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UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 82 00.00 20

TERMINAL HEATING UNITS

02/16, CHG 1: 08/18

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SECTION 23 82 00.00 20

TERMINAL HEATING UNITS
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****
NOTE: This guide specification covers the requirements for unit heaters and infrared heaters.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

1.1 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z83.8/CSA 2.6	(2016; R 2021) Gas Unit Heaters, Gas Packaged Heaters, Gas Utility Heaters, and Gas-Fired Duct Furnaces
ANSI Z83.19/CSA 2.35	(2017; R 2022) Gas-Fired High-Intensity Infrared Heaters

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 33	(2016) Method of Testing Forced Circulation Air Cooling and Air Heating Coils

ASTM INTERNATIONAL (ASTM)

ASTM A109/A109M	(2016; R 2018) Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	(2023) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A463/A463M	(2022) Standard Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A1011/A1011M	(2023) Standard Specification for Steel Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM B209	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B209M	(2014) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
ASTM D1654	(2008; R 2016; E 2017) Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2	(2000; R 2020) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 54	(2021) National Fuel Gas Code
NFPA 70	(2023) National Electrical Code
NFPA 90A	(2024) Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2024) Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	(2020) Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

UNDERWRITERS LABORATORIES (UL)

UL 441	(2016; Reprint Jul 2016) UL Standard for SafetyGas Vents
UL 731	(2018; Reprint Nov 2021) UL Standard for Safety Oil-Fired Unit Heaters

1.2 RELATED REQUIREMENTS

Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Unit Heaters

Infrared Heaters

SD-10 Operation and Maintenance Data

Unit Heaters, Data Package 2

Infrared Heaters, Data Package 2

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

****

NOTE: In order to comply with UFC 1-200-02, designs must achieve energy consumption levels that are at least 30 percent below the baseline established in the 2010 publication of ASHRAE 90.1. The Designer of Record must design heating and cooling systems that assist in achieving this requirement.

****

2.1 UNIT HEATERS

Self-contained and factory assembled, [propeller] [or] [centrifugal] fan with capacities expressed as Btu per hour output and cubic foot-per-minute air delivery, operating conditions, and mounting arrangements as indicated. Average fan bearing life must be minimum 200,000 hours at operating conditions. Provide fan motor with [direct] [or] [belt] drive. Construct fan-guard motor mount of steel wire. Equip each heater with individually adjustable package discharge louver. Louvers may be substituted by discharge cones or diffusers. Provide thermostats [as indicated]. Furnish circuit breaker disconnect switch.

2.1.1 Gas-Fired Unit Heater

ANSI Z83.8/CSA 2.6 and AGA label.

2.1.1.1 Casing

Minimum [22] [_____] gage [steel] [or] [aluminum]. Provide removable access panels.

2.1.1.2 Heat Exchanger

Minimum [20] [_____] gage all-welded steel construction with corrosion-resistant aluminum finish.

2.1.1.3 Burners

Die-formed, slot ports, and steel construction with aluminum paint.

2.1.1.4 Draft Diverter

All-welded steel construction and an integral part of each heat exchanger section. Allows backdrafts to bypass burner assembly without affecting normal operation.

2.1.1.5 Controls

Consisting of a combination pressure regulator, [two-stage gas valve in 100 percent and [55] [_____] percent of full rating,] main shutoff valve, pilot cock, pilot safety switch for 100 percent shutoff, high temperature limit switch, and time-delay fan switch. Include power and control connections in an integral junction box.

2.1.1.6 Efficiency

Unit heater must have a minimum combustion efficiency of 80 percent when tested in accordance with ANSI Z83.8/CSA 2.6.

[2.1.1.7 Accessories

****
NOTE: Do not acquire propane-gas conversion kit for project locations where it is not cost effective to use propane gas as fuel. Delete this paragraph if not required.
****

Provide [propane-gas conversion kit] [automatic electric pilot recognition kit].

]2.1.2 Oil-Fired Unit Heater

UL 731 and UL labeled.

2.1.2.1 Casing

Minimum [22] [_____] gage [aluminum] [or] [[enamel] [or] [vinyl] coated steel]. Provide removable access door.

2.1.2.2 Heat Exchanger

Minimum 16 gage primary combustion chamber constructed of [perlite-clad steel] [, aluminum-clad steel] [, or] [400 series stainless steel]; minimum 14 gage secondary heating section composed of aluminized, mild, or hot-rolled steel. Provide a flame observation port on the burner side of the heater.

