
USACE / NAVFAC / AFCEA UFGS-11181 (August 2004)

Preparing Activity: USACE Superseding
UFGS-11181A (June 2003)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags

SECTION TABLE OF CONTENTS

DIVISION 11 - EQUIPMENT

SECTION 11181

INCINERATORS, GENERAL PURPOSE

08/04

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 GENERAL REQUIREMENTS
 - 1.3.1 Standard Products
 - 1.3.2 Nameplates
 - 1.3.3 Equipment Guards and Access
 - 1.3.4 Verification of Dimensions
 - 1.3.5 Welding
 - 1.3.6 Prohibition of Asbestos
 - 1.3.7 Conformance with Agency Requirements
 - 1.3.8 Permits
 - 1.3.9 Spare Parts
 - 1.3.10 Detail Drawings
- 1.4 SYSTEM DESCRIPTION
- 1.5 OPERATING AND PERFORMANCE REQUIREMENTS
 - 1.5.1 Waste Reduction
 - 1.5.2 Heat Recovery Boiler
 - 1.5.3 Pollution Control
 - 1.5.3.1 Gaseous Emissions
 - 1.5.3.2 Particle Size and Particulate Limits
 - 1.5.4 Noise
- 1.6 DELIVERY AND STORAGE
- 1.7 MANUFACTURER'S SERVICES

PART 2 PRODUCTS

- 2.1 ELECTRICAL WORK
- 2.2 INCINERATOR
 - 2.2.1 Type of Unit and Unit Capacity
 - 2.2.2 Unit
 - 2.2.2.1 Supports
 - 2.2.2.2 Access Doors

- 2.2.3 Minimum Design Requirements
- 2.3 FURNACE CONSTRUCTION
 - 2.3.1 General
 - 2.3.2 Lubrication
 - 2.3.2.1 Lubrication Fittings
 - 2.3.2.2 Lubrication Equipment, 6.9 MPa 1,000 psi and Higher
 - 2.3.3 Lifting Attachments
 - 2.3.4 Accessibility
 - 2.3.5 Interchangeability
 - 2.3.6 Fastening Devices
 - 2.3.7 Electrical
 - 2.3.8 Castings and Forgings
 - 2.3.9 Welding, Brazing, Soldering, Riveting, or Wiring
 - 2.3.10 Incinerator Furnace Lining
 - 2.3.11 Castable Refractory
 - 2.3.12 Refractory Wall Construction
 - 2.3.13 Insulation
 - 2.3.14 Expansion Joints
 - 2.3.15 Exterior Walls of the Furnace
 - 2.3.16 Primary Chamber
 - 2.3.17 Secondary Chamber
 - 2.3.18 Primary and Secondary Cowling
 - 2.3.19 Grates
 - 2.3.19.1 Stoker Design
 - 2.3.19.2 Stoker or Ram Operation
 - 2.3.20 Furnace Doors
 - 2.3.20.1 Mechanical Charging Doors
 - 2.3.20.2 Stoking and Cleanout Doors
 - 2.3.21 Observation Ports
 - 2.3.22 Test Holes
 - 2.3.23 Safety Devices
 - 2.3.24 Freeze Protection
 - 2.3.25 Incinerator Cooling System
- 2.4 INCINERATOR AUXILIARY EQUIPMENT
 - 2.4.1 Charging Method
 - 2.4.1.1 Feed Hopper
 - 2.4.1.2 Charging Ram
 - 2.4.2 Auxiliary Burners
 - 2.4.2.1 Oil Burners
 - 2.4.2.2 Mechanical Pressure Atomizer
 - 2.4.2.3 Air Jet Atomizer
 - 2.4.2.4 Air Register
 - 2.4.2.5 Throat Openings
 - 2.4.2.6 Electric Ignition System
 - 2.4.3 Fuel Oil System
 - 2.4.3.1 Automatic Safety Shutoff Valve
 - 2.4.4 Fuel-Oil Piping
 - 2.4.5 Fuel-Oil Storage Tank
 - 2.4.6 Gas Meter
 - 2.4.7 Stack
 - 2.4.8 Breaching
 - 2.4.9 Draft Equipment
 - 2.4.9.1 Combustion Air Damper
 - 2.4.9.2 Flue Gas Damper
 - 2.4.9.3 Blowers
 - 2.4.9.4 Draft Fans
 - 2.4.9.5 Control Equipment
 - 2.4.9.6 Air Ducts
 - 2.4.10 Heat Recovery System

