Preparing Activity: USACE Superseding without Revision
UFGS-11 82 20 (August 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 11 82 19

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05/20

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PACKAGED INCINERATORS
05/20

NOTE: This guide specification covers the requirements for packaged, and modular field-erected; starved, and excess air incinerators.

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

NOTE: The packaged incinerator specified herein is intended to burn waste materials for residential and nonresidential structures in batch burning applications. Waste includes combustible material, rubbish, garbage, and classified materials.

This section addresses incinerators having a capacity ranging from 1.05 MW 3.58 MBtuh or 378 kg/hr 833 pounds/hr, 9 metric tons/day 10 TPD up to 7.91 MW (27 MBtuh), or approximately 2.7 metric tons/hr 3 tons per hour, 68 metric tons/day 75 TPD of Type 2 waste 10 MJ/kg 4300 Btu per pound, or the Joule Btu

equivalent amount of Types 0, 1, or 3.

Excess air incinerators covered by this guide specification are expected to operate in a "controlled air" mode, similar to starved air incinerators, but constructed as a single chamber rather than two separate chambers. These units may have either an integral, or a separate heat recovery boiler. Auxiliary burners are fired with gas, oil, or a combination thereof and sized to supply the input required to ensure complete combustion of the refuse in the primary and secondary combustion zones.

****

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.

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL, INC. (AMCA)

AMCA 99	(2016) Standards Handbook
AMCA 210	(2016) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 801	(2001; R 2008) Industrial Process/Power Generation Fans: Specification Guidelines

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z21.13/CSA 4.9	(2022) Gas-Fired Low Pressure Steam and Hot Water Boilers

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.1	(2003; R 2018) Unified Inch Screw Threads

	(UN and UNR Thread Form)
ASME B18.2.1	(2012; Errata 2013) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2022) Nuts for General Applications: Machine Screw Nuts, and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B31.1	(2022) Power Piping
ASME B40.100	(2022) Pressure Gauges and Gauge Attachments
ASME PTC 4	(2013) Fired Steam Generators
ASME PTC 10	(1997; R 2014) Performance Test Code on Compressors and Exhausters
ASME PTC 19.2	(2010; R 2015) Pressure Measurement
ASME PTC 19.3 TW	(2016) Thermowells Performance Test Codes
ASME PTC 19.10	(1981) Flue and Exhaust Gas Analyses

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C700	(2020) Cold-Water Meters - Displacement Type, Metal Alloy Main Case

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1/B2.1M	(2021) Specification for Welding Procedure and Performance Qualification
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A48/A48M	(2003; R 2021) Standard Specification for Gray Iron Castings
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A297/A297M	(2021a) Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A319	(1971; R 2020) Standard Specification for Gray Iron Castings for Elevated Temperatures for Non-Pressure Containing Parts
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A568/A568M	(2019a) Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A653/A653M	(2023) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2022a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated 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 B61	(2015; R 2021) Standard Specification for Steam or Valve Bronze Castings
ASTM B68/B68M	(2011) Standard Specification for Seamless Copper Tube, Bright Annealed (Metric)
ASTM B88	(2022) Standard Specification for Seamless Copper Water Tube
ASTM B88M	(2020) Standard Specification for Seamless Copper Water Tube (Metric)
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B633	(2023) Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B766	(2023) Standard Specification for Electrodeposited Coatings of Cadmium

ASTM C27	(1998; R 2022) Fireclay and High-Alumina Refractory Brick
ASTM C155	(1997; R 2022) Standard Specification for Insulating Firebrick
ASTM C195	(2007; R 2013) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C196	(2000; R 2016) Standard Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement
ASTM C401	(2012; R 2022) Alumina and Alumina-Silicate Castable Refractories
ASTM C612	(2014; R 2019) Standard Specification for Mineral Fiber Block and Board Thermal Insulation
ASTM D396	(2021) Standard Specification for Fuel Oils
ASTM E230/E230M	(2012) Standard Specification and Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
ASTM F1097	(2017; R 2022) Standard Specification for Mortar, Refractory (High-Temperature, Air-Setting)

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 7.0.01	(1996) Quality Standard for Instrument Air

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA MG 1	(2021) Motors and Generators
NEMA SM 23	(1991; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 30	(2024) Flammable and Combustible Liquids Code
NFPA 31	(2020) Standard for the Installation of Oil-Burning Equipment
NFPA 54	(2021) National Fuel Gas Code

NFPA 70	(2023) National Electrical Code
NFPA 82	(2019) Standard on Incinerators and Waste and Linen Handling Systems and Equipment
NFPA 85	(2023) Boiler and Combustion Systems Hazards Code
NFPA 211	(2019) Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1403	(2008) Accepted Industry Practice for Industrial Duct Construction, 2nd Edition

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-DTL-15024	(2018; Rev G; Notice 1 2022) Plates and Tags for Identification of Equipment, General Specification for
MIL-STD-461	(2015; Rev G) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
UFC 3-301-01	(2023) Structural Engineering

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-59222	(Basic; Notice 1; CANC Notice 1 2021) Fans, Centrifugal, Draft, Forced and Induced

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

40 CFR 60	Standards of Performance for New Stationary Sources

UNDERWRITERS LABORATORIES (UL)

UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 296	(2017; Reprint Nov 2022) UL Standard for Safety Oil Burners
UL 726	(1995; Reprint Oct 2013) Oil-Fired Boiler Assemblies
UL 795	(2016; Reprint May 2022) UL Standard for Safety Commercial-Industrial Gas Heating Equipment
UL FLAMMABLE & COMBUSTIBLE	(2012) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 DEFINITIONS

1.2.1 Waste Type 0, Trash

A mixture of highly combustible waste such as paper, cardboard cartons, wood boxes, and floor sweepings from commercial and industrial activities. The mixture consists of up to 10 percent by weight plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily rags, and plastic or rubber scraps. This type of waste contains up to 10 percent moisture and not more than 5 percent non-combustible solids, and has a heating value of 19,805 kJ/kg 8,500 BTU per pound as fired.

1.2.2 Waste Type 1, Rubbish

A mixture of combustible waste such as paper, cardboard cartons, wood scraps, foliage, and floor sweepings from domestic, commercial, and industrial activities. The mixture consists of up to 20 percent by weight restaurant waste, but contains little or no treated paper, plastic, or rubber wastes. This type of waste contains up to 25 percent moisture and not more than 10 percent incombustible solids, and has a heating value of 15,145 kJ/kg 6,500 BTU per pound as fired.

1.2.3 Waste Type 2, Refuse

An approximately even mixture of rubbish and garbage by weight. This type of waste, common to apartment and residential occupancy, consists of up to 50 percent moisture and not more than 7 percent incombustible solids, and has a heating value of 10,019 kJ/kg 4,300 BTU per pound as fired.

1.2.4 Waste Type 3, Garbage

Garbage such as animal and vegetable wastes from restaurants, hotels, hospitals, markets, and similar installations. This type of waste contains up to 70 percent moisture and up to not more than 5 percent incombustible solids, and has a heating value of 5825 kJ/kg 2,500 BTU per pound as fired.

1.2.5 Waste Type 4, Pathological

Human and animal remains, such as organs, animal carcasses, and solid organic wastes from hospitals, laboratories, slaughterhouses, animal pounds, and similar sources. This type of waste contains up to 85 percent moisture and not more than 5 percent incombustible solids, and has a heating value as low as 2330 kJ/kg 1,000 BTU per pound as fired.

1.2.6 Waste Type 5, Classified

A mixture of highly combustible waste such as paper, plastics, or other items that have been used for intelligence purposes, or deemed sensitive to completing a sensitive mission on behalf of our National security. This mixture consists of up to 10 per cent by weight plastic bags, coated paper, laminated paper, and plastic products. This type waste has approximately zero percent moisture content and non-combustible solids, and has a heating value of 16,310 to 23,300 kJ/kg 7,000 to 10,000 BTU per pound as fired.

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-02 Shop Drawings

Detailed Installation Drawings; G[, [_____]]

SD-03 Product Data

Incinerator; G[, [_____]]

Controls and Instruments; G[, [_____]]

Spare Parts; G[, [_____]]

Framed Instructions; G[, [_____]]

SD-06 Test Reports

Testing; G[, [_____]]

Instrument Readings; G[, [_____]]

Computations; G[, [_____]]

Methods; G[, [_____]]

Performance; G[, [_____]]

SD-07 Certificates

Incinerator System Equipment; G[, [_____]]

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions; G[, [_____]]

Incinerator; G[, [_____]]

Data Package 4 in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.4 QUALITY ASSURANCE

1.4.1 Pollution Control

****
NOTE: Research air pollution emission requirements by State and local agencies early in the project, including any anticipated changes that the project has to comply with, including particulates, carbon monoxide, HCL, sulfur oxides, heavy metals in the ash, and dioxins and furans. Hydrogen sulfide, hydrocarbons, and carbonyl emissions are normally not of concern in the design and operation of an incinerator at a military facility unless the State or local environmental regulatory agency requires them, in which case compliance needs to be indicated.
****

Provide incinerators meeting all applicable Federal, State, and local environmental requirements.

1.4.1.1 Gaseous Emissions

****
NOTE: In states with stringent air pollution control requirements, a baghouse and scrubber may be needed and should be specified in a separate specification section. Section 44 10 00 AIR POLLUTION CONTROL may not be adequate for this application, but may form a basis for writing this section.
****

[Limits for carbon monoxide emissions are [_____] ppm [to be corrected to [_____]].] [Limits for acid gases in the form of hydrogen chloride are restricted [to 30 ppm] [to 50 ppm] [by 90 percent removal] [_____] through

the use of pollution control equipment specified in Section [_____].] [Exposure limitations for dioxins and furans of the flue gases are restricted to temperatures of [982 degrees C 1800 degrees F] [[_____] degrees C degrees F] for [2] [_____] seconds.] If the incinerator equipment furnished cannot meet the above emission limits, it is the responsibility of the Contractor to provide additional emission control equipment to meet the emission standards.

1.4.1.2 Particle Size and Particulate Limits

****

NOTE: If requirements are more stringent, specify them in the blanks. Unless proven otherwise as a result of actual testing of the completed unit, the two-chambered, controlled-air incinerator is inherently nonpolluting and does not require the provision of supplemental special scrubbers, precipitators, or other air pollution control devices in most states, unless acid gas requirements have been established. In the event that actual testing of a unit indicates that pollutants are in excess of Federal, State, or local requirements, provide proper control devices as integral elements of the basic installation. Local air pollution control authorities must be contacted during the initial stages of design to determine what their requirements are and whether any changes are anticipated with which the Army will have to comply.

****

The emission of particles larger than 60 micrometers microns during normal operation is not allowed. At maximum designed charging rate, [emission can not exceed [229] [193] [_____] mg per standard cubic meter [0.1] [0.08] [_____] grains per standard cubic foot of dry flue gas adjusted to 12 percent carbon dioxide without the contribution of carbon dioxide from auxiliary fuel.] [emission minus water vapor, corrected to standard conditions containing 6 percent oxygen by volume, and as if no auxiliary fuel had been used, cannot contain particulate matter in excess of a concentration of [229] [_____] mg per dry cubic meter [0.1] [_____] grains per dry cubic foot of exhaust gas.] Measure visible emissions in accordance with and not exceeding zero on the Ringelmann scale. Emissions may be as high as 1 on the Ringelmann scale, but not for more than 3 cumulative minutes.

1.4.2 Noise Level

****

NOTE: Select the noise level required by the location of the equipment. Equipment in remote areas can be allowed to produce noise at a level slightly higher than the normal 85 dBA. OSHA regulations and Corps of Engineers safety regulations should be consulted for the most current 8-hour exposure limits.

****

Noise level at 305 mm 1 foot from any operating equipment cannot exceed [85] [_____] dBA.

[1.4.3 Electromagnetic Interference Control

****
NOTE: This paragraph should be used only for projects located in electromagnetic sensitive areas.
****

Provide equipment conforming to Class IIIC electromagnetic interference control and test limit requirements specified in MIL-STD-461.

]1.4.4 Welding

****
NOTE: Where pipeline, structural, or other welding is required on the same project, tests will be required accordingly. Testing may be by the coupon method as prescribed in the welding code or by special radiographic methods.
****

Perform all welding in accordance with qualified procedures using performance qualified welders and welding operators. Qualify procedures and welders in accordance with AWS B2.1/B2.1M. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests and perform the tests at the work site if practical. Furnish the Contracting Officer with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. Apply each welder's or welding operator's assigned symbol near each weld made as a permanent record. Weld structural members in accordance with AWS D1.1/D1.1M. Perform welding and nondestructive testing of piping systems in accordance with ASME B31.1.

1.4.5 Prohibition of Asbestos

Asbestos and asbestos-containing products are prohibited.

1.4.6 Permits

****
NOTE: Preliminary applications required before awarding of contract will be filed by the District. The Contractor cannot be held liable for changes in environmental requirements after award of contract. USAEHA must be contacted well in advance (approximately six months minimum.) in order to determine if they can do the testing. If they cannot do the testing, delete references to USAEHA.
****

Submit an operating and environmental test plan containing detailed, step-by-step actions and explain the expected result to demonstrate compliance with the requirements of this specification. Written approval by the Government of the test plan is one of the prerequisites for beginning the specified testing. Incinerator system must comply with the requirements of all applicable municipal, State and Federal emission regulations. Obtain all permits to construct and test the units, and conduct all tests required by regulatory authorities in order for the

owner to obtain a final permit to operate the facility. Perform environmental tests [by an approved independent qualified testing laboratory] [by the U.S. Army Environmental Hygiene Agency (USAEHA)] [_____].

1.4.7 Quality Control

****
NOTE: A QA/QC paragraph should be inserted using the District's most current QA/QC policy and plans.
****

Inspection will be continued during installation, after installation, and during tests. Ensure the Contracting Officer is present for tests. Furnish bound reports certifying instrument readings indicated are actual, computations required for testing are accurate, acceptable methods were used, and units satisfactory performed in accordance with requirements as specified.

1.4.8 Detailed Installation Drawings

Submit detailed installation drawings consisting of a complete list of equipment and materials, including illustrations, schedules, manufacturer's descriptive and technical literature, performance charts, catalog cuts, and installation instructions. Include complete wiring and piping diagrams and schematics, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Show proposed layout and anchorage of equipment and appurtenances, and the equipment's relationship to other parts of the work including clearances for installation, maintenance, and operation.

1.5 DELIVERY, STORAGE, AND HANDLING

Protect all equipment delivered and placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.6 EXTRA MATERIALS

Submit spare parts data for each different item of material and equipment specified, after approval of drawings and not later than [_____] days prior to the date of beneficial occupancy. Include in the data a list of parts and supplies, with current unit prices and source of supply, and the recommended number to be maintained in inventory for [_____] months of facility operation.

