
USACE / NAVFAC / AFCEA UFGS-15760N (September 1999)

Preparing Activity: NAVFAC Replacing without revision
NFGS of same number and date

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15760N

TERMINAL HEATING AND COOLING UNITS

09/99

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 RELATED REQUIREMENTS
- 1.3 SUBMITTALS

PART 2 PRODUCTS

2.1 UNIT HEATERS

2.1.1 Gas-Fired Unit Heater

- 2.1.1.1 Casing
- 2.1.1.2 Heat Exchanger
- 2.1.1.3 Burners
- 2.1.1.4 Draft Diverter
- 2.1.1.5 Controls
- 2.1.1.6 Efficiency
- 2.1.1.7 Accessories

2.1.2 Oil-Fired Unit Heater

- 2.1.2.1 Casing
- 2.1.2.2 Heat Exchanger
- 2.1.2.3 Burner
- 2.1.2.4 Controls
- 2.1.2.5 Accessories
- 2.1.2.6 Efficiency

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

- 2.1.3.1 Casing
- 2.1.3.2 Coil
- 2.1.3.3 Controls

2.1.4 Electric Unit Heater

- 2.1.4.1 Casing
- 2.1.4.2 Heating Element
- 2.1.4.3 Controls
- 2.1.4.4 Wiring
- 2.1.4.5 Accessories

2.2 INFRARED HEATERS

2.2.1 Sheet Metal

- 2.2.2 Unvented Gas Infrared Heater
 - 2.2.2.1 Heating Element
 - 2.2.2.2 Reflector
 - 2.2.2.3 Controls
 - 2.2.2.4 Ventilation
- 2.2.3 Vented Gas Infrared Heater
 - 2.2.3.1 Vent
 - 2.2.3.2 Reflector
 - 2.2.3.3 Heat Exchanger and Combustion Chamber
 - 2.2.3.4 Controls
 - 2.2.3.5 Fan or Vacuum Pump
 - 2.2.3.6 Performance
- 2.2.4 Electric Infrared Heater
 - 2.2.4.1 Heating Element
 - 2.2.4.2 Heater Housing
 - 2.2.4.3 Reflector
 - 2.2.4.4 Wiring
 - 2.2.4.5 Accessories
- 2.3 FAN
- 2.4 MOTOR AND STARTER
- 2.5 [NOISE, VIBRATION AND SEISMIC CONTROLS]
- 2.6 GAS PIPING SYSTEM AND FLUE VENT
- 2.7 FUEL OIL [TANK] AND PIPING SYSTEM
- 2.8 HOT WATER PIPING SYSTEM
- 2.9 STEAM AND CONDENSATE PIPING SYSTEM
- 2.10 SOURCE QUALITY CONTROL

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 Suspensions of Equipment
 - 3.1.2 Vents
 - 3.1.3 Electrical Work
- 3.2 FIELD QUALITY CONTROL
 - 3.2.1 Test Instruments and Apparatus
 - 3.2.2 Field Inspection
 - 3.2.3 Field Tests
 - 3.2.3.1 Fuel Piping Pressure Tests
 - 3.2.3.2 Fire Tests for Nonelectrical Heating Equipment
 - 3.2.3.3 Insulation-Resistance Tests for Electrical Equipment
 - 3.2.3.4 Operational Tests
- 3.3 SCHEDULE

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEA UFGS-15760N (September 1999)

Preparing Activity: NAVFAC Replacing without revision
NFGS of same number and date

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

SECTION 15760N

TERMINAL HEATING AND COOLING UNITS 09/99

NOTE: This guide specification covers the requirements for unit heaters and infrared heaters.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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 Z83.6 (1990; A 1993) Gas-Fired Infrared Heaters

ANSI Z83.8 (2002) Gas Unit Heaters and Gas-Fired Duct

Furnaces

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

ASHRAE 33 (2000) Method of Testing Forced Circulation Air Cooling and Air Heating Coils

ASTM INTERNATIONAL (ASTM)