- 2.4.11 Ash Removal
 - 2.4.11.1 Ash Pits
 - 2.4.11.2 Drag Chain Conveyor
 - 2.4.11.3 Elevator Conveyor
- 2.4.12 Steam Piping
- 2.5 COMBUSTION CONTROL EQUIPMENT
 - 2.5.1 General
 - 2.5.2 Equipment
 - 2.5.3 Combustion Control
 - 2.5.4 Incinerator System Operation Sequence
 - 2.5.5 Controllers
 - 2.5.5.1 Automatic Controller
 - 2.5.5.2 Fuel-Flow, Air-Flow Type
 - 2.5.6 Damper Control
 - 2.5.7 Fuel Feed Controls
 - 2.5.8 Burner Controls and Safety System
 - 2.5.8.1 Incinerator Burners
 - 2.5.8.2 Combustion-Safety Controls System
 - 2.5.8.3 Purge Timer
 - 2.5.8.4 Safety Shutdown Interlocks
 - 2.5.9 Combustion Temperature Control
 - 2.5.9.1 Primary Combustion Chamber or Zone Controller
 - 2.5.9.2 Secondary Combustion Chamber or Zone Controller
 - 2.5.10 Draft Fan Control
 - 2.5.11 Draft Fan Drives
 - 2.5.12 Ash System Control
 - 2.5.13 Soot Blower
 - 2.5.14 Incinerator Shutdown
 - 2.5.15 Control Panel
 - 2.5.15.1 Panel Details
 - 2.5.15.2 Identification
 - 2.5.15.3 System Diagram
 - 2.5.16 Indicating Lights
 - 2.5.17 Selector Switches
 - 2.5.18 Clock
 - 2.5.19 Recorders
 - 2.5.20 Water Meters
 - 2.5.21 Annunciator
 - 2.5.22 Flame Sensor
 - 2.5.23 Temperature Indicators
 - 2.5.23.1 Thermometers
 - 2.5.23.2 Thermocouples
 - 2.5.23.3 Pyrometers
 - 2.5.24 Pressure and Vacuum Gauges
 - 2.5.25 Draft Indicator and Control
 - 2.5.26 Opacity Alarm
- 2.6 TOOLS
- 2.7 PAINTING AND FINISHING
 - 2.7.1 Treatment
 - 2.7.2 Incinerator Coating
 - 2.7.3 Equipment Coating
- 2.8 FACTORY TESTS

PART 3 EXECUTION

- 3.1 INCINERATOR INSTALLATION
 - 3.1.1 Gas Systems
 - 3.1.2 Fuel Oil System
 - 3.1.3 Foundation

- 3.1.4 Steel Ladders
- 3.1.5 Stack Support
- 3.1.6 Equipment Structural Support
 - 3.1.6.1 Column Base Plates
 - 3.1.6.2 Anchor Bolts
- 3.1.7 Insulation
- 3.1.8 Catwalks and Access Platforms
- 3.1.9 Control System Installation
- 3.1.10 Field Tubing
 - 3.1.10.1 Tubing Supports
 - 3.1.10.2 Air Supply
- 3.1.11 Electrical
 - 3.1.11.1 Cable-Conductor Identification
 - 3.1.11.2 Relays
- 3.1.12 Field Painting
- 3.2 TESTING
 - 3.2.1 General
 - 3.2.1.1 Schedule for Testing
 - 3.2.1.2 Visual Inspection
 - 3.2.1.3 Repairs
 - 3.2.2 Instrumentation
 - 3.2.3 Dielectric Tests
 - 3.2.4 Fuel Systems Test
 - 3.2.5 Fuel Burning Equipment Test
 - 3.2.6 Controls Test
 - 3.2.7 Performance Testing
 - 3.2.7.1 Procedure
 - 3.2.7.2 Efficiency and Operating Tests Procedures
 - 3.2.7.3 Alternate Efficiency Testing Procedures
 - 3.2.7.4 Shell Temperature
 - 3.2.8 Emission Test
- 3.3 QUALITY CONTROL
- 3.4 FRAMED INSTRUCTIONS
- 3.5 DEMONSTRATION