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

****
NOTE: An incinerator is normally supplied with a boiler for heat recovery in the form of steam or hot water. However, in some cases, it is possible that heat recovery is not included in the project. An example would be where a boiler already exists in an adjacent boiler plant. There may also be cases where an insufficient thermal demand exists relative to the amount of available waste, but high disposal costs by other methods dictate the use of

incineration. In those cases, references to the boiler, steam system, and thermal efficiency must be deleted. A thorough economic analysis must be done to determine the economic impact of having or not having heat energy recovery. When part of the project, the boiler is normally supplied by the incinerator manufacturer and is compatible with his equipment.

Delete the bracketed sentences regarding multiple units if only one system is to be provided.
****

Provide a complete and properly operating waste incineration facility [designed to operate with a steam boiler],consisting of [_____] [a] complete modular type waste incineration system[s] (unit systems) [each] with the capability of fully independent[or simultaneous] operation.[Ordinary mode of operation is for any [two] [_____] of the [three] [_____] unit systems to be operated simultaneously with the [third] [_____] system on stand-by. Provide each unit system with identical features to create redundancy and capability for maintaining continuous operation of the facility at full rated capacity.] [Each system] [System] must include:

a. An automatic or semi-automatic, hydraulically operated loader to inject waste into the incinerator.

b. A primary combustion chamber or zone consisting of the grate area within the furnace, or a separate chamber with internal rams.

c. A secondary combustion chamber or zone which consisting of an area above the grate within the furnace, or a separate chamber. Include auxiliary burners to maintain adequate combustion temperatures in either arrangement.

d. An ash removal system including a water quench system adequate to extinguish any combustion still occurring in the ash.

e. All auxiliary fans, burners, controls, and any additional air pollution control equipment required.

2.1.1 Waste Reduction

****
NOTE: Indicate the effectiveness and burnout capability of the incinerator to be provided. The combustible (carbon) content of the ash cannot exceed 10 percent with a minimum volume reduction of 90 percent of the combustible portion of the waste. Allowable weight reduction is only 45 percent measured on a dry basis. If the waste has a high amount of noncombustibles, either the 90 percent volume reduction is to be decreased, or only the combustible content of the ash can be specified. Indicate which criteria is to be used based upon ease of measurement and other project specific considerations.
****

[Provide incinerator which reduces waste to an ash not to exceed [45.0

percent (dry basis) by weight] [10 percent by volume] of the total combustible portion of the charge as specified.] [Combustible content of the ash cannot exceed [10] [_____] percent.]

2.1.2 Heat Recovery Boiler

****
NOTE: HHV is usually used in the United States while the LHV value is usually used in Europe. LHV is being advocated for use in the United States for thermal efficiency calculations. Indicate which value to use.
****

When equipped with a heat recovery boiler, the thermal efficiency of the total unit cannot be less than [_____] percent including all auxiliary fuel consumption while producing [_____] kg/hour pounds/hour of steam at a pressure of [_____] kPa psig and a temperature of [_____] degrees C degrees F. Provide soot-blowers for fire-tube and water-tube boilers to maintain thermal efficiency. Thermal efficiency is determined by the input-output method in accordance with ASME PTC 4.

2.1.3 Stack Design

****
NOTE: Indicate wind force the stack design will have to withstand. Structural design will include seismic resistance, see next paragraph.
****

Provide stack support in accordance with NFPA 82 and NFPA 211, as applicable. Design vertical and lateral supports for exterior chimneys to withstand wind forces of [129] [_____] km/hour [80] [_____] mph.

2.1.4 Structural Supports

****
NOTE: Provide seismic requirements for stack and equipment supports, if a Government designer is the Engineer of Record, and show on the drawings. Delete the inappropriate bracketed phrase. Pertinent portions of UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC must be included in the contract documents. Designer should investigate bearing requirements of several manufacturers and design footings accordingly.
****

Design structural steel equipment supports shown in accordance Section 05 12 00 STRUCTURAL STEEL. Design support steel to resist all applicable dead loads, live loads, and seismic loads as [specified in UFC 3-301-01 and Sections 13 48 73 SEISMIC CONTROL FOR MISCELLANEOUS EQUIPMENT and 23 05 48.19 [SEISMIC] BRACING FOR HVAC] [indicated]. Show a complete loading and support diagram on the detail drawings. Equipment supports shown on the contract drawings are for a general equipment layout and may not conform to the system furnished. Piers and footings may be relocated to suit equipment furnished provided they do not interfere with other

footings. Fabricate support steel in accordance with the provisions of AWS D1.1/D1.1M or field bolt using ASTM A325M ASTM A325 high strength bolts.

2.1.5 Special Tools

Furnish, as standard accessories, any special tools required for assembly, adjustment, setting, or maintenance of equipment specified under this section.

2.2 MATERIALS AND EQUIPMENT

2.2.1 Standard Products

****
NOTE: In lieu of the label or listing, the Contractor may submit a written certificate from any nationally recognized testing organization adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements, including methods of testing, of the specified agency.
****

Provide materials, incinerator system equipment, and controls which are the standard products of a manufacturer regularly engaged in the manufacture of the incinerator systems and essentially duplicate equipment that has been in satisfactory use for at least [2] [3] [_____] years prior to bid opening.

a. Where materials or equipment are specified to conform to the requirements of, or listed in rating publications of, agencies such as the Underwriter's Laboratories (UL), American Gas Association (AGA), American National Standards Institute (ANSI), the Hydronics Institute (formerly SBI and IBR) and American Boiler Manufacturers Association (ABMA), submit proof of such conformance. Label or listing of the specified agency is acceptable evidence. Where equipment is specified to conform to the requirements of the ASME Boiler and Pressure Vessel Code, also ensure code conformance of the design, fabrication, testing, and installation.

b. Submit certificates attesting that the incinerator equipment to be furnished is of a type that has been used on at least [three][_____] jobs of similar design and capacity as that specified for this project, accompanied with documentation that in a commercially operating industrial plant, the incineration system[and the steam generating system] [has][have] operated continuously and without interruption for a period of not less than [100] [_____] consecutive hours. Certify this documentation by an independent organization, such as an environmental testing firm or design consultant, who witnessed such operation, the actual plant owner if other than the incinerator manufacturer, or the energy customer.

c. Submit evidence that the incinerator[s] proposed to be furnished [meets] [meet] the applicable air pollution requirements and the emission requirements specified for pollution control. Test data must be for the model proposed to be furnished and for Incinerator Institute of America (IIA) Type.

d. Identify an equipment supporting service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the plant site. Controls that have been shown to have operated satisfactorily for the period may have modifications, provided it can be clearly shown that the modifications will not increase maintenance and operating costs and will not decrease the life of the equipment.

e. Submit framed instructions of proposed diagrams, instructions procedures, and other required sheets for review and approval by the Contracting Officer.

2.2.2 Nameplates

Furnish all field items with a permanent metal tag suitable for tag number or service identification; back-of-panel items are included in this category. Identify front-of-panel items by panel nameplates affixed to the item or panel surface, consistent in appearance from panel to panel and including the service function of the item involved. Color code or otherwise identify all wiring and piping within the panel. Install wires and cables without joints or splices except at terminal points. Label wires at each end. Identification of equipment must conform to MIL-DTL-15024. Each nameplate is to contain the following:

a. The manufacturer's name and address.
b. Equipment catalog or model number.
c. Equipment serial number.
d. Maximum refuse fuel feed rate of incinerator in kg/hour lbs/hour.
e. Incinerator volume in cubic meters cubic feet.

2.2.3 Equipment Guards and Access

****
NOTE: Catwalk, ladder, and guardrail, if required, will be indicated on drawings.
****

Provide enclosures and/or guards for all belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located to protect any person coming in close proximity thereto. Guard or cover high-temperature equipment and piping so located as to endanger personnel or create a fire hazard with insulation of the type specified for service. Provide items such as [catwalk,][stair,][ladder,][and guardrail] where shown in accordance with paragraph Catwalks and Access Platforms.

2.3 ELECTRICAL WORK

****
NOTE: Indicate on the drawings the type and class of motor enclosure depending on the environment in which the motor is to be used.
****

Provide electric-motor driven equipment specified herein complete with motor, motor starter and controls, conforming to NEMA MG 1, with enclosures as indicated. For motors smaller than 746 W fractional horsepower motors provide Type I, Class 1B or Class 2A or 2B, Continuous Duty. For motors larger than 746 watts integral horsepower motors provide

Type I or II, Class 2 Continuous Duty, Design L or M. Provide motor starters of one manufacturer and install in a motor control center located in the control room. Provide electrical equipment and power supply wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Provide motor starters complete with properly sized thermal-overload protection and other appurtenances necessary for the motor control specified. Select motors of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. Provide manual or automatic control and protective or signal devices required for the operation specified and any control wiring required for controls and devices, but not shown on the electrical plans, under this section.

2.4 INCINERATOR

****

NOTE: House the equipment in a pre-engineered, industrialized metal building which is specified using Section 13 34 19 PREENGINEERED METAL BUILDINGS. Include a sprinkler system in the building.

****

Provide incinerators suitable for indoor installation and consisting of a primary combustion chamber or furnace zone (grate area) for partial burning of and conversion of combustible material to a gas, and a secondary combustion chamber or furnace zone that consumes combustible gases and entrained particles. Select an incinerator of the starved air (pyrolytic) [or controlled air grate] type designed for continuous duty, with a gas tight constructed shell. Equip both combustion chambers or zones with combination natural gas/No. 2 oil burners, each designed to use [No. 2 fuel oil] [gas] as a supplementary fuel. Equip burners with an electronic ignition. Minimize supplementary fuel consumption for normal operations, not to exceed [326] [_____] MJ/metric ton [281,000] [_____] Btu per ton of waste fuel. Furnish a complete unit including combustion air and burner controls, interconnected ducts, breaching and piping, facilities for charging of the unit, a means of heat dissipation, [heat recovery unit], stack and air pollution control devices.

2.4.1 Type of Unit and Unit Capacity

****

NOTE: The incinerators should be capable of burning Types 0, 1, 2, 3, and 5 wastes. The approximate general characteristics of each type are indicated in the following table:

WASTE VS CONTENT				
Type	**Plastics, Rubber, Treated Paper (Max. Percent)**	**Noncombustible Solids (Max. Percent by Weight**	**Moisture Content (Max. Percent)**	**Heating Value MJ/Kg Btu Per Pound**
0 (Trash	**10**	**5**	**10**	**19.76 8,500**

WASTE VS CONTENT				
Type	**Plastics, Rubber, Treated Paper (Max. Percent)**	**Noncombustible Solids (Max. Percent by Weight**	**Moisture Content (Max. Percent)**	**Heating Value MJ/Kg Btu Per Pound**
1 (Rubbish)	**0**	**10**	**25**	**15.11 6,500**
2 (Refuse)	**-**	**7**	**50**	**9.99 (4,300)**
3 (Garbage)	**-**	**5**	**70**	**5.81 2,500**
4 (Pathological)	**(not applicable to this section)**			
5 (Classified)	**10**	**0**	**0**	**16.3-23.37-10,000**

Rubbish is a maximum 20 percent by weight of restaurant waste. The waste stream at each installation must be carefully quantified and analyzed. The information should be utilized for the final design to ensure that each incinerator is correctly sized. Wastes may contain polyurethane foam which may result in the release of cyanide or cyanide products in the exhaust. Include specific instructions regarding the hazardous materials that may be incinerated and excluded by the particular installation. Indicate capacity and operating schedule. Complete design sizing.

****

Provide incinerator with a continuous capacity not less than [_____] kg/hour pounds/hour when provided with the waste fuel specified below. This rate is a continuous burning rate and is not to be considered a charging rate, with no manual stoking required to accomplish the destruction of this waste. Design for each incinerator to normally be in operation [_____] days per week for [one] [two] [three] 8-hour shifts daily, with a primary fuel of unsorted and unprocessed municipal solid waste (MSW) as specified and delivered to the incinerator site including non-homogeneous combustible materials, cans, bottles, metal banding, and other non-combustible materials and significant concentrated quantities of combustible high energy Btu cellulose materials. Provide incinerator[s] [each] capable of burning municipal waste [of IIA Type [_____]] [with the following proximate analysis:

Waste Component	Range	Typical
Moisture	[_____] - [_____] percent	[_____] percent
Volatile matter	[_____] - [_____] percent	[_____] percent

Waste Component	Range	Typical
Fixed carbon	[_____] - [_____] percent	[_____] percent
Glass, metal, ash	[_____] - [_____] percent	[_____] percent
Btu/lb [LHV] [HHV]	[_____] - [_____]	[_____] (as received)

]

During normal, steady-state operations, use the self-sustained incineration process when burning waste as characterized above. Do not exceed auxiliary fuel limits given above except during start-up or burn-down, or when charging waste with an excessive moisture content. [When fired at the rate of [_____] metric tons/24-hour day tons/24-hour day with municipal solid waste, IIA Type [_____], each system must be capable of producing a minimum of [_____] kg/hour lb/hr of dry saturated steam at a pressure of [_____] kPa psig when furnished with entering water at [_____] degrees C degrees F] Incorporate accessibility for maintenance and service into equipment design and accessory installations.

2.4.2 Unit

****
NOTE: Indicate the type of incinerator to be provided by optional wording.
****

Equip unit for mechanical charging and operation, and to operate under negative pressure. Equip each unit system with automatic, continuous flow ash removal and ash conveyor equipment to remove all ash and residue as generated. Provide each incinerator as a complete [package-type unit,] [factory fabricated and field assembled,] self-contained, [free standing, mounted on a heavy steel frame,] [and erected at the project site], ready for immediate mounting on a foundation and for attachment of water supply, fuel, electrical, and vent connections, including lifting eye rings for adjusting and setting.

2.4.2.1 Supports

Support each incinerator upon the foundations with structural steel, independent of all refractory, conforming to ASTM A36/A36M. Design the incinerator supports to allow for free expansion and contraction of each portion of the incinerator without placing undue stress on any part of the incinerator or setting.

2.4.2.2 Access Doors

Provide gastight doors in sufficient numbers, adequately sized and properly located, to allow for cleaning, inspection and repair of all areas in the unit. Line interior surfaces exposed to direct radiation and high temperatures with an approved refractory material to prevent excessive heat losses and warping of doors. Hinge doors that are too large or bulky for hand removal or that weigh more than 11 kg 25 pounds.