2.1.2.3 Burner

Provide pressure oil-atomizing burner with mechanically forced draft, suitable for fuel oil No. 2. Provide two-stage oil pump. Equip burner motor with a combustion air damper.

2.1.2.4 Controls

Include fan and limit switch, low voltage (24-volt) transformer, electronic flame safeguard with flame safety relay, and electric spark ignition.

2.1.2.5 Accessories

Provide [power exhauster,] oil filter, oil pressure regulator, and barometric damper.

2.1.2.6 Efficiency

Unit heater must have a minimum combustion efficiency of 80 percent when tested in accordance with UL 731.

2.1.3 [Steam] [or] [Hot-Water] Unit Heater

ASHRAE 33 tested for heating coils; UL listed for motor and controls.

2.1.3.1 Casing

Minimum [20] [_____] gage [steel] [or] [aluminum] with removable access

panels or means to remove, service, and maintain major components.

2.1.3.2 Coil

****
NOTE: Use copper for maximum 517 kPa (gage) 75 psig steam or maximum 163 degrees C 325 degrees F hot water at 1379 kPa (gage) 200 psig, red brass for maximum 1379 kPa (gage) 200 psig steam or 218 degrees C 425 degrees F hot water at 2068 kPa (gage) 300 psig, copper nickel for maximum 2758 kPa (gage) 400 psig steam or maximum 232 degrees C 450 degrees F at 4136 kPa (gage) 600 psig, and steel for maximum 232 degrees C 450 degrees F hot water at 4136 kPa (gage) 600 psig.
****

Fin-and-tube coil constructed of [copper,] [red brass,] [90-10 copper nickel,] [or] [steel] tubes and [copper] [or] [aluminum] fins. Use maximum design pressure of [steam at [_____] kilopascal (kpa (gage)) pounds per square inch gage (psig)] [and] [hot water at [_____] kpa (gage) psig and [_____] degrees C F].

2.1.3.3 Controls

[Automatic controls of [modulating] [on-off-auto] [or] [combination of modulating and on-off-auto] system] [As indicated]. [Provide a three-position selector switch.]

2.1.4 Electric Unit Heater

****
NOTE: Check if Section 23 83 00.00 20 ELECTRIC SPACE HEATING EQUIPMENT or Section 23 82 43.00 40 ELECTRIC DUCT HEATERS covers electric unit heater. Recommend to cover unit heaters exclusively in this section. Avoid redundant statement.
****

UL listed; wattage, voltage, phase, and number of steps as indicated. Provide control-circuit terminals and single source of power supply. Heater 5 Kw and larger must be three-phase, with load balanced on each of the three phases. Limit leaving air temperature below 60 degrees C at 15.5 degrees C 140 degrees F at 60 degrees F entering air.

2.1.4.1 Casing

Minimum [21] [_____] gage steel.

2.1.4.2 Heating Element

Nickel-chromium heating wire element, free from expansion noise and 60 Hz hum. Embed element in magnesium-oxide insulating refractory. Seal element in high-mass steel or corrosion-resisting metallic sheath with fins. Enclose element ends in terminal box. Space fins at maximum six fins per inch. Limit fin surface temperature 288 degrees C 550 degrees F at any point during normal operation.

2.1.4.3 Controls

Include limit controls for thermal overheat protection of heaters. For remote thermostatic operation, provide contactor rated for 100,000 duty cycles. [Provide a control transformer to supply 120-volt thermostat control circuit for each heater.] Provide room thermostat for pilot duty.

2.1.4.4 Wiring

Completely factory-prewired to terminal strips, ready to receive branch circuit and control connections for 60 degrees C 140 degrees F [copper] [or] [aluminum] wiring.

[2.1.4.5 Accessories

****
NOTE: These accessories are not integral components of electric unit heater. Delete this paragraph if not required.
****

Provide fan switching devices to independently operate fan motor for summer ventilation and winter heat recovery.

]2.2 INFRARED HEATERS

****
NOTE: Check if Section 23 83 00.00 20 ELECTRIC SPACE HEATING EQUIPMENT or Section 23 82 43.00 40 ELECTRIC DUCT HEATERS covers electric unit heater. Recommend to cover unit heaters exclusively in this section. Avoid redundant statement.
****

[Reflector-beam spread] [and] operating conditions as indicated. Provide pre-wired control boxes, thermostats, and reflector [and duct] hangers.