-- End of Section Table of Contents --

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SECTION 11181

INCINERATORS, GENERAL PURPOSE 08/04

NOTE: This guide specification covers the requirements for packaged, and modular field-erected; starved, and excess air incinerators having a capacity ranging from 1.05 MW (3.58 MBtuh) or 378 kg per hour (833 pounds per hour) 9 metric tons per day (10 TPD) up to 7.91 MW (27 MBtuh) or approximately 2.7 metric tons per hour (3 tons per hour) 68 metric tons per day (75 TPD) of Type 2 waste 10 MJ per kg (4300 Btu per pound), or the Joule (Btu) equivalent amount of Types 0, 1, or 3.

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

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

Use of electronic communication is encouraged.

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

PART 1 GENERAL

NOTE: Pathological waste incinerators are covered by Section 11182A INCINERATORS, MEDICAL WASTE. The 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 will be fired with gas, oil, or a combination thereof and will be sized to supply the input required to ensure complete combustion of the refuse in the primary and secondary combustion zones.

1.1 REFERENCES

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

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

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)

- | | |
|----------|--|
| AMCA 210 | (1999) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating |
| AMCA 801 | (2001) Industrial Process/Power Generation Fans: Specification Guidelines |
| AMCA 99 | (1986; R 1998) Standards Handbook |

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- | | |
|-------------|---|
| ANSI Z21.13 | (2001; A 2002) Gas-Fired Low-Pressure Steam and Hot Water Boilers |
|-------------|---|

AMERICAN WATER WORKS ASSOCIATION (AWWA)

- | | |
|-----------|--|
| AWWA C700 | (2002) Cold-Water Meters - Displacement Type, Bronze Main Case |
|-----------|--|

AMERICAN WELDING SOCIETY (AWS)

- | | |
|----------------|--|
| AWS B2.1 | (2000) Welding Procedure and Performance Qualification |
| AWS D1.1/D1.1M | (2002) Structural Welding Code - Steel |

ASME INTERNATIONAL (ASME)

- | | |
|--------------|--|
| ASME B1.1 | (1989; R 2001) Unified Inch Screw Threads (UN and UNR Thread Form) |
| ASME B15.1 | (2000) Safety Standard for Mechanical Power Transmission Apparatus |
| ASME B18.2.1 | (1996) Square and Hex Bolts and Screws, Inch Series |

ASME B18.2.2	(1987; R 1999) Square and Hex Nuts
ASME B31.1	(2001) Power Piping
ASME B40.100	(2000) Pressure Gauges and Gauge Attachments
ASME PTC 10	(1997) Test Code on Compressors and Exhausters
ASME PTC 19.10	(1981) Flue and Exhaust Gas Analyses - Part 10
ASME PTC 19.2	(1987; R 1998) Pressure Measurement
ASME PTC 19.3	(1974; R 1998) Temperature Measurement
ASME PTC 33	(1978; R 1991) Large Incinerators
ASME PTC 4	(1998) Fired Steam Generators

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M	(2002) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153/A 153M	(2003) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 297/A 297M	(2003) Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application
ASTM A 307	(2002) Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A 319	(1971; R 2001) Gray Iron Castings for Elevated Temperatures for Non-Pressure Containing Parts
ASTM A 325	(2002) Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 325M	(2003) Structural Bolts, Steel, Heat Treated, 830 Mpa Minimum Tensile Strength (Metric)
ASTM A 36/A 36M	(2003a) Carbon Structural Steel
ASTM A 48/A 48M	(2000) Gray Iron Castings
ASTM A 568/A 568M	(2003) Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for
ASTM A 653/A 653M	(2003) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated

	(Galvannealed) by the Hot-Dip Process
ASTM A 924/A 924M	(1999) General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B 117	(2002) Operating Salt Spray (Fog) Apparatus
ASTM B 61	(2002) Steam or Valve Bronze Castings
ASTM B 633	(1998e1) Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B 68	(2002) Seamless Copper Tube, Bright Annealed
ASTM B 68M	(1999) Seamless Copper Tube, Bright Annealed (Metric)
ASTM B 766	(1986; R 2003) Electrodeposited Coatings of Cadmium
ASTM B 88	(2002) Seamless Copper Water Tube
ASTM B 88M	(1999) Seamless Copper Water Tube (Metric)
ASTM C 155	(1997; R 2002) Insulating Firebrick
ASTM C 27	(1998; R 2002) Fireclay and High-Alumina Refractory Brick
ASTM C 401	(1991; R 2000) Alumina and Alumina-Silicate Castable Refractories
ASTM C 612	(2000a) Mineral Fiber Block and Board Thermal Insulation
ASTM F 1097	(1991; R 2001) Mortar, Refractory (High-Temperature, Air-Setting)
FM GLOBAL (FM)	
FM P7825a	(2003) Approval Guide Fire Protection
FM P7825b	(2003) Approval Guide Electrical Equipment
ISA - THE INSTRUMENTATION, SYSTEMS AND AUTOMATION SOCIETY (ISA)	
ISA MC96.1	(1982) Temperature Measurement Thermocouples
ISA S7.0.01	(1996) Quality Standard for Instrument Air
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA ICS 6	(1993; R 2001) Industrial Control and Systems: Enclosures
NEMA MG 1	(2003) Motors and Generators

NEMA SM 23 (1991; R 1997; R 2002) Steam Turbines for Mechanical Drive Service

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 211 (2003) Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances

NFPA 30 (2003) Flammable and Combustible Liquids Code

NFPA 31 (2001) Installation of Oil Burning Equipment

NFPA 54 (2002) National Fuel Gas Code

NFPA 70 (2002) National Electrical Code

NFPA 82 (2004) Incinerators and Waste and Linen Handling Systems and Equipment

NFPA 8501 (1997) Single Burner Boiler Operation

NFPA 8502 (1999) Prevention of Furnace Explosions/Implosions in Multiple Burner Boilers

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

SMACNA Industry Practice (1975, 1st Ed) Accepted Industry Practice for Industrial Duct Construction

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

40 CFR 60 Standards of Performance for New Stationary Sources

UNDERWRITERS LABORATORIES (UL)

UL 296 (2003; Rev thru Jan 2004) Oil Burners

UL 50 (1995; Rev thru Sep 2003) Enclosures for Electrical Equipment

UL 726 (1995; Rev thru Jan 2001) Oil-Fired Boiler Assemblies

UL 795 (1999) Commercial-Industrial Gas Heating Equipment

UL Gas&Oil Dir (2003) Flammable and Combustible Liquids and Gases Equipment Directory

1.2 SUBMITTALS

NOTE: Submittals must be limited to those necessary

for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

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

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

SD-02 Shop Drawings

Detail Drawings

Drawings for the specific equipment being proposed, as specified.

SD-03 Product Data

Spare Parts

Spare parts data for each different item of material and equipment specified.

Framed Instructions

Proposed diagrams, instructions procedures, and other required sheets.

SD-06 Test Reports

Testing

Evidence that the incinerators proposed to be furnished will 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.

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. Each test report shall indicate the final position of controls, and shall include logs [thermal efficiency calculations,] and tabulated results together with conclusions. Reports shall include the following:

- 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 and ASME PTC 33.

Operating and environmental test plan shall contain 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 shall be one of the prerequisites for beginning the specified testing.

SD-07 Certificates

Equipment

Certificates attesting that the 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. Documentation that in a commercially operating industrial plant, the incineration system [and the steam generating system] have operated continuously and without interruption for a period of not less than [100] [_____] consecutive hours shall be included. This documentation shall be certified 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.

SD-10 Operation and Maintenance Data

Operating and Maintenance Instructions

[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. Instructions shall include the manufacturer's name, model number, service manual, parts list, and a brief description of all equipment and their basic operating features. 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. Instructions shall include simplified wiring, piping, and control diagrams for the system as installed and other information necessary for the equipment maintenance.

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Products

Materials, equipment, and controls shall be the standard products of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate equipment that has been in satisfactory use for at least 2 years prior to bid opening. Equipment shall be supported by a 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.