2.4.3 Minimum Requirements

****
NOTE: During design phase, contact manufacturers of the type and size of equipment to be used and obtain

typical values. If this information is difficult to obtain or varies widely between manufacturers, delete the indicated optional sentences. Check with local regulatory authorities concerning residence time at elevated temperatures if dioxin and furan control are required.
****

Provide incinerator with total furnace volume in which the heat released per cubic meter cubic foot of furnace volume will not exceed [_____] W Btu/hr, and the gas velocity does not exceed [_____] m/second feet/second through the primary combustion zone and [_____] m/second feet/second through the secondary combustion zone and flue. Minimum secondary combustion zone volume is at least [_____] cubic m/kg cubic feet/pound of gas produced per second including excess air required for cooling purposes, and primary combustion zone operating temperature is sufficient for near complete carbon burn-out. After warm-up, maintain a minimum primary combustion zone temperature of at least 704 to 871 degrees C 1300 to 1600 degrees F, but do not exceed 982 degrees C 1800 degrees F at any time. Combustion time in the secondary combustion zone is to be at least [_____] seconds total time with temperatures maintained at 927 to 982 degrees C 1700 to 1800 degrees F with momentary and infrequent peaks not to exceed 1149 degrees C 2100 degrees F.

2.5 FURNACE CONSTRUCTION

2.5.1 General

Provide incinerator[s] meeting the requirements of NFPA 82, for IIA Types 1 and 2 waste, and Class III incinerators. When exposed to the internal environment of the incinerator, provide materials that are compatible with the temperature and atmospheric conditions which they will encounter. Ensure connections between dissimilar materials are electrically isolated from each other with dielectric unions or flanges. Provide galvanizing, where specified, in accordance with ASTM A123/A123M or ASTM A153/A153M.

2.5.2 Lubrication

Provide all sliding, moving, or rotating parts normally requiring lubrication, except those provided with "sealed-for-life" lubrication, with suitable means for such lubrication. Design equipment to operate efficiently and satisfactorily when lubricated using standard military lubricants.

2.5.2.1 Lubrication Fittings

Locate lubrication fittings in accessible protected positions, with a bright red circle painted around each point. Provide carbon steel balls, bodies and tips of fittings threaded with a 1/4-28 taper, straight or 1/8 pipe threads. Incorporate into fittings a surface ball-check valve located at the surface of the inlet tip. Cadmium plate carbon steel fittings in accordance with ASTM B766, Type I, Class 5, or zinc coat in accordance with ASTM B633, Type I, Class 1, except that the salt spray test period for red rust corrosion is a minimum of 50 hours.

2.5.2.2 Lubrication Equipment, 6.9 MPa 1,000 psi and Higher

When the use of high-pressure lubrication equipment, 6.9 MPa 1,000 psi and higher, could possibly damage grease seals or other parts, affix a

suitable warning or caution plate to the equipment in a conspicuous location.

2.5.3 Lifting Attachments

Equip each unit with lifting attachments designed and installed to enable the equipment to be lifted in its normal position without undue stress on the units.

2.5.4 Accessibility

Make all parts subject to wear, breakage, or distortion, and all parts which require periodic maintenance, readily accessible for adjustment or replacement.

2.5.5 Interchangeability

Provide only parts manufactured to standards that permit replacement without modification to parts or equipment.

2.5.6 Fastening Devices

Use suitable bolts and nuts conforming to ASME B18.2.1 and ASME B18.2.2 respectively, and screw threads conforming to the requirements of ASME B1.1. Install all screws, pins, bolts, hydraulic fittings, and similar parts with means for preventing loss of tightness. Do not swag, peen, stake, or otherwise permanently deform parts subject to removal or adjustment.

2.5.7 Electrical

Factory wire equipment complete with all necessary accessory devices, with all wiring brought to a single location, requiring only a source of power at [_____] volts, [_____] phase, 60 hertz, to make the equipment operable.

2.5.8 Castings and Forgings

Use gray iron conforming to ASTM A48/A48M; cast iron conforming to ASTM A319; and heat-resistant alloy conforming to ASTM A297/A297M Grade HF. Provide castings and forgings free from defects such as scale, mismatching, blowholes, or any other defect that will affect the life, or function of the part.

2.5.9 Welding, Brazing, Soldering, Riveting, or Wiring

Employ welding, brazing, soldering, riveting, or wiring only where these operations are required in the original design.

2.5.10 Incinerator Furnace Lining

Line furnace and flue connection with high-heat-duty firebrick conforming to ASTM C27 and ASTM C155 laid in high-heat-duty mortar conforming to ASTM F1097, suitable for use up to 1427 degrees C 2600 degrees F. At the Contractor's option, plastic or castable refractory containing high-duty or super-duty fireclay may be used, except that firebrick must be used in floors and hearths. Attach plastic refractory with anchors. Provide regular castable refractory conforming to ASTM C401, High Strength, Class C, except that the minimum modulus of rupture for transverse strength cannot be less than 4.14 MPa 600 psi after being heat soaked for 5 hours

or more at a temperature in excess of 1371 degrees C 2500 degrees F.

a. Provide insulating castable refractory conforming to ASTM C401, Class R , with hydraulic setting of a type especially suitable for incinerators required to burn wet material. Install plastic refractory in accordance with the manufacturer's recommendations and by workmen skilled in its application.

b. Make joints for firebrick as thin as practicable, not exceeding 3.2 mm 1/8 inch in thickness buildup as a buttered joint. Cover the entire surface of the adjoining faces with mortar. Construct arches and circular linings with the necessary radial or wedge brick, straight brick, and special shapes for skewbacks, so as [to conform to the radius shown and] to produce approximately the same joint thickness at the inner and outer curves. Use 228.6 mm 9 inch series firebrick in the main arches of the furnace and flue connection, laid on end with joints interlocking one-half the width of the brick. Except in the ash pit, lay firebrick on edge with interlocking joints in the hearths and floors.

c. Provide a casing construction not thinner than 3.213 mm 10 gauge steel sheet conforming to ASTM A1011/A1011M for the incinerator roof, with steel sheets and strips conforming to ASTM A568/A568M for incinerator casings, housings, and components. Provide other uncoated black sheet steel of composition and finish best suited to the end use. Use galvanized steel sheets conforming to ASTM A653/A653M and ASTM A924/A924M for incinerator casings, housing, and components. Gauge numbers specified are United States Standard gauge.

d. Use special rounded shapes for the exposed edges of the openings for the charging, firing, and stoking doors. Make the thickness of the refractory furnace lining as necessary to comply with the outer surface temperature requirements specified. Attach refractory walls to the casing with alloy steel or refractory anchors to form a monolithic structure which will resist heat and support the walls with a Safety Factor of 4. Prevent bulging and destruction of refractory due to heat stress by reinforcing, expansion joints, ties, and anchors. Provide manholes and other inspection and access openings, identification plates, and stamps with insulation finished neatly against a metal ring provided for this purpose.

2.5.11 Castable Refractory

Use castable refractory in [guillotine doors, and door sills,] dampers and lids for charging throats. Thoroughly dry-mix material from each original container to ensure uniform distribution of constituents and particle sizes and then mix with water to the consistency of a stiff concrete. Place the mixture in the molds or frames in such manner as to exclude air bubbles and keep moist for 24 hours. Castings may be premolded or molded in place and conform to the details shown. Firmly set premolded castings in place and, where required, bond to the firebrick masonry with firebrick mortar.

2.5.12 Refractory Wall Construction

****

NOTE: Values for minimum thickness of refractory:

REFRACTORY THICKNESS VS. CAPACITY	
Capacity (grams per second) (pounds per hour)	Min. Refractory Thickness (mm) (inches)
For Walls	
Up to 63Up to 500	1084-1/4
63 to 252500 to 2,000	1084-1/4
For Hearths	
Indoors Up to 63	1144-1/2
Indoors 63 to 252 500 to 2000	1144-1/2
Outdoors	63.52-1/2

****

Suspended wall construction with a spring arch type roof may be utilized. Install structural steel columns around the perimeter of the furnace, designed to support a succession of low sections of refractory wall, and framed to carry the heavy refractory walls by suspension while allowing gaps to remain in the walls for expansion of the chamber.

2.5.13 Insulation

****

NOTE: The values for minimum thickness of insulation are in the following table:

INSULATION THICKNESS VS. CAPACITY	
Capacity (grams per second) (pounds per hour)	Min. Refractory Thickness (mm) (inches)
For Walls	
Up to 63Up to 500	50.802
63 to 252500 to 2,000	63.52-1/2
For Hearths	
Indoors Up to 63	63.52-1/2
Indoors 63 to 252 500 to 2000	101.604
Outdoors	38.101-1/2

****

Where specified or indicated, provide insulating block insulation conforming to ASTM C612, containing no asbestos material, and designed to prevent damage to foundation and incinerator exterior due to excessive heat. Unless otherwise specified, comply with the requirements of Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

a. Provide Class 5 mineral fiber block, laid in approved mortar specially manufactured for this purpose or recommended by the insulating material manufacturer. Provide insulating cement conforming to ASTM C195 or ASTM C196.

b. Provide firebrick conforming to ASTM C27 or ASTM C155 for insulating firebrick, laid up in air-setting mortar. Interpret firebrick to include straight brick, radial brick, wedge brick, skew-type brick, cupola blocks, and other similar shapes. Dip each brick in mortar, rub, shove into place, and then tap with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel is not permitted, maximum mortar joint thickness cannot exceed 3.2 mm 1/8 inch, and average joint thickness cannot exceed 1.6 mm 1/16 inch. Insulate main arches of the furnace and flue connection above the firebrick and, where exposed to the weather, protect with a suitable sheath. Insulate firebrick floors from any supporting floors with insulating brick except full bearing supporting floors on earth, on which a 75 mm 3 inch layer of contained dry sand may be used in lieu of insulating brick. Provide walls with a minimum thickness to limit the temperature of the outer incinerator surface to 49 degrees C 120 degrees F in an ambient temperature of 21 degrees C 70 degrees F when the unit is operating at full rated capacity.

2.5.14 Expansion Joints

Provide joints in the firebrick masonry [at approximately the locations as shown] [at spacings of approximately 2.4 m 8 feet], 13 mm 1/2 inch wide, as completely separated sections without any interlocking of the bricks. [Locations may be changed from those indicated by as much as 300 mm 12 inches in either direction to suit convenience of construction. Change as necessary, by offset or otherwise, to avoid weakening the arch over an opening.] Allow no expansion joint to be closer than 300 mm 12 inches to the vertical side of an arched opening or to the top of the brick forming the arch over the opening. When joints are offset, do not allow bonding of the horizontal faces between the two courses of brick along the offset. In addition, to allow for expansion of the inner face, construct a series of 3.2 mm 1/8 inch wide vertical openings spaced 1.8 m 6 feet apart on the furnace side of the wall. Make proper provision for expansion and contraction between incinerator foundation and floor.

2.5.15 Exterior Walls of the Furnace

Provide a plate steel shell wall at least 6.4 mm 1/4 inch thick separated from the firebrick by suitable insulation, with exterior walls of the flue connection of plate steel shell at least [4.8][6.4] mm [3/16][1/4] inch thick separated from the firebrick by insulation. Structurally reinforce shells as necessary to support burners, combustion air blowers, stack, refractories, and other components.

2.5.16 Primary Chamber

Construct the primary chamber for dual chamber systems of a steel casing supported by a steel frame and provide with insulation and refractory as necessary to comply with the specified outer surface temperature requirements specified. Make the casing not less than 2.657 mm 12 gauge sheet steel reinforced to withstand internal pressures without deflection or damage to refractory or other components of the incinerator. Construct frame and all reinforcing members of structural steel, free standing, and

capable of supporting the weight of all components of the incinerator, including doors, burners, breaching, stack connections, and appurtenant assemblies without binding or warping. Provide frame and casing consisting of all-welded construction, complete and erect prior to installation of the refractory and insulation. Build all access doors and parts with seals to prevent emission of smoke or admission of significant amounts of air during incinerator operation. Primary chamber with openings permitting leakage of waste fluids is not acceptable.

2.5.17 Secondary Chamber

a. Construct the secondary chamber of dual chamber systems with minimum 4.8 mm 3/16 inch thick hot-rolled steel lined with mineral wool insulation and high strength refractory, rated at not less than 1427 degrees C 2600 degrees F, as necessary to comply with the specified outer surface temperature requirements. [A make-up air preheater of the manufacturer's standard design may be installed for this chamber.]

b. Provide secondary chamber burner capable of firing with [No. 2 fuel oil] [gas] with an electric ignition system, having a net out put rating capable of reducing the emission of combustible gases and particulate material to meet the current local, State and Federal air pollution emission standards. Equip burners with an FM approved flame sensor and direct spark ignition. Design combustion air supply for the secondary chamber to ensure complete combustion of all volatiles in the flue gas. Equip combustion air supply fans with control dampers to vary the air supply as required to provide complete air pollution control. Control temperature in the secondary chamber through the use of a temperature controller to vary the firing rate of the burner and combustion air supply.

[2.5.18 Primary and Secondary Cowling

****

NOTE: Check with manufacturers of the type and size of equipment expected to be used to determine the availability of this option. If available, preheating the combustion air will improve thermal efficiency and enhance the completeness of the combustion process.

****

The primary and secondary chambers of dual chamber systems may be provided with cowling in such a way as to preheat incinerator combustion air.

][2.5.19 Grates

When so equipped, construct grates of cast iron of size and configuration to support the rated capacity of the type of waste specified. Provide flat type grates, step type grates, or a combination of the two, as standard with the manufacturer of the incinerator, with a minimum weight of 195 kg/square meter 40 psf. Design grates to rest on supporting cast iron channels, I-beams, angles, or similar cast-iron shapes. Make stoker grates of heat-resistant alloy castings with holes or slots in metal surfaces through which combustion air enters. Size these openings to minimize plugging by ash or slag. Design grates to resist distortion, growth, cracking, and oxidation. Actuate grates or internal ram by mechanical or hydraulic means so as to move the refuse through the furnace, agitate the refuse to promote complete combustion, and remove the

ash and residue from the furnace. Provide a [traveling,] [reciprocating,] [reverse reciprocating,] [rocking,] [or vibrating] stoker grate.

[2.5.19.1 Stoker Design

Design the stoker or internal ram (when so equipped) with a hydraulically or mechanically operated, self-contained mechanism located inside the furnace comprising a means of moving, shearing, or tumbling the waste material while burning to ash, admitting waste at one end while causing ash to fall off the other end continuously. Design stoker and feed equipment for thin layer distribution of the incoming waste, and slow and thorough agitation of the bed length to ensure ample aeration and complete burnout prior to discharge into the residue quench area. In the drying and ignition zone, retain the refuse long enough for the volatile combustible gases, water vapor, and smoke to be driven off from the refuse and flow into the secondary combustion zone where they are mixed with air and retained for a sufficient length of time to ensure complete combustion.