ASTM A 109 (1993) Steel, Strip, Carbon, Cold-Rolled

ASTM A 109M (1991) Steel, Strip, Carbon, Cold-Rolled (Metric)

ASTM A 123 (1989a) Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 167 (1999) Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

ASTM A 463/A 463M (2002a) Steel Sheet, Aluminum-Coated, by the Hot-Dip Process

ASTM A 569/A 569M (1998) Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip, Commercial

ASTM A 653/A 653M (2003) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM B 117 (2002) Operating Salt Spray (Fog) Apparatus

ASTM B 209 (2002a) Aluminum and Aluminum-Alloy Sheet and Plate

ASTM B 209M (2002a) Aluminum and Aluminum-Alloy Sheet and Plate (Metric)

ASTM D 1654 (1992; R 2000) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 2 (2000) Industrial Controls and Systems: Controllers, Contactors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC

NEMA ICS 6 (1993; R 2001) Industrial Control and Systems: Enclosures

NEMA MG 1 (2003) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211	(2003) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances
NFPA 54	(2002) National Fuel Gas Code
NFPA 70	(2002) National Electrical Code
NFPA 90A	(2002) Installation of Air Conditioning and Ventilating Systems
NFPA 90B	(2002) Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	(1999) Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids

UNDERWRITERS LABORATORIES (UL)

UL 441	(1996; Rev thru Dec 1999) Gas Vents
UL 731	(1995; Rev thru Jan 1999) Oil-Fired Unit Heaters

1.2 RELATED REQUIREMENTS

Section 15050N BASIC MECHANICAL MATERIALS AND METHODS, applies to this section with additions and modifications specified herein.

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 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 01781 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

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 shall 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 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

Minimum steady state efficiencies shall be 78 percent at maximum rated capacity and 75 percent at minimum rated capacity that is provided and allowed by the controls.

[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

Minimum steady state efficiencies shall be 81 percent at maximum rated capacity and 78 percent at minimum rated capacity that is provided and allowed by the controls.

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 15768, "Electric Space Heating Equipment," 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 shall 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 15768, "Electric Space Heating Equipment," 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 A 463/A 463M, nominal thickness of

minimum 16 gage for radiant tubing between burners and vacuum pump or vent.]

- [b. Aluminum: ASTM B 209M ASTM B 209, manufacturer's standard thickness.]
- [c. Stainless Steel: ASTM A 167, nominal thickness of not less than 20 gage.]
- [d. [Ceramic-Coated] [Enamel-Coated] Steel: ASTM A 569/A 569M hot rolled or ASTM A 109M ASTM A 109 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 Z83.6 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 15720N AIR HANDLING UNITS.

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. Do not use vented gas
infrared heaters in projects in the
SOUTHNAVFACENGCOM area.

ANSI Z83.6 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 Foot of Heating Surface
Single-Burner Power Vented Heater	80	2,750

	Minimum Steady State Thermal Efficiency (Percent)	Maximum Heat Release (BTU Per Square Foot of Heating Surface
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 15768, "Electric Space Heating Equipment," 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 shall 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.

<u>Motor kW</u>	<u>Voltage</u>	<u>Type Starter</u>
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
<u>Motor hp</u>	<u>Voltage</u>	<u>Type Starter</u>
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

Motor hp	Voltage	Type Starter

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 15070N MECHANICAL SOUND VIBRATION AND SEISMIC CONTROL.]

[2.6 GAS PIPING SYSTEM AND FLUE VENT

Comply with Section 15195N NATURAL GAS AND LIQUID PETROLEUM PIPING, 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 15192N FUEL OIL PIPING.

] 2.8 HOT WATER PIPING SYSTEM

Section 15185N LOW TEMPERATURE WATER [LTW] HEATING SYSTEMS.

] 2.9 STEAM AND CONDENSATE PIPING SYSTEM

Section 15183N 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 A 123] [ASTM A 653/A 653M]&\. 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 B 117. 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 D 1654.

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 07600 FLASHING AND SHEET METAL.

3.1.3 Electrical Work

NFPA 70 and Division 16, "Electrical Work." 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:

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

-- End of Section --