1.3.2 Nameplates

Each major component of equipment and each waste incineration system shall be furnished with a metal or laminated plastic nameplate securely attached to the equipment and readily accessible for visual access. Each nameplate shall 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 kilograms per hour. pounds per hour.
- e. Incinerator volume in cubic meters. cubic feet.

1.3.3 Equipment Guards and Access

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

Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts so located that any person may come in close proximity thereto shall be enclosed or guarded and comply with ASME B15.1. High-temperature equipment and piping so located as to endanger personnel

or create a fire hazard shall be guarded or covered with insulation of the type specified for service. Items such as [catwalk,] [stair,] [ladder,] [and guardrail] shall be provided where shown and shall be in accordance with paragraph Catwalks and Access Platforms.

1.3.4 Verification of Dimensions

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.

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and shall 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. Structural and finish conditions affecting all work shall be investigated, arranged accordingly, and such fittings and accessories shall be furnished as may be required to meet such conditions. Plans are generally diagrammatic and the work of the different trades shall be harmonized so interference between conduit, piping, equipment, architectural, and structural work will be avoided. Building design modifications required for the specific equipment being supplied will be submitted prior to start of construction.

1.3.5 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.

All welding shall be in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified by the Contractor in accordance with AWS B2.1. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Contracting Officer shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practical. The Contracting Officer shall be furnished with a copy of qualified procedures and a list of names and identification symbols of qualified welders and welding operators. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with AWS D1.1/D1.1M. Welding and nondestructive testing of piping systems shall be in accordance with ASME B31.1.

1.3.6 Prohibition of Asbestos

Asbestos and asbestos-containing products shall not be used.

1.3.7 Conformance with Agency Requirements

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.

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), proof of such conformance shall be submitted. Label or listing of the specified agency will be acceptable evidence. Where equipment is specified to conform to the requirements of the ASME Boiler and Pressure Vessel Code, the design, fabrication, testing, and installation shall also conform to the code.

1.3.8 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.

Incinerator system must comply with the requirements of all applicable municipal, State and Federal emission regulations. The Contractor shall obtain all permits to construct and test the units. The Contractor shall conduct all tests required by regulatory authorities in order for the owner to obtain a final permit to operate the facility. Environmental tests shall be performed [by an approved independent qualified testing laboratory] [by the U.S. Army Environmental Hygiene Agency (USAEHA)].

1.3.9 Spare Parts

The Contractor shall 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. The data shall include 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.

1.3.10 Detail Drawings

The Contractor shall submit detail 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. Drawings shall also contain

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. Drawings shall 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.

1.4 SYSTEM DESCRIPTION

NOTE: An incinerator will normally be 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 may not be 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 will normally be supplied by the incinerator manufacturer and be compatible with his equipment.

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

- a. An automatic or semi-automatic, hydraulically operated loader to inject waste into the incinerator.
- b. A primary combustion chamber or zone which shall consist of the grate area within the furnace, or a separate chamber with internal rams.
- c. A secondary combustion chamber or zone which shall consist of an area above the grate within the furnace, or a separate chamber. Either arrangement will include auxiliary burners to maintain adequate combustion temperatures.
- 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.

1.5 OPERATING AND PERFORMANCE REQUIREMENTS

1.5.1 Waste Reduction

NOTE: Indicate the effectiveness and burnout capability of the incinerator to be provided. The combustible (carbon) content of the ash should not exceed 10 percent and the volume reduction should be 90 percent of the combustible portion of the waste. Weight reduction may be only 45 percent measured on a dry basis. If the waste has a high amount of noncombustibles, either the 90 percent volume reduction will have 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.

[Incinerator shall reduce 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 shall not exceed [10] [_____] percent.]

1.5.2 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 shall not be less than [_____] percent including all auxiliary fuel consumption while producing [_____] kg per hour ([_____] pounds per hour) [_____] pounds per hour of steam at a pressure of [_____] kPa ([_____] psig) [_____] psig and a temperature of [_____] degrees C ([_____] degrees F). [_____] degrees F. Soot-blowers will be provided for fire-tube and water-tube boilers to maintain thermal efficiency. Thermal efficiency is determined by the input - output method per ASME PTC 4.

1.5.3 Pollution Control

NOTE: Air pollution emission requirements by State and local agencies should be researched early in the project, including any anticipated changes that the project will have to comply with. This should include 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 should be indicated.