]2.5.19.2 Stoker or Ram Operation

Devise a means of activation for hydraulic cylinders of adequate size with a minimum stroke of [_____] mm inches to ensure progressive movement of the refuse. Mount cylinders under the [stoker] [ram] carriages or side girders on specially designed mounting brackets and beams arranged so that all thrusts and stresses are contained within the [stoker] [ram] structure without transmission into the furnace structure.

]2.5.20 Furnace Doors

Provide doors as necessary for inspection, stoking, cleanout, and charging areas, with door frames securely attached to the frame of the incinerator, having minimum edge thickness of 16 mm 5/8 inch increasing to 19 mm 3/4 inch around the door, to provide a seat for the door. Construct doors and frames of cast iron or steel, with a minimum door thickness of 10 mm 3/8 inch, gastight and when exposed to flame or direct heat of combustion gases and lined with the same type and thickness of refractory and insulation used in the combustion chamber to prevent excessive heat losses and warping. Secure refractory to the doors to prevent sagging. Design refractory with tapered edges to clear door frames during the movement of swinging doors. Weld alloysteel hooked bars to the door cover to anchor the refractory, with doors safely operable by one person. Temperature of door handles must permit operation of doors without gloves or other protective devices. Interlock charging doors with primary burners and air supply so that burner ignition shuts off and under-fire air dampers close when doors open. Gasket door closure with nonasbestos packing suitable for the service.[Provide guillotine-type doors that lift completely off the seals to effect opening.] Provide doors with hasps or brackets to permit locking. Also make provision to lock the doors in an open position during maintenance to prevent accidental closure while someone is inside the incinerator.

2.5.20.1 Mechanical Charging Doors

Provide guillotine type doors, with a charging door that opens with operation of the charger. Interlock charging and feed hopper doors to prevent simultaneous opening during operation of incinerator. Insulate combustion chamber doors, including guillotine doors as specified above for furnace doors. Provide doors with means for manual operation, which are raised and lowered by flexible steel cables operating over a system of

smoothly operated sheaves or hydraulic or pneumatic cylinders attached to a steel frame. Construct doors which, in closed position, rest tightly against the frames.

2.5.20.2 Stoking and Cleanout Doors

Provide access doors for cleanout, stoking mechanism and visual inspection of the entire interior of the incinerator without permitting leakage of waste fluids.

2.5.21 Observation Ports

****

NOTE: Requirements for observation ports and test holes depend upon the specific project, including competence and availability of operating and maintenance personnel, and type of material to be burned. Conform the number and location of the test holes to the requirements of the regulatory authority, and provide test holes for monitoring operating efficiency as needed.

****

Provide [one] [two] observation port[s] 75 mm 3 inches in diameter on the access door for viewing the primary combustion chamber or zone during operation. Make ports no less than 2.7 mm 12 gauge black steel or cast iron tube or duct with a heat-resistant glass cover or an angular steel frame and closure plate with handle for operation without gloves or other protective devices. Extend the tube or duct from the exterior of the casing to not less than one-half the thickness of the refractory opening and make gastight. Make provision for air purging of the port to avoid ash buildup.

2.5.22 Test Holes

Provide incinerators with test holes as indicated and fit with standard weight, 50 mm 2 inch diameter, black steel pipe. Extend sleeve from the exterior of the casing to not less than one-half the thickness of the refractory lining. Form the refractory opening from the end of the pipe sleeve to the interior wall surface to shield the end of the sleeve from reflected heat. Fit the sleeve with a brass screw cap, and each test pipe with two or more sturdy lugs welded approximately in the middle of its length to prevent the pipe from turning when the cap is being removed.

2.5.23 Safety Devices

Provide incinerators with safety devices to provide safe operation, including automatic overheat shutdown and manual shutoff for each burner and main fuel supply, and equipment meeting the requirements of the Occupational Safety and Health Administration (OSHA).

2.5.24 Freeze Protection

Equip low points of all piping and tubing with drains for freeze protection.

2.5.25 Incinerator Cooling System

Provide the manufacturer's standard cooling system for the incinerator

furnished, including all necessary equipment, piping, valves and control devices.

2.6 INCINERATOR AUXILIARY EQUIPMENT

2.6.1 Charging Method

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NOTE: It is not expected that cranes will be used in most military incinerator plants. The referenced standards may not be sufficient for the severe service conditions the crane would encounter. A separate section based upon Division 41, may be required to adequately deal with the crane.

****

a. Mechanically charge incinerator and operate the combustion chamber at negative air pressure when the loading door is open, to prevent injury to the operator and the escape of smoke and gases. Provide a mechanical charger, including an inner door and an outer door, or other form of isolation from the combustion chamber, to discharge the contents of the loading and holding chamber into the combustion chamber. Flange loader directly to the feed opening of the incinerator.

b. Provide charger with a manual control and an adjustable timer to permit semi-automatic charging, with the manual box next to the ram loader opening as indicated. Provide an indication light to show when the incinerator can be charged and when the incinerator cannot be loaded due to insufficient temperature. Mount the light on the control box, visible to the operator when the box is closed. Include an interlock to prevent operation of the charger when a predetermined safe operating temperature is exceeded.

c. Locate the charger on the end of the incinerator. [Provide cranes to load the charger as specified in [Section 41 22 13.14 BRIDGE CRANES, OVERHEAD ELECTRIC, TOP RUNNING] [Section 41 22 13.14 BRIDGE CRANES, OVERHEAD, TOP RUNNING] [Section 41 22 13.15 BRIDGE CRANES, OVERHEAD ELECTRIC, UNDER RUNNING] to load the charger.] Design charging chambers with a minimum capacity of not less than [0.5] [1.0] [_____] cubic meter [0.5] [1.0] [_____] cubic yard, with an installed digital counter to count the number of loads delivered by the automatic ram loader into the combustion chamber.

2.6.1.1 Feed Hopper

Provide a hopper-type chamber for top loading chargers, constructed of heavy-duty welded steel plate and structural shapes throughout, fabricated of 6 mm 1/4 inch minimum thickness hot-rolled steel, with steel plates and shapes conforming to ASTM A36/A36M. Orient hoppers loaded directly from the tipping floor to be loaded from the side of their longest dimension whenever physically possible, with the opening flush with the tipping floor.

2.6.1.2 Charging Ram

Provide a hydraulically operated ram, self-contained type with directional control, which injects small loads of refuse at frequent intervals, to ensure relatively uniform burning rates, and limits the amount of air

entering the primary chamber with each charge through the use of double gates or similar device. Provide a ram which continuously pushes the burning waste toward the cleanout area, constructed to minimize the possibility of refuse becoming trapped in areas that would interfere with the operation of the ram and its seals. Provide sufficient cooling by either air or water to preclude warpage or excessive thermal expansion of the ram. Parts of the ram that come in direct contact with or ride upon the combustion zone refractory or grating are not acceptable.

2.6.2 Auxiliary Burners

****
NOTE: Indicate if auxiliary fuel system is to be gas and/or oil by deleting the inappropriate subparagraphs.
****

Provide [gas] [oil] [combination gas and oil] [LPG] burners for the primary and secondary combustion zones, meeting the requirements set forth in UL 296, UL 726, UL 795, and NFPA 85. Provide each burner as a complete assembly, including fuel and control systems, and accessories. Locate primary chamber burners so that the burner flame impinges directly on the waste materials when present during start-up, but does not impinge directly on the refractory when waste is not present during warm-up.

a. Provide primary burners with a capacity of not less than [_____] W Btu/hr and capable of maintaining a minimum continuous temperature of 760 degrees C 1400 degrees F and a maximum of 871 degrees C 1600 degrees F in that chamber or zone.

b. Provide secondary burners with a minimum capacity of [_____] J Btu and capable of maintaining a minimum continuous temperature in the secondary chamber of [982] [_____] degrees C [1800] [_____] degrees F. [Maintain a minimum continuous temperature of 760 degrees C 1400 degrees F at the roof near the exit of the primary chamber.]

c. Provide burners that are electrically spark-ignited and regulated by a variable set point indicator-controller adjustable from 427 degrees C 800 degrees F to 1316 degrees C 2400 degrees F to operate within the temperature limits recommended by the manufacturer. Include an on/off firing burner in the primary chamber. Provide a modulating burner with continuous burning capability for the secondary chamber, which modulates from high-to low-fire to off, based on the temperature of the secondary chamber. Provide secondary burner that cycles automatically as a function of the chamber temperature in order to minimize the consumption of auxiliary fuel and to minimize temperature peaks.

d. Actuate controllers by a thermocouple or shielded bimetallic sensor located in the upper 1/3 of the combustion chamber. Provide Type K thermocouples in the primary and secondary chambers, suitable for a maximum temperature of 1538 degrees C 2800 degrees F. Incorporate FM-IRI components in burner controls and meet NFPA current standards for gas- and oil-fired boilers, including ultraviolet flame scanners as specified in paragraph Flame Sensor, or flame rods for flame failure safety shutoff for burner and pilot and pre-ignition and postcombustion purging control. Mounting, flame shape, and characteristics of each burner must be suitable for the incinerator chamber in which the burner is installed, with burners that are easily

moved out of firing position for inspection, cleaning, adjustment, and maintenance. On mechanically charged incinerators, include an interlock to prevent operation of the charger until secondary chamber or zone temperature has reached 871 degrees C 1600 degrees F.

2.6.2.1 Oil Burners

Provide air-atomizing or mechanical-pressure-atomizing type oil burners (when required), capable of burning unheated Grade No. 2 fuel oil. Provide only oil-burning equipment which meets the requirements of UL FLAMMABLE & COMBUSTIBLE and is installed in accordance with NFPA 30 and NFPA 31.

[2.6.2.2 Mechanical Pressure Atomizer

When so equipped, provide mechanical pressure atomizers which operate solely by the use of oil pressure and have no moving parts within the atomizer, and are capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates when furnished with oil at the manufacturer's required pressure. Design to supply a constant volume of oil to the atomizer, with variable capacity obtained by adjusting a control valve on the return line. Mount a diffuser to stabilize the flame near the furnace end of the atomizer but in such a position that oil will not strike it.

][2.6.2.3 Air Jet Atomizer

When so required, provide inside mix type air jet atomizers utilizing air mixing with the oil inside the nozzle, with no moving parts required within the atomizer assembly. Furnish the air compressor with the burner, from the burner manufacturer and capable of completely atomizing the oil through a minimum capacity range of 6 to 1 without changing nozzles or sprayer plates, when supplied with air at a maximum pressure of 689 kPa 100 psi gauge, and varying unit capacity by adjusting air pressure supplied to the unit. Furnish unit with a blow-out valve so that air may be blown through the oil passages to clear them of any accumulation. Mount a diffuser to stabilize the flame near the furnace end of the atomizer but in such a position that oil will not strike it.

]2.6.2.4 Air Register

Provide the most suitable type air registers for the atomizer furnished and arrange for connection to the forced-draft fan duct, with adjustable air-volume louvers with all louvers operated by a single, easily accessible lever. Register is to support atomizer and closely related components, and fastened directly to the front of the incinerator. Properly size the throat ring to match the atomizer. Mount a diffuser to stabilize the flame near the furnace end of the atomizer but in such a position that oil will not strike it. Design the register and diffuser to ensure complete mixing of air and fuel with a minimum of excess air.

2.6.2.5 Throat Openings

Construct burner throat openings of superduty plastic refractory or matched sections of refractory tile. Make the throat concentric with the burner, of proper contour to ensure complete mixing of the air and oil, and designed to assist in complete combustion by radiating heat to the fuel. Position the burner so that the flame parallels the contour of the throat but avoids striking the refractory.

2.6.2.6 Electric Ignition System

Provide an ignition system suitable for operation with [No. 2 fuel oil] [gas]. Furnish igniter assembly complete for each burner, with a suitable ignition transformer and electrode rated for not less than 5,000 volts on the secondary side, as a unit readily removable from the incinerator setting for repair. Make provisions in the igniter assembly for manual operation and for inspection of the pilot flame. Provide components in conformance with NFPA 85 requirements, as applicable.

[2.6.3 Fuel Oil System

****
NOTE: Delete these paragraphs and their subparagraphs if oil is not used.
****

Install fuel oil system (when applicable) in strict accordance with NFPA 31 and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, unless otherwise indicated. Equip oil supply line to each burner with an automatically operated valve designed to shut off the oil supply in case of fire in the immediate vicinity of the burner. Provide a thermoelectrically or thermomechanically actuated type valve and locate immediately downstream of the manual shutoff valve or other building shutoff devices where oil supply line enters the building. Locate a thermoelectrical or thermomechanical detection device over the oil burner to activate the valve. A fire shutoff valve may be combined with other automatic shutoff devices if listed in UL FLAMMABLE & COMBUSTIBLE.

2.6.4 Fuel-Oil Piping

Furnish piping required between the oil storage tank, burners, and pumps complete with valves, strainers, traps, insulation, and accessories, conforming to Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

2.6.5 Fuel-Oil Storage Tank

Provide storage tanks constructed of steel or fiberglass, suitable for underground installation, constructed and labeled in accordance with NFPA 30, NFPA 31 and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS.

][2.6.6 Gas Meter

Furnish and install gas meters where indicated, having the full capacity indicated when receiving gas at [100] [_____] kPa [15] [_____] psig. Maximum differential pressure across any meter at full capacity is 3 kPa 0.5 psi. Provide meter housing of pressed steel, cast aluminum or cast iron, suitable for natural gas at [172] [_____] kPa [25] [_____] psig. Provide meters with a 3-valve bypass, with valves and bypass the same size as the gas line in which they are installed. Equip meter with an accessory instrument that indicates a corrected volume reading and an uncorrected volume reading of the gas passed, where the corrected volume reading is in standard cubic meters/second and cubic feet/minute cubic feet/minute. Install the meter in strict accordance with the manufacturer's recommendation. Provide positive displacement type meter of either rotary or diaphragm type. Provide gas piping, fittings, valves, regulators, test, cleaning and adjustments in accordance with

Section 23 11 20 FACILITY GAS PIPING. Comply with requirements of ANSI Z21.13/CSA 4.9 as applicable unless otherwise specified herein and appropriate certification is submitted.

]2.6.7 Stack

****

NOTE: Depending on requirements at location and personnel involved, temperature of the casing can be 66 to 93 degrees C 150 to 200 degrees F. The casing temperature is limited to 49 degrees C 120 degrees F maximum when personnel safety is involved. Provide spark arrester if there are no pollution control devices between the incinerator and the stack. References to heat recovery and boilers may have to be deleted if that feature has been excluded from the project.