2.2.1 Sheet Metal

[a. Aluminum-Clad Steel: ASTM A463/A463M, nominal thickness of minimum 16 gage for radiant tubing between burners and vacuum pump or vent.

][b. Aluminum: ASTM B209M ASTM B209, manufacturer's standard thickness.

][c. Stainless Steel: ASTM A240/A240M, nominal thickness of not less than 20 gage.

][d. [Ceramic-Coated] [Enamel-Coated] Steel: ASTM A1011/A1011M hot rolled orASTM A109/A109M cold rolled, low-carbon steel. Provide coating able to withstand infrared heater operating temperatures.

]2.2.2 Unvented Gas Infrared Heater

****
NOTE: Use only if adequate ventilation ensured for the project location.
****

ANSI Z83.19/CSA 2.35 and AGA approved.

2.2.2.1 Heating Element

Perforated ceramic capable of withstanding thermal shock in [3] [_____] minutes from 1093 to 0 degrees C 2000 to 32 degrees F without fatigue and of minimum 871 degrees C 1600 degrees F operating temperature. When re-radiating screens are used to obtain operating temperature, provide [stainless-steel] [or] [chromized-steel] matching screen.

2.2.2.2 Reflector

[Polished [aluminum] [stainless steel]] [or] [approved high infrared reflector materials]. Provide reflector supports of manufacturer's standard.

2.2.2.3 Controls

Provide either an intermittent pilot ignition system or a solid-state direct ignition system. Provide automatic gas safety valve capable of withstanding a 10 percent voltage fluctuation.

2.2.2.4 Ventilation

Section 23 30 00 HVAC AIR DISTRIBUTION.

2.2.3 Vented Gas Infrared Heater

****

NOTE: For spot heating, use single-burner power vented heater; for small area heating, uses single-burner vacuum vented heater; and for large area or entire building heating, use multiple-burner vacuum vented heater.

****

ANSI Z83.19/CSA 2.35 with AGA label, [single-burner power vented] [single-burner vacuum vented] [or] [multiple-burner vacuum vented].

2.2.3.1 Vent

NFPA 54 and NFPA 211, [Type 316 stainless steel] [or] [high-temperature corrosion-resistant plastic rated for minimum 204 degrees C 400 degrees F]. Vent flue gas to outdoors by induced draft.

2.2.3.2 Reflector

[Polished [aluminum] [stainless steel]] [or] [approved high infrared reflector materials]. Provide manufacturer's standard reflector supports.

2.2.3.3 Heat Exchanger and Combustion Chamber

Construct heat exchanger and combustion chamber of [aluminum-clad steel] [ceramic-coated steel] [or] stainless steel.

2.2.3.4 Controls

Incorporate either an intermittent pilot ignition system or a solid-state direct ignition system. Provide safety air-flow switch for each burner.

2.2.3.5 Fan or Vacuum Pump

Heater manufacturer's standard.

2.2.3.6 Performance

****

NOTE: Performance Criteria are:

	Minimum Steady State Thermal Efficiency (Percent)	Maximum Heat Release (kJ Per Square Meter of Heating Surface
Single-Burner Power Vented Heater	80	31,350
Single-Burner Vacuum Vented Heater	80	33,060
Multiple-Burner Vacuum Vented Heater	85	23,940

	Minimum Steady State Thermal Efficiency (Percent)	Maximum Heat Release (BTU Per Square Meter of Heating Surface
Single-Burner Power Vented Heater	80	2,750
Single-Burner Vacuum Vented Heater	80	2,900
Multiple-Burner Vacuum Vented Heater	85	2,100

****

Provide sufficient radiant heating surface to attain a minimum steady-state thermal efficiency of [80] [85] percent and a maximum heat release of [31,350] [33,060] [23.940] kJ per square meter [2,750] [2,900] [2,100] Btu per square foot.

2.2.4 Electric Infrared Heater

****

NOTE: Check if Section 23 83 00.00 20 ELECTRIC SPACE HEATING EQUIPMENT or Section 23 82 43.00 40 ELECTRIC DUCT HEATERS covers electric unit heater. Recommend to cover unit heaters exclusively in this section. Avoid redundant statement.