Incinerators proposed to be furnished shall meet all applicable Federal, State, and local environmental requirements.

1.5.3.1 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 11500A AIR POLLUTION CONTROL may not be adequate for this application, but may form a basis for writing this section.

[Carbon monoxide emissions shall be limited to [_____] ppm [corrected to [_____]].] [Acid gases in the form of hydrogen chloride shall be limited [to 30 ppm] [to 50 ppm] [by 90 percent removal] [_____] through the use of pollution control equipment specified in Section [_____]].] [Dioxins and Furans shall be limited by exposure of the flue gases to temperatures of [982 degrees C (1800 degrees F) 1800 degrees F] [[_____] degrees C ([_____] degrees F) [_____] degrees F] for [2] [_____] seconds.] If the incinerator equipment furnished cannot meet the above emission limits, it shall be the responsibility of the Contractor to provide additional emission control equipment to meet the emission standards.

1.5.3.2 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, proper control devices shall be provided 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.

During normal operation the emission of particles larger than 60 micrometers microns shall not occur. At maximum designed charging rate, [emission shall 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, shall not 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.] Visible emissions shall be measured in accordance with and shall not exceed zero on the Ringelmann scale. However, emissions may be as high as 1 on the Ringelmann scale, but not for more than 3 cumulative minutes.

1.5.4 Noise

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) 1 foot from any operating equipment shall not exceed [85] [_____] dBA.

1.6 DELIVERY AND STORAGE

All equipment delivered and placed in storage shall be protected from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 MANUFACTURER'S SERVICES

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

PART 2 PRODUCTS

2.1 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.

Electric-motor driven equipment specified herein shall be provided complete with motor, motor starter and controls. Motors shall conform to NEMA MG 1, with enclosures as indicated. Motors smaller than 746 W (Fractional horsepower motors) Fractional horsepower motors shall be Type I, Class 1B or Class 2A or 2B, Continuous Duty. Motors larger than 746 watts (Integral horsepower) Integral horsepower shall be Type I or II, Class 2 Continuous Duty, Design L or M. Motor starters shall all be of one manufacturer and shall be located in a motor control center located in the control room. All electrical equipment and power supply wiring shall be in accordance with Section 16415A ELECTRICAL WORK, INTERIOR. Motor starters shall be provided complete with properly sized thermal-overload protection and other appurtenances necessary for the motor control specified. Each motor shall be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating of the motor. 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, shall be provided under this section.

2.2 INCINERATOR

NOTE: The equipment will be housed in a pre-engineered, industrialized metal building which should be specified using Section 13120 PREENGINEERED METAL BUILDING. The building shall also include a sprinkler system.

Incinerators shall be suitable for indoor installation and shall consist 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 shall consume combustible gases and entrained particles. Incinerator shall be of the starved air (pyrolytic) [or controlled air grate] type designed for continuous duty. Shells shall be of gas-tight construction. Both combustion chambers or zones shall be equipped with combination natural gas/No. 2 oil burners. Each system shall be designed to use [No. 2 fuel oil] [gas] as a supplementary fuel. Burners shall be equipped with an electronic ignition. Supplementary fuel consumption for normal operations shall be minimized and shall not exceed [326] [_____] MJ per metric ton ([281,000] [_____] Btu per ton) [281,000] [_____] Btu per ton of waste fuel. Complete unit shall include 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.

2.2.1 Type of Unit and Unit Capacity

NOTE: The incinerators should be capable of burning Types 0, 1, 2, and 3 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) (8,500)	10	5	10	19.76
1 (Rubbish) (6,500)	0	10	25	15.11
2 (Refuse) (4,300)	-	7	50	9.99
3 (Garbage) (2,500)	-	5	70	5.81

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. Specific instructions should be included regarding the hazardous materials that may be incinerated and excluded by the particular installation. Indicate capacity and operating schedule. Complete design sizing.