****

a. Provide sectional, energy recovery and heat dump stacks set on a concrete foundation or otherwise adequately supported. [Make provisions in the ducting to bypass the flue gas around the heat recovery boiler to the normal stack, or direct it to a separate dump stack in the event of a boiler failure.] Provide the , size, and number of sections in accordance with the requirements of the stack and refractory manufacturer to adequately support the refractory lining, permit expansion, and prevent cracking of the refractory.

b. Line the entire height of the chimney with refractory as specified for the furnace, and provide with a cleanout door frame and a protective cap. Where the chimney is in the open, furnish a metal side-rail-and-rung ladder, with a [ladder cage or]fall protection device, designed for a live load of 890 N 200 pounds with a safety factor of at least 2 based on the yield strength of ductile metals, or a safety factor of 4 based on the ultimate strength of cast metals.

c. Provide a stack conforming to NFPA 82 and NFPA 211. Secure refractory to the casing by steel anchors. [Attach a corrosion-resistant steel spark arrester fabricated of 18 gauge, 13 mm 1/2 inch mesh wire screen to the top of the stack.] Provide a corrosion-resistant steel weather cap. The temperature of the casing of any stack must not exceed [_____] degrees C degrees F in an ambient temperature of 21 degrees C 70 degrees F while passing [_____] actual cubic meters/second ACFM of flue gas at[232] [_____] degrees C [450] [_____] degrees F. Provide fire stops, thimbles, and support assemblies conforming to NFPA 211. Extend stacks at least 1 m 3 feet above the highest point where they pass through the roof of the building and at least 600 mm 2 feet higher than any portion of the roof or building located within 3 m 10 feet horizontally of such chimney. Design and construct each stack to withstand winds up to[210] [_____] km/hour [130] [_____] mph. Provide adequate support, without placing any of the load on the refractory walls of the incinerator, for any stack installed on top of the incinerator.

d. Provide [freestanding stacks with painter's ring and trolley.][required aircraft markings.] Weld stack sampling ports into each stack, consisting of two collars, at least 100 mm 4 inches in diameter.[Use one hundred fifty mm six inch collars if particle-size sampling is required.] Locate and set collars at a right angle to

each other at least ten stack diameters downstream from a fan or change of direction for stack sampling. Provide ports with suitable, removable, replaceable caps.

2.6.8 Breaching

Construct breaching of not lighter than 3.416 mm 0.1345 inch thick, black-steel sheets conforming to ASTM A568/A568M. Reinforce and brace breaching with structural steel angles not smaller than 50.8 by 50.8 by 6.4 mm 2 by 2 by 1/4 inch and weld all joints and seams in the sheets and angles . Construct flexible type expansion joints requiring no packing and install where required. Provide breaching with angle flanges for connection to boilers or other equipment with breaching full size of opening. Supply breaching in bolted or welded sections for ease of handling or erection. Connectors must be in accordance with NFPA 211. Line breaching with a minimum of 75 mm 3 inch thick refractory, and seal tightly all around with a nonasbestos type rope and cement to form an airtight joint where required. Provide cleanout openings of suitable size, with tight fitting hinged doors and frames, at approved locations for access to all sections of the breaching. [Locate one 406 by 406 mm 16 by 16 inch inspection door in the side of the breaching just preceding the boiler unit.] [Locate a similar inspection door in the side of the breaching just following the boiler unit.]

2.6.9 Draft Equipment

Supply combustion air in the primary and secondary zones by a motor-driven blower as specified for draft fans. Design control circuits to shut down incinerator in case of a power failure, and to purge the chamber prior to ignition of the burners. Provide an air compressor for soot blowing or oil atomization. Also provide equipment to supply the correct amount of air to permit complete, controlled combustion, including forced draft fans, draft gauges, dampers, damper actuators, linkage, and appurtenances necessary to maintain a negative draft in the primary chamber, in order to provide optimum incinerator performance at all operating rates.

2.6.9.1 Combustion Air Damper

Regulate secondary, under-fire, and over-fire air with controller actuated dampers, constructed of black-sheet steel, not less than 1.519 mm 16 gauge, which operate without noise or flutter. Provide electric motor actuators [at [110] [220] [440] volt ac], hydraulic, or pneumatic operated.

2.6.9.2 Flue Gas Damper

****
NOTE: Optional wording applicable to guillotine-type dampers.
****

[Install a [guillotine-type] [butterfly] [shutter] damper [of the thickness indicated] [at least 63 mm 2 1/2 inches thick] and consisting of a steel frame enclosing refractory material at the entrance of the waste heat recovery boiler for the purpose of isolation from the incinerator during emergency boiler repairs.] Also install a damper in the dump stack which opens upon occurrence of [excess boiler steam pressure,] induced draft fan failure [, and boiler shutoff]. [Provide a boiler damper operated by a controller actuated motor based on the [boiler steam pressure] [boiler water temperature.] When the boiler damper is open, the

stack damper will close. Furnish [a chain hoist for raising and lowering][a manual lever for][an electrical control for] the boiler damper of correct size and design to ensure freedom of movement by the damper. [Secure the hoist cable to the damper frame by means of shackles and bolts, and a damper slot with a steel plate cover 6 mm 1/4 inch thick and of the length and width indicated or required. Provide the cover with a slot to permit the passage of the cable for raising and lowering the damper, and for easy removal of the cover. Provide a spur-geared hoist which is a product of a manufacturer regularly engaged in the manufacture of hoists. Design unit for high-speed lifting, with high mechanical efficiency, an automatic load brake and a built-in load limit.] Maximum effort to operate the unit must not exceed 311 N 70 pounds, with the capacity to move the required load freely and maintain the damper in the desired position within the limits of the flue opening].

2.6.9.3 Blowers

Provide auxiliary fuel burner blowers capable of delivering the necessary amount of air at an atmospheric temperature of [16] [_____] degrees C [60] [_____] degrees F and a barometric pressure of 101 kPa absolute 14.7 psia to allow the burners to achieve rated capacity. Provide single-inlet, single-width, non-overloading blowers designed for quiet operation with as little vibration as practicable, with grease lubricated bearings, ball or roller type, to accommodate all radial and end thrust. Construct housing of 1.897 mm 14 gauge sheet steel with a smooth interior that will eliminate unnecessary turbulence.

2.6.9.4 Draft Fans

Furnish centrifugal, forced-draft fans conforming to CID A-A-59222 as an integral part of incinerator design, conforming to AMCA 801, Type [I] [II] and AMCA 99, applicable to centrifugal furnace fans and rated for flow rate, pressure, power, speed of rotation, and efficiency in accordance with AMCA 210 and ASME PTC 10, with [backward curved blades] [forward curved blades]. Size each fan for operation at an elevation of [_____] m feet, with an output volume and static pressure rating sufficient for pressure losses, excess air requirements at the secondary zone exit, leakages, temperatures and elevation corrections for worst ambient conditions. Include in the design conditions, at full combustion, net rated output at normal firing condition capacity plus additional capacity sufficient to provide a 15 percent excess volume against a 32 percent static overpressure, and air temperature 14 degrees C 25 degrees F above operating temperature. Provide fan that is driven by a totally enclosed, fan-cooled electric motor. Connect fan directly or indirectly to the driving motor. If the fan is indirectly connected, provide a V-belt drive designed for 50 percent overload capacity, with the motor mounted on the base in a manner that permits tightening of the belt. Noise levels for fans exceeding 85 decibels at 914 mm 3 foot station are not permitted. Provide air-cooled fan bearings, of the backward curved fan blade type with bearings not requiring water cooling of the self-aligning antifriction type. [Provide scroll sheets and rotor blades with liners.] Factory paint fans with the manufacturer's standard finish. Design control circuits to shut down incinerator in case of power failure and to purge the chamber prior to ignition of the burners.

2.6.9.5 Control Equipment

Furnish each motor with a manually operated starter, of the enclosed, across-the-line type with manually reset thermal-overload protection.

Provide a separate pole for each ungrounded conductor.

2.6.9.6 Air Ducts

Supply over-fire and under-fire air from the blowers through ducts conforming to SMACNA 1403. Introduce combustion air to the primary chamber below the waste material by means of under-fire air lines or ducts. Regulate over-fire air by controlled air ports located in the wall of the incinerator for completing combustion of combustible materials in the gases. Size ducts to minimize pressure drops and construct of sheet steel with all seams and connections air tight. Construct duct work of galvanized sheet metal, with galvanizing conforming to ASTM A123/A123M and ASTM A153/A153M. Provide access and inspection doors as required. Provide duct wall thickness as follows:

Ducts, Maximum Dimension	Steel (Gauge, Thickness)
1200 mm48 inches	0.759 mm22 gauge, 0.0299 inch thick
1225 mm49 inches thru 1500 mm 60 inches	0.912 mm20 gauge, 0.0359 inch thick
1525 mm61 inches thru 1800 mm 72 inches	1.214 mm18 gauge, 0.0478 inch thick
1825 mm73 inches and larger	1.519 mm16 gauge, 0.0598 inch thick

[2.6.10 Heat Recovery System

Boilers for the heat recovery system are as indicated in Section 23 52 30.00 10 HEAT RECOVERY BOILERS.

]2.6.11 Ash Removal

****
NOTE: Where required, include complete requirements for pretreatment of quench water and liquid waste. Pretreatment may include pH adjustment, solids removal, and toxic compound treatment as necessary. Ash systems that directly discharge from the incinerator into the disposal container should be allowed for very small 9 metric tons per day 10 TPD incinerators.
****

Provide a unit with provisions for mechanical removal of the ash or residue, which is to discharge from the combustion of the refuse from the far end of the incinerator, opposite the location where waste is introduced. Provide an ash plow or other device, automatically interlocked with the doors for the removal operation, combined with a water quench, spray, or bath which will extinguish live embers and control airborne dust. Also make provisions for manual removal of ash for maintenance purposes upon completion of the cool-down cycle, through the access door. Treat waste liquids (ash water) as necessary to be compatible with, and discharged to, the sewage collection system. Remove ash and residue from the area by mechanical conveyors, constructed of corrosion resistant material, and portable containers. Equip each unit

system with an independent ash removal and ash conveyor system designed to conform to the equipment arrangement shown.

2.6.11.1 Ash Pits

Provide funnel shaped ash pits, containing receiving hoppers constructed of 6 mm 1/4 inch steel plate, minimum, covered with a heavy grating with openings approximately 50 mm 2 inches square for personnel protection. Discharge ashes and clinkers from the incinerator into the ash hopper located directly below the ash discharge opening. Arrange a combination drag chain conveyor for horizontal conveying and an elevator conveyor for vertical conveying of ashes as indicated to take ashes from the bottom of the ash hopper for discharge into the ash container. Provide conveyors with a capacity of not less than [_____] kg/hour pounds/hour when handling ashes weighing approximately [_____] kg/cubic meter pcf at a maximum speed of [0.5] [_____] m/second [100] [_____] fpm. Provide doors for access to all parts as required. Provide totally enclosed, [nonventilated type][fan-cooled type][fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70] electric motors, with [manual] [magnetic] [across-the-line] [reduced voltage start] type motor starter and [general-purpose] [weather-resistant] [watertight] [dust-tight] [explosion-proof] enclosure.

[2.6.11.2 Drag Chain Conveyor

****
NOTE: Both types of conveyors may not be applicable to the project. Select the appropriate paragraph based on the conveyors required.
****

Provide a drag chain conveyor consisting of a [single] [double] strand of wide, malleable iron, drag chain with a [_____] mm inch overall width, and [_____] N pounds working strength. The upper strand of the chain must convey the ash in a trough constructed of10 mm 3/8 inch cast iron, or other suitable material, extending from [_____] mm inches in front of the foot shaft to [_____] mm inches behind the head shaft and set flush with the floor. Carry the return strand of chain in angle runways set flush with the trench floor, without passing through the falling ash.

][2.6.11.3 Elevator Conveyor

Provide a double strand elevator conveyor, chain type with head and takeup and an extended foot shaft to provide a drive for the drag conveyor. Construct casing of 2.657 mm 12 gauge black steel, minimum, with 4.8 mm 3/16 inch thick boot plates. Include with head-end drive a gear motor and steel roller chain complete with drive brackets, guards, and backstop. Equip elevator with head-end platform and ladder. Factory prime all exposed metal surfaces for field painting.

][2.6.12 Steam Piping

Steam piping system consists of those piping sections actually conducting steam, condensate return piping, and vent piping. Provide steam piping conforming to the provisions of Section 33 63 23 ABOVEGROUND HEAT DISTRIBUTION SYSTEM, unless otherwise specified, designed for [_____] kPa psi steam.

]2.7 COMBUSTION CONTROL EQUIPMENT

2.7.1 General

Provide and install all locally indicating instrumentation and local controls complete, as required to suit equipment furnished and as shown. Also provide and install all remote instrumentation, controls, and their connection points as indicated, or as specified, as well as an automatic combustion-control system for each incinerator in accordance with the incinerator manufacturer's recommendations. If controls are manufactured by a manufacturer other than the incinerator manufacturer, install the controls in accordance with the control manufacturer's instructions. Locate automatic controllers on the control room panel as specified. Provide pneumatically, electrically, or electronically operated equipment. If pneumatic controls are provided in lieu of electric, provide duplex air compressors, with a drier between the compressors and tank. Size air compressor unit to run not more than 60 percent of the time when all controls are in service. Install air filter regulator sets at each control valve and transmitter in the system. Provide dual type master air filter regulator set on the control panel such that one side can be cleaned and repaired while the other is in operation. Provide each system with a selector switch or other means to permit manual control of the firing rate when required. Provide two-wire 120 volts nominal or less, 60 Hz with grounded neutral power supply to the electrical circuit. Wire all operating and limit controls to interrupt the ungrounded circuit conductor.

2.7.2 Equipment

Include in control equipment and instruments burner and fan controls, time clocks, relays, operating switches, indicating lights, gauges, motor starters, fuses, alarms, and circuit elements of the control system, and other controls and instruments necessary for unit operation, in accordance with FM APP GUIDE. Provide proportioning control of the overfire and underfire air supply and of the air supply and fuel supply to the burners. Ensure a visual indication for safe loading of the incinerator and excessive high temperature conditions which may require control or adjustment by the operator are provided within temperature indicator controllers or other indicators. Provide indicating and recording instruments for pressure, flow of air and liquids, as well as for alarm circuitry. Interlock automatic control circuit systems and manual switches to prevent hazardous conditions or the discharge of excessive amounts of air pollutants.