****

Self-contained, factory assembled, and UL listed and including the heating element, reflector, heater housing, mounting brackets, element holders, wire guards, and high-temperature internal wiring.

2.2.4.1 Heating Element

Minimum 9 1/2 mm 3/8 inch diameter quartz tube or metal sheath with coiled resistor wire. Element operating temperature range must be 649 to 982 degrees C 1200 to 1800 degrees F.

2.2.4.2 Heater Housing

[Weatherproof] [aluminum-clad steel] [stainless-steel] [aluminum] [or] [low-carbon steel] construction. Provide a baked enamel finish over a corrosion-resistant primer. Provide a chrome-plated or stainless-steel wire guard to prevent heating elements from accidental damage. Furnish swivel brackets to position heater in any horizontal angle.

2.2.4.3 Reflector

Polished [aluminum] [or] [stainless steel].

2.2.4.4 Wiring

Fully enclosed internal wiring. Provide minimum 152 mm 6 inch slack fixture (heater) wire for connection to branch circuit wiring.

[2.2.4.5 Accessories

****

NOTE: Electric-clock controller is an input controller provided separately as an optional addition to unit heaters. Delete this paragraph if not required.

****

Provide electric-clock controller with self-starting synchronous motors and snap acting switch, rated for 125 percent of the load which it controls. Provide a 30-second time cycle with an infinitely adjustable "on-off" period each cycle. Equip controller with external indicating knob for manual adjustment from zero to 100 percent. If surface mounted, furnish steel enclosure with a baked enamel finish over a corrosion-resistant primer. If flush mounted, furnish galvanized steel enclosure with knockouts for conduit in bottom and sides. Provide a connection wiring diagram on the inside cover of the enclosure. Where loads exceed the maximum available rating of controller, provide high duty-cycle contactors serving as pilot devices.

]2.3 FAN

Provide [steel] [or] [aluminum] fans with ball or roller bearings for motors over 0.09 kW 1/8 horsepower (hp) and sleeve bearings for motors 0.09 kW 1/8 hp and under. Provide sleeve bearings with oil reservoir, if not permanently lubricated.

2.4 MOTOR AND STARTER

****

NOTE: The motor control requirements should be coordinated with the electrical section and will depend on field conditions. The following types of motor starters should be used as a guide only. When

electrical power circuits to which equipment are connected are heavily loaded, the full voltage-across line starting may result in excessive voltage drop on the circuit.

Motor kW	Voltage	Type Starter
Up to 5 1/2	208-230	Across line magnetic
5 1/2 to 11	208-230	Across line magnetic part wind or wye delta
11 to 22 3/8	460	Across line magnetic part wind or wye delta
Above 11	208-230	Part wind or wye delta
Above 22 3/8	460	Part wind or wye delta

Motor kW	Voltage	Type Starter
Up to 7-1/2	208-230	Across line magnetic
7-1/2 to 15	208-230	Across line magnetic part wind or wye delta
15 to 30	460	Across line magnetic part wind or wye delta
Above 15	208-230	Part wind or wye delta
Above 30	460	Part wind or wye delta

****

NEMA MG 1, and NEMA ICS 2, and NEMA ICS 6, respectively. [Provide explosion-proof motors and motor starters where indicated.] Provide continuous-duty motor with built-in automatic reset thermal overload protection. For motor 0.37 kW 1/2 hp and larger, use three-phase. Provide single-phase motor of permanent split capacitor or capacitor start. Limit motor speed at 1800 rpm r/min. Wire motor to heater power supply source.

[2.5 NOISE, VIBRATION AND SEISMIC CONTROLS

****

NOTE: Depending upon various heaters, delete any irrelevant paragraph for piping systems.

****

Section 22 05 48.00 20 MECHANICAL SOUND VIBRATION AND SEISMIC CONTROL.

][2.6 GAS PIPING SYSTEM AND FLUE VENT

Comply with Section 23 11 20 FACILITY GAS PIPING, Section 33 51 15

NATURAL-GAS / LIQUID PETROLEUM DISTRIBUTION PIPELINES, for gas valves and piping. Use UL 441 flue vents [and] [gas-vent roof jacks], of [galvanized steel] [aluminum] [or] [stainless steel].

][2.7 FUEL OIL [TANK] AND PIPING SYSTEM

Section 33 52 10 FUEL SYSTEMS PIPING (SERVICE STATION).

