
Williamson Heater Co., The, Cincinnati, Ohio.
Wise Furnace Co., The, Akron, Ohio.
Wyeth Hardware & Manufacturing Co., St. Joseph, Mo.

U. S. GOVERNMENT

Agriculture, U. S. Department of, Washington, D. C.
Federal Works Agency, Public Buildings Administration, Washington, D. C. (In principle.)
Interior, Department of the, Office of Indian Affairs, Construction Division, Chicago, Ill.
Navy Department, Bureau of Yards & Docks, Washington, D. C.