2.7.3 Combustion Control

Control of the products of combustion is based on maintaining a pre-set temperature, not to exceed limits as specified for minimum design requirements under paragraph INCINERATOR. Design the system to minimize auxiliary fuel usage by controlling the quantity of air and waste fuel introduced into the primary chamber or zone in accordance with the temperature. Provide over-fire protection by controlling the upper chamber or zone combustion air as a function of the chamber or zone temperature, with a fully automated and integrated control system, which operates at near the design conditions, and at near constant temperature output.

2.7.4 Incinerator System Operation Sequence

2.7.4.1 Starting

Provide a "START" button which causes the secondary (pollution control) chamber or zone burner to ignite to preheat that area prior to charging the system, using auxiliary fuel only as a heat source during the preheat period. The secondary burner, after ignition, must be under the control of a modulating thermal controller which controls the air/fuel ratio in the secondary chamber or zone. Burner for the primary chamber or zone may be either automatically or manually activated. Interlock the burner control circuit with a timer or temperature sensor which functions to shut off and lock out the burner after a predetermined and preset time or temperature has been achieved.

2.7.4.2 Loading

After a predetermined warm-up period, the system must be ready for loading. Feeder controls allow for two modes of operation, automatic cycle and manual. Control automatic system by a timer or speed control, interlocked with limit switches and temperature sensors. Initiate automatic feed cycle by a single push button when the operator is ready for that unit to begin the cycle. After cycle initiation, the vertical charging door (when present) must open and the ram or other stoking device must start moving forward to discharge the refuse into the primary chamber or zone. After the ram or other stoking device has reached the end of its stroke, it withdraws back into the hopper to a position where the charging door (when present) is allowed to close, and the ram returns to its original start position.

2.7.4.3 Overrriding

Equip feeder with a charging ram water spray system. Equip loader control with a manual override system which enables the operator to override the automatic sequence if necessary to correct a malfunction of the loader. In the event of a malfunction, provide a flashing light and an audible alarm to signal the operator that a problem has occurred. In the manual mode of operation, provide selector switches to individually control the motions of the charge door, hopper door and ram.

2.7.5 Controllers

Mount controllers on the instrument panel to indicate and control measurement in the areas shown. Provide proportional type controllers with reset, and automatic/manual operation. Provide a set point with a manual adjustment on the front of the instrument. Install controllers complete with wiring or piping between the controller, transmitter, and the final control device. Provide proportional type combustion control equipment capable of maintaining optimum combustion conditions. Set point controllers may be used for on/off functions only. Maintain combustion efficiency without appreciable manual adjustment.

2.7.5.1 Automatic Controller

Provide each automatic controller with a manual-to-automatic station and indicator on the control panel that offers selecting either automatic control or manual control and also allows manual operation. Arrange manual controls to allow any one or more of the functions of the control system to be controlled manually while the other functions remain on

automatic control. Provide manual control station complete with all necessary indicators to facilitate changing from automatic control to manual control and vice versa.

2.7.5.2 Fuel-Flow, Air-Flow Type

Provide proportional, reset type combination fuel-flow, air-flow type combustion control equipment for the auxiliary burners , which positions the feed or air flow and then adjusts one to the other by a ratio controller operating from airflow and feed. Include in controls fuel-flow measuring elements and airflow measuring elements which are field-mounted and separate from panel devices. Panel mount separate fuel feed and air-flow controllers along with a fuel-to-air ratio controller. Airflow index may be set by a measuring element in the air stream or in the gas stream exiting the incinerator. Systems controlling fuel and air by line shafting and mechanical connections are not acceptable.

2.7.6 Damper Control

Size power units for the damper movement to operate the device to be positioned, and mounted to allow for a rigid mechanical connection to the device being operated. Provide automatic draft control by controlling the main damper or uptake damper. Main damper or uptake damper must open to allow air purging of the incinerator and control draft to suit burner operation, and automatically close units in event of failure of the operating medium except for any dump stack damper which fails to open. Provide manual operation of the controller without disconnecting the linkages during power failure or other emergency. Include position switches on fuel and air-drive units for interlock with safety systems. Place retransmitting devices on all power units for remote indication on the control panel of the position of the operator at any time. If electric operators are utilized, provide oil-immersed gear trains on the units.

2.7.7 Fuel Feed Controls

Control automatic feed cycle by an adjustable timer for rams and a speed control for feed grates. Provide an interlock to interrupt the automatic cycle in the event of an emergency such as an extreme overtemperature condition in the primary chamber or zone.

2.7.8 Burner Controls and Safety System

Burner control and safety system must provide for the start, purge, ignition, main flame supervision, safe shutdown and alarm of the incinerator fuel burning equipment, such that a burner malfunction at any time prevents the burners from operating by tripping a burner relay. Integrate control of the burner and incinerator system to ensure overall safety. Provide safety shutoff valves and fuel trains for main burners as required by FM APP GUIDE and NFPA 85. Automatically control sequence of burner operation by programming relays to start a mandatory pre-purge cycle with full protection against flame failure during both electric spark ignition and normal burner operation. Normal cycling of burners that require system pre-purge is prohibited. Govern operation of the programming relays by a [steam pressure limit switch,] approved draft switch, low fuel pressure switch, [low drum level cut-off switch] and an electronic flame failure protection device. A flame failure condition will cause the burner to shut down on safety and require a manual reset before the burner can be restarted. Control normal cycling by means of

temperature switch as described earlier.

2.7.8.1 Incinerator Burners

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NOTE: Insert appropriate fuel oil or gas specification section(s) associated with this project. Only allow direct electric spark ignition for burners up to 732,500 watt 2,500,000 BTU/hour. Values of minimum burner input capacity:

SIZE OF BURNERS, (x1000) Watts BTU/Hr Primary Burners						
Capacity of Incinerator, (grams/sec) (lb/hr)	2490 Min. kJ/kg 8500 Min. BTU/lb Refuse	1905 Min. kJ/kg 6500 Min. BTU/lb Refuse	1260 Min. kJ/kg 4300 Min. BTU/lb Refuse	733 Min. kJ/kg 2500 Min. BTU/lb Refuse	293 Min. kJ/kg 1000 Min. BTU/lb Refuse	Secondary Burners All Refuse
6.3050	350150	350150	582250	815350	990425	466200
12.60100	466200	466200	1282550	1631700	1980850	699300
18.90150	582250	559240	1514650	23301000	32621400	932400
31.50250	699300	699300	1748750	26801150	37281600	1514650
63.00500	1282550	1282550	25631100	38451650	51262200	23301000
94.50750	1748750	1748750	34951500	52422250	69903000	30291300
126.001000	2097900	2097900	39611700	55922400	72233100	39611700
189.001500	25631100	25631100	51262200	76893300	10,252 4400	48932100

SIZE OF BURNERS, (x1000) Watts BTU/Hr Primary Burners						
252.002000	37281600	37281600	76893300	11,650 5000	15,378 6600	62912700

NOTE: Insert appropriate Section number and title in blank below using format per UFC 1-300-02.
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Provide [gas] [oil] [combination gas and oil] burners for the primary and secondary combustion chambers. Design burners for [natural type gas] [or] [No. 2 fuel oil conforming to ASTM D396]. [Fuel oil] [Gas] piping is covered in [_____]. Design incinerator burners for fully automatic nonrecycling operation, with a combustion-safety control system conforming to FM APP GUIDE or NFPA 85, as appropriate. Certify that the installed control system conforms to FM APP GUIDE or NFPA 85. Provide UL listed and FM approved system components, designed for use with industrial grade burners. Include the following with all accessories for a complete system.

2.7.8.2 Combustion-Safety Controls System

Provide a combustion-safety control system which includes a flame safeguard relay or control unit that has solid state electronic circuitry and continuous self-check feature. Provide relay or control unit consisting of amplifiers, transformers, power supply, relays, indicating lights, and terminal strips factory prewired and assembled in a NEMA ICS 6, Type 12 steel cabinet with door. Provide a cabinet made of steel, 1.897 mm 14 gauge minimum thickness, with gray enamel finish throughout or any other color selected by the Contracting Officer. Provide cabinet door with piano hinges and latch, with components and supporting chassis which is easily removed for replacement and repair. Provide plug-in or similar units. Provide a flame safeguard relay or control unit which checks itself and the detector circuit for flame simulating component failure at start-up and at intervals not to exceed manufacturer's recommendation or the specified flame failure response time throughout the burner operation. Loss of combustion airflow, flame failure and flame simulating component failure must cause the flame safeguard relay or control unit to de-energize all fuel levels for the burner and initiate a non-recycling burner shutdown and alarm. Provide flame safeguard relay or control unit to program the burner operation to conform to FM APP GUIDE or NFPA 85.

2.7.8.3 Purge Timer

Provide a purge timer to prevent the operation of the flame safeguard relay or control unit until the minimum purges, as required in NFPA 85 or FM APP GUIDE, have been completed. Volume to be purged includes the volume of the combustion chamber, boiler passes and breachings. Interlock the purge timer with the airflow differential pressure switch and igniter and main firing valves to ensure that all fuel lines are closed. Provide a green indicating light as specified above to indicate purge completion.

2.7.8.4 Safety Shutdown Interlocks

Provide safety shutdown interlocks in the flame safeguard relay or control unit for the conditions specified by FM APP GUIDE or NFPA 85. Provide low

and high fuel pressure interlock switches, interlocked with the flame safeguard relay or control unit to prevent burner operation if low or high fuel pressure is detected.

2.7.9 Combustion Temperature Control

Provide a separate temperature control for each combustion chamber which controls the firing rate within that chamber. Provide Type "K" thermocouple temperature sensors in a ceramic protection tube, suitable for operation up to 1538 degrees C 2800 degrees F. Temperature is to be transmitted to the controller mounted in the control panel. Provide the type of controllers that can be operated in the automatic or manual mode. Control the temperature within plus or minus 5 percent of the set point over the full operating range required by the manufacturer of the incinerator.

2.7.9.1 Primary Combustion Chamber or Zone Controller

This controller varies the combustion rate through control of the primary air supply and auxiliary burners, and also prevent overfeeding the primary chamber or zone by locking out the feed system during extreme over or under temperature situations.

2.7.9.2 Secondary Combustion Chamber or Zone Controller

The temperature controller in the secondary chamber maintains the required temperature for complete combustion of the gases and reduction of particulates. This controller varies the firing rate of the burner and the flow of combustion air to the secondary chamber or zone.

2.7.10 Draft Fan Control

Provide forced-draft centrifugal fans with inlet vane controls [and variable speed control where indicated]. [Provide axial propeller fans with variable propeller pitch control.] Provide inlet vanes suitable for use with combustion control equipment. Provide a means for operating the draft fans for 15 minutes after last charge in the incinerator has burned down.

2.7.11 Draft Fan Drives

Provide a draft fan driven by [an electric motor] [or] [a steam turbine]. [Electric motor must be [drip-proof] [totally enclosed nonventilated] [totally enclosed fan-cooled] [totally enclosed fan-cooled, suitable for installation in a Class 1, Division 1, Group F, hazardous location conforming to NFPA 70].] [Motor starter must be magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [weather resistant] [watertight] [dust-tight] [explosion-proof] enclosure and furnished with four auxiliary interlock contacts.] [Provide a steam turbine with horizontally-split, centerline supported casings, water-cooled bearing housings with ring-oiled, babbitt-lined, bronze packing sleeve bearings, and equipped with a mechanical shaft speed governor and valve, and independent emergency over-speed governor and trip valve, reed tachometer, constant pressure type governor, insulation with removable metal jacket, oil-sight glasses with guards, removable stainless steel steam strainer [without disconnecting piping], any special wrenches and tools required for servicing turbine, and a sentinel warning on the exhaust casings. Provide turbines conforming to NEMA SM 23.]

2.7.12 Ash System Control

Provide controls for the ash discharge system which allow for two modes of operation, automatic and manual. Manually initiate and control automatic cycle by cycle programmers or automatically initiated by the charging system programmer. Install lights, controls and interlocks as described earlier for automatic ash removal control in and on the main cabinet with manual controls installed near the ash removal equipment of each incinerator.

2.7.13 Soot Blower

Mount all controls, lights, switches, and indicator provided for operation of soot blower on the control cabinet.

2.7.14 Incinerator Shutdown

When the primary chamber or zone temperature exceeds a control limit of 982 degrees C 1800 degrees F, lock out feed system and suspend waste feeding until manually reset.. Shutdown the entire incinerator at 1538 degrees C 2800 degrees F in the furnace, 400 degrees C 750 degrees F at the induced draft fan, or 260 degrees C 500 degrees F at the combustion air fan. In the event of a complete shutdown, reset the system manually and go through a normal start-up procedure including purging, prior to starting the burners.

2.7.15 Control Panel

Provide wall mounted cabinets conforming to UL 50 and free standing cabinets or panels conforming to NEMA ICS 6, Type 6 or Type 4. Provide prewired, steel, and weathertight panel. Unless enclosed in a booth or separate room, construct the panel to protect the instruments and controls from dust. Instrumentation fabricator must wire all instrument connectors and cable termination connectors in the factory. Flush mount all controls, instruments, and other equipment at the factory and assembly-test prior to shipment. Furnish a lock and two keys. Identify all controls and instruments with nameplates. [Provide a heater to prevent condensation.]

2.7.15.1 Panel Details

a. Size panels to contain all controls, instruments, gauge, and meters. Provide free standing panels with faceplate of not less than 6.4 mm 1/4 inch reinforced steel plate, coated with an approved laminated plastic suitable for the duty and finished with the manufacturer's standard finish coating. Flush mount controls and instrumentation on the panel as far as practicable.

b. Enclose back of panel with sheet metal, with adequate access panels for maintenance and removal of any component without interfering with other components. Provide door-latching equipment and hardware.

c. Identify each recorder, indicator, and control unit with engraved metal or laminated plastic nameplates secured to the panel. Provide panel with a continuous rapid-start fluorescent light fixtures mounted with reflectors providing suitable shielding to illuminate all controls, instruments, gauges, and meters.

d. Terminate field piping connections for each panel in one

bulkhead-mounted manifold located to conform with the installation requirements of the system. Terminate field electrical connections in a mounted color-coded terminal strip located to conform with the installation requirements of the system.

e. If a pneumatic control system is provided, mount the panel air supply filter and regulator set on the rear of the panel with properly identified pneumatic terminal blocks. No high pressure lines are allowed to enter the panel. If packaged-type burner units with integral controls are furnished, the control equipment may be mounted on a separate panel for each incinerator. Panel mount and test controller and indicators specified or required at the factory, complete with relays, transformers, switches, wiring, valves, and piping.

f. Completely isolate thermocouple and low energy signal conductors from power and alarm conductors, subject to approval by the Contracting Officer. Provide visual and audible alarms to protect personnel and equipment. Mount annunciator system on each control panel. Provide visual signals consisting of backlighted nameplates for each point. Provide a common audible alarm signal and a common acknowledge pushbutton for each control panel. Indicate malfunctions on the annunciator panel as specified [in Section 23 52 30.00 10 HEAT RECOVERY BOILERS] plus the following as a minimum:

(1) Loader
(2) Burner (each)
(3) Ash Discharge System
(4) Ash Transfer Rams (if used)
(5) Ash Conveyor

Also include in the panel visual indication of the various modes of the main system components such as loading and charging system, burners, ash discharge system, ash conveyor, damper positions, [induced draft fans]. Additionally, include in the incinerator/[boiler] panel [as specified in Section 23 52 30.00 10 HEAT RECOVERY BOILERS plus]the following:

(1) Temperature Recorder (lower chamber, upper chamber)
(2) Clock with minimum 200 mm 8 inch diameter face (one panel only)

2.7.15.2 System Diagram

Mount laminated, color-coded system diagram on the control panel indicating all system components and location of all sensors and alarm points.