Continuous capacity shall not be less than [_____] kg per hour ([_____] pounds per hour) [_____] pounds per 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. No manual stoking shall be required to accomplish the destruction of this waste. Each incinerator will normally be in operation [_____] days per week for [one] [two] [three] 8-hour shifts daily. Primary fuel shall be 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. Each incinerator shall be capable of burning municipal waste [of IIA Type [_____]] [with the following proximate analysis:

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

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

2.2.2 Unit

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

Unit shall be equipped for mechanical charging and operation. Incinerator shall operate under negative pressure. Each unit system shall be equipped with automatic, continuous flow ash removal and ash conveyor equipment to remove all ash and residue as generated. Each incinerator shall be 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]. Unit shall be ready for immediate mounting on a foundation and for attachment of water supply, fuel, electrical, and vent connections. Lifting eye rings shall be provided.

2.2.2.1 Supports

Each incinerator shall be supported from the foundations with structural steel independent of all refractory. Structural steel shall conform to ASTM A 36/A 36M. Incinerator supports shall permit free expansion and contraction of each portion of the incinerator without placing undue stress on any part of the incinerator or setting.

2.2.2.2 Access Doors

Doors shall be in sufficient numbers, adequately sized and properly located, and shall provide for cleaning, inspection and repair of all areas in the unit. Doors shall be gastight. Interior surfaces exposed to direct radiation and high temperatures shall be lined with an approved refractory material to prevent excessive heat losses and warping of doors. Doors that are too large or bulky for hand removal or that weigh more than 11 kg25 pounds shall be hinged.

2.2.3 Minimum Design 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.

Total furnace volume shall be such that the heat released per cubic meter (cubic foot) cubic foot of furnace volume will not exceed [_____] W ([_____] Btu/hr). [_____] Btu/hr. Gas velocity shall not exceed [_____] meters per second ([_____] feet per second) [_____] feet per second through the primary combustion zone and [_____] meters per second ([_____] feet per second) [_____] feet per second through the secondary combustion zone and flue. Secondary combustion zone volume shall be at least [_____] cubic meters per kg ([_____] cubic feet per pound) [_____] cubic feet per pound of gas produced per second including excess air required for cooling purposes.

Primary combustion zone operating temperature shall be sufficient for near complete carbon burn-out. After warm-up, the incinerators shall maintain primary combustion zone temperatures of at least 704 to 871 degrees C (1300 to 1600 degrees F), 1300 to 1600 degrees F, but not to exceed 982 degrees C (1800 degrees F) 1800 degrees F at any time. Combustion time in the secondary combustion zone shall be at least [_____] seconds total time with temperatures maintained at 927 to 982 degrees C (1700 to 1800 degrees F) 1700 to 1800 degrees F with momentary and infrequent peaks not to exceed

1149 degrees C (2100 degrees F). 2100 degrees F.

2.3 FURNACE CONSTRUCTION

2.3.1 General

Incinerator shall meet 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, materials shall be compatible with the temperature and atmospheric conditions which they will encounter. Connections between dissimilar materials shall be electrically isolated from each other with dielectric unions or flanges. Galvanizing, where specified, shall be in accordance with ASTM A 123/A 123M or ASTM A 153/A 153M.

2.3.2 Lubrication

All sliding, moving, or rotating parts normally requiring lubrication, except those provided with "sealed-for-life" lubrication, shall be provided with suitable means for such lubrication. Equipment shall be designed to operate efficiently and satisfactorily when lubricated using standard military lubricants.

2.3.2.1 Lubrication Fittings

Lubrication fittings shall be located in accessible protected positions. A bright red circle shall be painted around each point. Balls, bodies and tips of fittings shall be carbon steel. Threads of fittings shall be 1/4-28 taper, straight or 1/8 pipe threads. Fittings shall incorporate a surface ball-check valve located at the surface of the inlet tip. Carbon steel fittings shall be cadmium plated in accordance with ASTM B 766, Type I, Class 5, or zinc coated in accordance with ASTM B 633, Type I, Class 1, except that the salt spray test period for red rust corrosion shall be a minimum of 50 hours.

2.3.2.2 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, will damage grease seals or other parts, a suitable warning or caution plate shall be affixed to the equipment in a conspicuous location.

2.3.3 Lifting Attachments

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

2.3.4 Accessibility

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

2.3.5 Interchangeability

All parts shall be manufactured to standards that will permit replacement without modification to parts or equipment.