][2.8 HOT WATER PIPING SYSTEM

Section 23 21 13.00 20 LOW TEMPERATURE WATER [LTW] HEATING SYSTEMS.

][2.9 STEAM AND CONDENSATE PIPING SYSTEM

Section 23 22 26.00 20 STEAM SYSTEM AND TERMINAL UNITS.

]2.10 SOURCE QUALITY CONTROL

Special protection is not required for equipment that has a zinc coating conforming to [ASTM A123/A123M] [ASTM A653/A653M]. Otherwise, protect affected equipment items by manufacturers' corrosion-inhibiting coating or paint system that has proved capable of withstanding salt-spray test in accordance with ASTM B117. Test indoor and outdoor equipment for 125 hours; test outdoor equipment used in a marine atmosphere for 500 hours. For each specimen, perform a scratch test as defined in ASTM D1654.

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment where indicated and as recommended by manufacturer's recommendations, NFPA 54, NFPA 90A, NFPA 90B, NFPA 91 and NFPA 211.

3.1.1 Suspensions of Equipment

Provide equipment supports including beam clamps, turnbuckles and twist links or weld-wire chains, wire ropes with rope clips and rope thimbles, threaded-eye rod hangers with lock nuts and heat-duct hangers, threaded-eye bolts with expansion screws, brackets, platform and mounting frame, and vibration isolators. Locate equipment in such a manner that working space is available for servicing, such as vacuum pump and burner removal, access to automatic controls, and lubrication. Provide electrical isolation of dissimilar metals. Clean interior of casings or cabinets before and after completion of installation.

3.1.2 Vents

NFPA 54 and NFPA 211. Provide vents with weatherproofing flashings in accordance with Section 07 60 00 FLASHING AND SHEET METAL.

3.1.3 Electrical Work

NFPA 70 and Division 26, "ELECTRICAL." When replacing original control wires, provide No. 16 AWG with minimum 105 degrees C insulation.

3.2 FIELD QUALITY CONTROL

Administer, schedule, and conduct specified tests. Furnish personnel, instruments and equipment for such tests. Correct defects and repeat the

respective inspections and tests. Conduct inspections and testing in the presence of the Contracting Officer.

3.2.1 Test Instruments and Apparatus

Provide instruments and apparatus currently certified as being accurate to within one percent of their full scale. Use gages with a maximum scale between 1 1/2 and 2 times test pressure.

3.2.2 Field Inspection

Prior to initial operation, inspect equipment installation to ensure that indicated and specified requirements have been met.

3.2.3 Field Tests

3.2.3.1 Fuel Piping Pressure Tests

[Pneumatically test gas piping at 1 1/2 times operating pressure and check for leakage with soap solution.] [Hydrostatically test fuel oil piping at 1 1/2 times maximum working pressure.]

3.2.3.2 Fire Tests for Nonelectrical Heating Equipment

Test combustion controls and equipment with specified fuel at 100 percent full rated load. During tests, verify proper operation of controls. Adjust burners for maximum efficiency using Orsat or similar apparatus. Maintain firing for at least four hours [, and where high-low-off combustion controls are provided, operate the heating equipment for one hour at low fire and 3 hours at high fire]. For acceptable combustion efficiency, allow maximum 4.5 percent carbon dioxide in flue gases.

3.2.3.3 Insulation-Resistance Tests for Electrical Equipment

At the completion of wiring, test 600 volt wiring to verify that no short circuits exist before or after the attachment of electrical heating equipment to the power source. Make tests with an instrument which applies a voltage of approximately 500 volts for a direct reading of insulation resistance.

3.2.3.4 Operational Tests

After completing fire tests and insulation-resistance tests, operate equipment continuously under varying load conditions to verify functioning of combustion controls, electrical controls, flame safeguard controls, safety interlocks, and specified operating sequence. Run each test for a minimum period of one hour.

3.3 SCHEDULE

Some metric measurements in this section are based on mathematical conversion of inch-pound measurements, and not on metric measurements commonly agreed on by the manufacturers or other parties. The inch-pound and metric measurements shown are as follows:

Products	Inch-Pound	Metric
a. Motor Capacity	= 7 1/2 hp	= 5 1/2 kW
	= 15 hp	= 11 kW
	= 30 hp	= 22 3/8 kW

-- End of Section --