2.7.16 Indicating Lights

Mount lights on the door of the control cabinet. Integrate components through appropriate electromechanical devices with push-to-test type indicating lights. Install indicators complete with all necessary wiring and conduit between the indicator and the transmitter in the equipment room. Operating ranges for each indicator as indicated. Provide industrial oiltight construction in the following colors for the indication functions:

Function	Indicator Color
Power on the system	Amber
Incinerator/boiler purge completion (one per unit)	Green
Energizing main fuel valves	White or manufacturer's standard color
High temperature in primary chamber	Red
High temperature in secondary chamber	Red
High temperature at induced draft fan inlet	Red
System operation	Red
Emergency damper open	Red

2.7.17 Selector Switches

As a minimum, provide the following hand-auto-off selector switches:

a. Each oil burner
[b. Induced draft fan]
[b.][c.] Combustion air fan (FD)
[c.][d.] Secondary air fan

2.7.18 Clock

Recess mount a single synchronous 120-volt ac, motor-driven, with shatterproof, crystal-covered white dial clock, a minimum of 200 mm 8 inches in diameter with black Arabic numerals, black hour and minute hands, red sweep hand, and anodized brushed aluminum bezel. Totally enclose clock motor and mechanism in a heavy plastic cover.

2.7.19 Recorders

Mount recorders on the instrument panel to record and indicate measurement in the areas shown. Make the record in ink on a [24-hour] [31-day], [100 mm 4 inch linear] [circular] [strip] chart driven by an electric-clock mechanism. Make each recorder point with a different colored ink. Install recorders complete with all necessary wiring or pipe between the recorder and the transmitter. Provide the unit with sufficient blank charts and ink for 1 year's operation.

2.7.20 Water Meters

Provide meters conforming to AWWA C700 of the disk type with reinforced disk for hot water above 66 degrees C 150 degrees F, and a rubber or carbon disk for cold water. Construct meters of bronze composition and cast iron protected by noncorrosive coating, with easily replaceable moving parts.

2.7.21 Annunciator

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NOTE: Edit to indicate the number of points desired and specific items in the list.
****

Provide an engraved, back-lit window annunciator complete with pushbuttons and alarm horn to indicate abnormal operating conditions of the incinerator. Include a common alarm silencing relay in the alarm circuit to permit the incinerator operator to silence the audible horn while retaining visual indication until the malfunction or abnormal condition has been cleared. Furnish one [_____]-point annunciator for each incinerator and install in the annunciator and pump control panel. Provide alarm module nameplates, nominal 70 mm 2-3/4 inches high by 75 mm 3 inches wide in translucent white acrylic plexiglass. Engrave all nomenclature on front surface in black lettering. Mount and prewire flasher module with silence and test pushbuttons. Provide alarm points and window engraving as [specified in Section 23 52 30.00 10 HEAT RECOVERY BOILERS plus the additional points] shown below. Provide an annunciator from the same manufacture and type as furnished by the supplier of other control panels, with interchangeable spare parts between annunciators.

ALARM POINT	WINDOW ENGRAVING
TSH-[_____]	Temp. - high primary chamber
TSL-[_____]	Temp. - low primary chamber
TSH-[_____]	Temp. - high secondary chamber
TSL-[_____]	Temp. - low secondary chamber
PSL-[_____]	Press. - low hydraulic
PSL-[_____]	Press. - low fuel oil
LSL-[_____]	Level - low, F.O. storage tank
LSH-[_____]	High flue gas opacity

2.7.22 Flame Sensor

Provide an ultraviolet flame-sensing device for each burner and install in accordance with the manufacturer's recommendations. The flame-sensing device must not respond to ignition spark, hot refractory, reflection of flame on atomizing media or oil spray. Sight flame safeguard sensor to detect only the burner flame for which it is designed. Perform a pilot turndown test, spark response test for ultraviolet detector, and manufacturer's approved test for rectification detectors to verify reliable sensor installation. Weld or fix sensor mount to prevent altering orientation to flame being proven.

2.7.23 Temperature Indicators

Provide temperature gauges to match pressure gauges in appearance and match requirements of the transmitters supplied. Use any of the following temperature sensors unless otherwise specified. Include the following:

a. Outdoor air
b. Incinerator room
c. Primary chamber or zone
d. Secondary chamber or zone
e. Flue gas leaving incinerator

2.7.23.1 Thermometers

Provide thermometers conforming to ASME PTC 19.3 TW, Type 1, Class 3, with wells and separable corrosion-resistant steel sockets and temperature range suitable for the use encountered. Provide dial type thermometers 90 mm 3-1/2 inch diameter chromium-plated case, remote-type bulb or direct-type bulb as required, with plus or minus 1 degree C 1 degree F accuracy and white face with black digits graduated in 2-degree increments. Do not use mercury in thermometers, and install as indicated, to be easily read from the operating floor.

2.7.23.2 Thermocouples

Provide thermocouples conforming to ASTM E230/E230M, Type K, indicating gas passage temperatures. Thermocouples must control burner operation, be suitable for continuous operation up to 1538 degrees C 2800 degrees F, and accurate to 0.75 percent of the operating and indicating temperature range. Provide thermocouples in the combustion chamber or as otherwise directed, long enough to be inserted 150 mm 6 inchesinto the furnace. Provide thermocouple with an adjustable flange and a high-temperature, metal alloy, closed-end protection tube suitable for inserting into the furnace without support of the projecting end. Supply thirty meters one hundred feet of 1.519 mm 16 gauge compensating lead wire with a weatherproof braid for connecting the thermocouple to the instrument. Transmit temperature to the instrument in the control panel as shown.

2.7.23.3 Pyrometers

Provide indicating [recording] pyrometers at the locations indicated or directed, with a temperature range from minus 18 to 1316 degrees C 0 to 2400 degrees, and accurate to within plus or minus 0.25 percent of the range. Indicate temperature on a large scale with prominent black letters on a white background [and record with a continuous ink line on a circular chart at least 300 mm 12 inches in diameter, with 24-hour revolution]. Provide instrument with automatic cold-junction compensation. Provide a simple means of pyrometer standardization, which will not be affected by vibration, dust, or air currents when the door of the instrument is open. Operate instrument on 110 volts ac.

2.7.24 Pressure and Vacuum Gauges

Provide gauges conforming to ASME B40.100, Type I, Class 1 or 2, as applicable, style as required; heavy-duty industrial type, suitable for pressure or vacuum specified, with minimum 150 mm 6 inch diameter dial, except as otherwise specified. Gauge piping must be copper tubing conforming to ASTM B68/B68M, Type K or L.

2.7.25 Draft Indicator and Control

Provide Draft Gauges conforming to ASME B40.100, Style I, with approved operating ranges, and with a diaphragm or bellows actuating system and a circular scale. Provide gauges with a zero adjustment screw and a connection to atmosphere and with suitable shutoff cocks. Gauges must be

remote-reading to the control panel. Install gauges complete with all necessary piping between them and the points at which the drafts are measured. Provide an indicator which continuously indicates pressure in primary chamber. Also provide a separate draft controlling instrument maintaining a constant 0.10 to 0.15 inch negative pressure in the primary chamber.

2.7.26 Opacity Alarm

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NOTE: This paragraph may be simplified based upon the monitoring requirements of the state in which the incinerator is to be located. Not all states may require continuous monitoring and recording. However, an opacity alarm should always be included to alert the operator to operational problems.

****

a. Provide a stack gas opacity alarm indicator and recorder system consisting of a stack unit, control or transmitter unit, chart recorder, red alarm, manufacturer's standard color Power On signal lights, and alarm bell on the instrument panel for each incinerator. Provide self compensating system, and provide continuous measurement, indication, and recording of smoke opacity from the incinerator. Include in stackunits a light source, a light detecting or receiving unit mounted in the stack or main breaching as recommended by the manufacturer, and fixed access to the units.

b. Provide the control or transmitter unit with electronic solid-state circuitry and meter or digital indicator, indicating smoke density by 0 to 100 percent opacity. In addition, furnish the control unit or transmitter with calibration and alarm adjustments, in a dust-tight metal enclosure. Provide a purging air system to clean light source lens and light detector lens. Make the control unit adjustable for various smoke densities at which alarm bell will sound and at which warning lights will operate. Warning bell must sound in conjunction with the red light.

c. Provide an electrical or electronic type recorder with a 250 mm 10 inch minimum diameter recorder chart having 24-hour rotation scale, graduated in 0 to 100 percent smoke density. Provide the smoke alarm indicator and recorder system with provisions to field-check 0 and 100 percent smoke density calibration points without shutdown of incinerator or removal of stack units, indicator, and recorder. Provide equipment suitable for ambient temperatures not more than [_____] degrees C degrees F and up to 100 percent humidity. Provide smoke alarm indicator and recorder, including air purging system, which operates on 115-volt, single-phase, 60 Hz electric power. Provide four hundred blank charts and a 1-year ink supply.

2.8 TOOLS

Provide uncommon tools necessary for the operation, cleanout and maintenance of the incinerator, [boilers,] burners, pumps, fans, valves, traps, strainers, [other steam piping equipment,] and other auxiliary equipment. Also provide any special wrenches as required for opening [boiler manholes], handholes, and cleanouts . Provide a smoke pipe cleaner to clean the breaching and smoke connections, with a jointed handle of sufficient length to clean breaching and smoke connections

without dismantling.

2.9 PAINTING AND FINISHING

2.9.1 Treatment

Clean all surfaces of castings, forgings, molded parts, stampings, welded parts, inner surfaces of the outer casing of the incinerator, the exterior surfaces of the outer casing, the control panel, and piping, except corrosion-resistant steel, to base metal for removal of oil, rust, sand, dirt, fins, spurs, scale, slag, flux and other extraneous materials before primer is applied at the factory. Make external surfaces smooth and all edges rounded or beveled, unless sharpness is required to perform a necessary function.

2.9.2 Incinerator Coating

Paint incinerator in accordance with the manufacturer's standard practice with a minimum of one primer coat and two finish coats. Paint metal subject to heat with heat resistant (up to 648 degrees C1200 degrees F) silicone aluminum paint. Apply paint directly to clean bare metal surfaces and attain a minimum dry film thickness of 1 mil per coat. Do not apply paint when the temperature is 10 degrees C 50 degrees F or below or above 32 degrees C 90 degrees F.

2.9.3 Equipment Coating

Factory finish equipment and component items, when fabricated from ferrous metal, with the manufacturer's standard finish if located within buildings. Provide items to be located outside with weather-resistant finishes that will withstand 500 hours of exposure to the salt spray test specified in ASTM B117, using a 20-percent sodium chloride solution. This test may be performed on test specimens coated and finished in the same manner as the actual equipment. Immediately after completion of the test, the specimens must show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Paint all exposed pipe covering as specified in Section 09 90 00 PAINTS AND COATINGS. Do not paint aluminum sheath over insulation.

2.10 FACTORY TESTS

Conduct initial capacity and performance tests of factory assembled incinerator components at the manufacturer's plant. Correct or replace any material and equipment rejected before installation.

PART 3 EXECUTION

3.1 EXAMINATION

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NOTE: Equipment dimensions vary widely between different manufacturers. Although the general arrangement of the building will remain the same, some structural dimensions may have to be changed after award of the contract to accommodate the specific equipment being proposed.

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After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancies before performing the work. Because of the small scale of the drawings, it is not possible to detail all runs and indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting all work, arranged accordingly, and furnish such fittings and accessories as may be required to meet such conditions. Plans are generally diagrammatic. Harmonize the work of the different trades so interference between conduit, piping, equipment, architectural, and structural work is avoided. Submit building design modifications required for the specific equipment being supplied prior to start of construction.

3.2 MANUFACTURER'S FIELD SERVICES

Obtain the services of the manufacturer's representative experienced in, and to supervise the installation, adjustment, operation, and testing of the equipment specified. Ensure that sufficient lead time is given to prevent late delivery of equipment and materials and installation delay problems.

3.3 INCINERATOR INSTALLATION

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NOTE: Delete inapplicable NFPA and FM Standards not to be employed.

****

Install equipment and material as indicated and in accordance with the manufacturer's written instructions, industry standards, and NFPA 82. Provide combustion air supply and ventilation in accordance with NFPA 31 or NFPA 54.

3.3.1 Gas Systems

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NOTE: Specify the utilities to which connections will be made by the Contractor. Show utilities on the drawings. Delete inapplicable paragraphs.

****

Provide gas service as specified in Section 23 11 20 FACILITY GAS PIPING.

3.3.2 Fuel Oil System

Install fuel oil system in accordance with NFPA 31 and Section 33 56 10 FACTORY-FABRICATED FUEL STORAGE TANKS, unless otherwise indicated.

3.3.3 Foundation

Construct foundations for the incinerator and for other heating equipment specified, when required, as indicated and recommended by the manufacturer. Construct incinerator foundation of [3000] [_____] psi concrete as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Set anchor bolts accurately and of adequate length to install the incinerator. When embedded in concrete, install anchor bolts with plates welded on the head and protect them against damage until the equipment is installed.

3.3.4 Steel Ladders

Provide a steel ladder where the depth of manhole exceeds 3.6 m 12 feet, not less than 406 mm 16 inches in width, with 19 mm 3/4 inch diameter rungs spaced 300 mm 12 inches apart, with two stringers a minimum 10 mm 3/8 inch thick and 50 mm 2 inches wide. Rigidly affix the ladder to the tank bottom with pipe guides or slip bars, secured with slip bars at the top, and spaced not more than 1.8 m 6 feet apart vertically, to accommodate expansion of the stringers. Install stringers to provide at least 150 mm 6 inches of space between the wall and the rungs. Galvanize ladders and inserts after fabrication in conformance with ASTM A123/A123M. The wall along the line of the ladder must be vertical for its entire length.

3.3.5 Equipment Structural Support

3.3.5.1 Column Base Plates

Design column base plates to bear on a [21] [_____] MPa [3000] [_____] psi concrete floor slab.

3.3.5.2 Anchor Bolts

Provide ASTM A307 anchor bolts. Show anchor bolt sizes and locations on the detail drawings.

3.3.6 Insulation

Provide shop and field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS unless otherwise specified. Insulate breaching [and dust collectors] with magnesia, mineral wool, calcium silicate, or approved mineral insulation. Insulation may be either block or blanket type. Fill joints in the insulation with magnesia, mineral wool, or other equally suitable cement.

3.3.7 Catwalks and Access Platforms

Catwalks, access platform stairs, ladders, and handrails shown, depict a general scheme of ingress and egress. Furnish and install all necessary platforms and stairs for safe and efficient operation and maintenance of the equipment. They may be relocated from the wall openings and passageways shown in order to suit the incineration equipment provided. Provide all railings with 100 mm 4 inch wide toe-board located not more than 6 mm 1/4 inch above the floor level. Conform construction, as close as practical, to similar items as indicated.

3.3.8 Control System Installation

Install equipment in accordance with the manufacturer's approved instructions. Provide all control conduit, wiring and/or tubing under this section of the specifications, except as specified elsewhere. Copper, stainless steel, or non-metallic tubing may be used as appropriate. Provide copper consisting of ASTM B88M ASTM B88, Type K with flare type, cast brass, or wrought copper fittings. Provide pneumatic tubing consisting of 6 mm 1/4 inch OD with a minimum wall thickness of 0.762 mm 0.030 inch unless otherwise indicated. Where 10 mm 3/8 inch or 13 mm 1/2 inch O D tubing is used, provide a minimum wall thickness of 1.245 mm 0.049 inch. Extent, general location, and arrangement of the system will be as indicated on the drawings. Locate control panels as

indicated relative to the incinerator, loader [and heat recovery system] and placed so that operating personnel may effectively monitor incinerator operations, but will not be in a position that would interfere with those operations. Fit equipment, instruments, piping, wiring and tubing into the space allotted allowing adequate clearances for entry, servicing, and maintenance. Install locally mounted instruments in such a manner as to prevent interference with mechanical installations and to ensure readability from the front aisles or operating area of the various items of equipment. Provide and install all materials and equipment indicated, specified, and/or required to provide a complete and operable system, including material and items required to arrange the system to compensate for the actual field conditions, whether or not the items required are specifically specified or shown. Carefully coordinate installation of the instrumentation with the work of other trades.

3.3.9 Field Tubing

Provide compression type tube fittings compatible with tubing material, of materials suited to the tubing (brass for copper tubing, stainless steel for stainless steel tubing, and nonmetallic for nonmetallic). Check each tubing connection for proper tightness and installation. All piping between primary connections and instruments must be a minimum of 10 mm 3/8 inch OD tubing. Provide all copper instrument connecting lines that require only a single line with brass, ASTM B61, 21 MPa 3000 psi rating, forged body screw or tube ends.

3.3.9.1 Tubing Supports

Use PVC coated expansion metal troughs or epoxy coated vertical unistrut racks as tubing supports. Do not use any elbows, tees, or crosses. Where the trough changes direction or branches, a suitable gap for the transition is acceptable; use unsupported tubing over the gap.

3.3.9.2 Air Supply

Instrument air supply headers are as shown. Instrument air is to be distributed through the area at nominally 620 kPa 90 psig. Pressure is to be reduced to that required at the instrument by installation of a local regulator. Furnish and install an air set unit for each instrument that has a pneumatic output signal, such as transmitter, transducer, controllers, positioner and relay. Provide air set units with a filter regulator with integral drip-well and drain cock and output gauge.

3.3.10 Electrical

Provide instrumentation and power-interconnecting wiring as [shown] [recommended by the manufacturer] and as specified in NFPA 70. Terminate all external wiring to the control panels on terminal boards or on devices in the panels. Carry all cable wire and cable runs in conduit or wireways. Run all signal-wiring used for alarm or measurement of control circuits in conduit separate from power circuits. Direct current signals used for electronic transmission may be run in multi-conductor cables. Wiring for control, shutdown, or interlock circuits may be run in the same conduit with power wiring as shown. Do not feed instruments from lighting branch circuits. Make termination of all wires on instrument binding screws with solderless type insulated shoulder ring-tongue lugs of the proper size for the wire and binding screw use. Crimp lugs properly and securely to the wire using the tool recommended by the lug manufacturer. Cut off any termination which is improperly made and install a new lug.

Strip all wire with an approved stripping tool or in such a manner as not to damage the conductor.

3.3.10.1 Cable-Conductor Identification

Permanently attach identification to each wire terminating on a terminal board or binding screw to facilitate maintenance. Provide identification by means of plastic sleeving with printed markings, permanently attached stamped foil markers, or by other approved means. Provide wire numbers corresponding to wire numbers shown.

3.3.10.2 Relays

Provide industrial type relays for interlocking circuits, with contacts and coils accessible for cleaning and replacement.

3.3.11 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, are as specified in Section 09 90 00 PAINTS AND COATINGS.

3.4 FRAMED INSTRUCTIONS

Post framed instructions under glass or in laminated plastic, including wiring and control diagrams showing the complete layout of the entire system, equipment, piping, valves, and control sequence, where directed. Prepare in typed form, condensed operating instructions explaining preventive maintenance procedures, methods of checking the system for normal safe operation, and procedures for safely starting and stopping the system, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Post framed instructions before acceptance testing of the systems.

3.5 TESTING

3.5.1 General

Prior to requesting commencement of the performance and acceptance test, conduct final checking of system installation in accordance with the manufacturer's recommendations and the requirements of the other sections of the project specifications. Include in final checking: preliminary operation testing and adjustments of facilities as necessary to ensure completeness of installation and satisfactory operation of all systems. Schedule all tests in advance, conduct at times approved, and perform in the presence of the Contracting Officer.

3.5.1.1 Schedule for Testing

Notify the Contracting Officer in writing at least [20] [_____] days in advance of his intent to test the incinerator, and submit a testing schedule. The Contracting Officer will notify the appropriate authorities.

3.5.1.2 Visual Inspection

Examine each incinerator for defects outlined below:

a. Parts of components missing
b. Improper assembly

c. Parts or components not functioning properly
d. Workmanship not as specified
e. Exposed edges of metal not smooth
f. Materials not as specified

3.5.1.3 Repairs

Replace defective parts and make all repairs disclosed to be necessary by capacity and operating tests to those items furnished and installed by the Contractor.

3.5.2 Instrumentation

Test all after completing the following activities:

a. Inspect complete work and make any non-operating checks required to ensure operability in the manner required for the process application.

b. Check instrument air lines and wiring for proper hook-up.

c. Test air lines for tightness according to the requirement of ISA 7.0.01.

d. Commissioning of instruments, controls, interlocks, alarms, and related items including operating checks, provision and installation of seals as required, checking and adjusting settings, standardizing and calibration and proof tests.

e. Installation of relief valves and filter regulator sets.

f. Insulation and winterizing of instruments. If such cannot be completed before startup, advise the Contract Officer in writing 2 weeks before testing.

3.5.3 Dielectric Tests

Test electrical system for dielectric strength. Subject electrical system, excluding control and recording instruments, to a voltage of twice its rated voltage, plus [500] [_____] volts, for a period of not less than [1] [_____] minute[s]. Prior to testing, disconnect all instruments and operators that could be damaged. After this test, the circuit must still register a resistance value of not less than 1 megohm at [600] [_____] volts, dc. Apply this test between all insulated circuits and external metal parts.

3.5.4 Fuel Systems Test

Hydrostatically test auxiliary fuel piping at a pressure of 1.5 times the working pressure. Remove gauges and other apparatus that may be damaged by the test pressure from the system prior to on-site testing. Maintain required test pressure for not less than 2 hours to provide sufficient time for inspection of joints and connections in all piping systems. Correct all defects that develop during testing and retest until no defects or leaks are found.

3.5.5 Fuel Burning Equipment Test

Perform test of fuel burning equipment to demonstrate that the equipment installed meets the requirements of the specifications.

3.5.6 Controls Test

Test incinerator under actual firing conditions. Verify with test that all controls function within the maximum and minimum limits for temperature or timing. Simulate unsafe conditions, such as high temperatures and flame failure, by reducing the settings for the activation of limit and safety controls. Test the stoking mechanism to demonstrate control and operational conformance with the requirements of the specification under varying load conditions.

3.5.7 Performance Testing

Upon completion of all related work and prior to acceptance, test the incinerator [heat recovery], associated equipment, and instrumentation to demonstrate indicated performance. Perform stack sampling for compliance with applicable emission limits by [the AEHA or] an approved independent qualified testing laboratory. Adjust all equipment and controls before the scheduled operating test. Test in accordance with the test procedures indicated below and in accordance with the requirements of ASME PTC 19.10. Take all pressure measurements in accordance with ASME PTC 19.2, and all temperature measurements in accordance with ASME PTC 19.3 TW. Furnish all instruments, equipment, and personnel required for the tests. The Government will supply fuel, water, electric power, and waste materials. Make two instruction manuals available at all times during the tests.

3.5.7.1 Procedure

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NOTE: Indicate performance requirements.
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Preheat incinerators for [4] [_____] hours to reach the firing temperature of [982] [_____] degrees C [1800] [_____] degrees F. Charge incinerator with waste at the rated burning capacity in pounds per hour for a minimum of 72 hours and operate in accordance with the manufacturer's written instructions. Include in performance testing the operation of the mechanical charging facilities, the incinerator, [the heat recovery boiler,] the air pollution control equipment, the ash handling equipment, and the operation monitoring facilities. Test full-scale, for three 24-hour runs accomplished within five days. Monitor performance to verify compliance with the contract requirements. If serious inconsistencies in the observed data are noted during any test run, or in later computational analysis, that run is to be rejected completely.[Heat recovery unit is to supply the rated amount of steam at the temperature, pressure,[and at the thermal efficiency specified] when the unit is charged with waste at the rated burning capacity. Entire unit must be able to maintain this efficiency during the entire test period.] Reduce waste to a fine ash residue. Follow normal burnout procedure. After the residue has cooled, analyze samples taken during testing.[The residue must not exceed [45.0 (dry basis)][10] percent of the total combustible portion of the charge when tested by [weight][volume] as specified.][The combustible content of the ash must not exceed [_____] percent.] After cleanout, inspect the incinerator for deterioration such as slagged or spalling refractory, warping of parts, and discolored exterior paint.

3.5.7.2 Efficiency and Operating Tests Procedures

Run an efficiency and capacity test, on one incinerator, conducted in accordance with ASME PTC 4 utilizing the input-output method, except for

use of alternate measuring or metering devices properly calibrated before the test, for the purpose of [metering the water used and] weighing the amount of fuel burned as approved by the Contracting Officer.[Use water meter in the test suitable for hot water. Efficiency less than specified in paragraph Heat Recovery Boiler is not acceptable. Provide maximum moisture content of saturated steam leaving the boiler as specified in Section 23 52 30.00 10 HEAT RECOVERY BOILERS.] Conduct efficiency and general performance tests on the incinerators[and boilers] using a qualified test engineer. Furnish calibration curves or test results furnished by an independent testing laboratory of each instrument, meter, gauge, and thermometer to be used in efficiency and capacity tests before the test. Read all indicating instruments at half-hour intervals unless otherwise directed.

3.5.7.3 Alternate Efficiency Testing Procedures

If equipped with a full-size, backup burner of its own, test the heat recovery boiler for thermal efficiency independent of the incinerator using hot gases supplied by that burner. Analyze ash from the incinerator, which is to show no more than [_____] percent carbon by weight. The entire system is required to produce the rated amount of steam while burning the rated amount of waste for the durations specified for testing procedures and comply with all other test requirements. This alternate method of testing is intended for use where the additional burner capacity exists, in order to avoid determining the actual heat content of the waste used for the tests.

3.5.7.4 Shell Temperature

Operate incinerator under normal load conditions for not less than [4] [_____] hours. After [4] [_____] hours, temperature instrument readings of the outer shell, taken at not less than five random locations, must not exceed the temperature limitation specified.

3.5.7.5 Test Reports

Submit test reports in booklet form showing all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion of construction and testing of the installed system. Indicate in each test report the final position of controls, including logs [thermal efficiency calculations,] and tabulated results together with conclusions. Include the following in the reports:

a. Time, date, and duration of test.
b. Incinerator make, model, rated capacity, grate area.
c. Proximate analysis of waste used during tests.
d. Flue-gas temperature at [boiler] [incinerator] outlet.
e. Percent O2 in flue gas.
f. Quantity of waste consumed.
g. Heat content of waste.
h. Any other data required by ASME PTC 4.

3.5.8 Emission Test

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NOTE: Local regulatory authorities should be contacted at an early stage of the project design to determine if they consider the methods cited to be

adequate, and if they have any additional requirements.
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Test one incinerator for excessive emissions in accordance with 40 CFR 60, methods 1, 2, 3, and 5 for incinerators or as required by local authorities. Do not exceed the specified emissions limits. Stack emissions sampling is required for a minimum period of [_____] continuous hour[s] of incinerator operation and done concurrently with the efficiency tests. Perform emissions tests by [the USAEHA, or] an independent laboratory recognized by the appropriate authorities. If it is determined during the tests specified above, that the incinerators fail to comply with the applicable air pollution regulations, the incinerator manufacturer is responsible for correcting the problem by modifying the equipment or by adding air pollution control equipment and also be responsible for any additional testing required to prove compliance.

3.6 TRAINING

Conduct a training course for the operating, maintenance, and supervising staff as designated by the Contracting Officer. Start the training period, a total of [_____] hours of normal working time, after the system is functionally complete but prior to final acceptance tests.

3.6.1 Content

During field instructions cover all of the items contained in the Operating and Maintenance Instructions, and include recommendations for total staffing and job descriptions.

3.6.2 Operating Instructions

Submit [six] [_____] complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation, and emergency procedures, prior to the start of the training course. Include the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment and their basic operating features.

3.6.3 Maintenance Instructions

Submit [six] [_____] complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns repairs, and trouble shooting guide, prior to the start of the training course. Include simplified wiring, piping, and control diagrams for the system as installed and other information necessary for the equipment maintenance.

-- End of Section --