2.3.6 Fastening Devices

Bolts and nuts shall be suitable and shall conform to ASME B18.2.1 and ASME B18.2.2 respectively. All screw threads shall conform to the requirements of ASME B1.1. All screws, pins, bolts, hydraulic fittings, and similar parts shall be installed with means for preventing loss of tightness. Such parts subject to removal or adjustment shall not be swagged, peened, staked or otherwise permanently deformed.

2.3.7 Electrical

All wiring shall be brought to a single location. Equipment shall be factory wired complete with all necessary accessory devices, so as to require only a source of power at [_____] volts, [_____] phase, 60 hertz, to make the equipment operable.

2.3.8 Castings and Forgings

Gray iron shall conform to ASTM A 48/A 48M; cast iron shall conform to ASTM A 319; and heat-resistant alloy shall conform to ASTM A 297/A 297M Grade HF. All castings and forgings shall be free from defects such as scale, mismatching, blowholes, or any other defect that will affect the life, or function of the part.

2.3.9 Welding, Brazing, Soldering, Riveting, or Wiring

Welding, brazing, soldering, riveting, or wiring shall be employed only where these operations are required in the original design.

2.3.10 Incinerator Furnace Lining

Furnace and flue connection shall be lined with high-heat-duty firebrick conforming to ASTM C 27 and ASTM C 155 laid in high-heat-duty mortar conforming to ASTM F 1097, suitable for use up to 1427 degrees C (2600 degrees F). 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. Plastic refractory shall be attached with anchors. Regular castable refractory shall conform to ASTM C 401, High Strength, Class C, except that the minimum modulus of rupture for transverse strength shall be not less than 4.14 MPa (600 pounds per square inch) 600 pounds per square inch after being heat soaked for 5 hours or more at a temperature in excess of 1371 degrees C (2500 degrees F). 2500 degrees F. Insulating castable refractory shall conform to ASTM C 401, Class R and shall be hydraulic setting of a type especially suitable for incinerators required to burn wet material. Plastic refractory shall be installed in accordance with the manufacturer's recommendations and by workmen skilled in its application. Joints for firebrick shall be as thin as practicable and shall not exceed 3.2 mm 1/8 inch in thickness buildup as a buttered joint. Mortar shall cover the entire surface of the adjoining faces. Arches and circular linings shall be constructed with the necessary radial or wedge brick, straight brick, and special shapes for skewbacks, so as [to conform to the radius shown and] to provide approximately the same joint thickness at the inner and outer curves. Firebrick in the main arches of the furnace and flue connection shall be of the 228.6 mm (9 inch) 9 inch series laid on end with joints interlocking one-half the width of the brick. Firebrick in hearths and floors, except in the ash pit shall be laid on edge with interlocking joints. Incinerator roof shall have a casing construction of not thinner than 3.213 mm (10 gauge) 10 gauge steel sheet. Steel sheets and strips

shall conform to ASTM A 568/A 568M for incinerator casings, housings, and components. Other uncoated black sheet steel shall be of composition and finish best suited to the end use. Galvanized Steel Sheets shall conform to ASTM A 653/A 653M and ASTM A 924/A 924M for incinerator casings, housing, and components. Gauge numbers specified are United States Standard gauge. Special rounded shapes shall be used for the exposed edges of the openings for the charging, firing, and stoking doors. Thickness of the refractory furnace lining shall be as necessary to comply with the outer surface temperature requirements specified. Refractory walls shall be attached 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. Bulging and destruction of refractory due to heat stress shall be prevented by reinforcing, expansion joints, ties, and anchors. Manholes and other inspection and access openings, identification plates, and stamps shall have insulation finished neatly against a metal ring provided for this purpose.

2.3.11 Castable Refractory

Castable refractory shall be used in [guillotine doors, and door sills,] dampers and lids for charging throats. Material from each original container shall be thoroughly mixed dry to ensure uniform distribution of constituents and particle sizes and then mixed with water to the consistency of a stiff concrete. The mixture shall be placed in the molds or frames in such manner as to exclude air bubbles and shall be kept moist for 24 hours. Castings may be premolded or molded in place and shall conform to the details shown. Premolded castings shall be firmly set in place and, where required, shall be bonded to the firebrick masonry with firebrick mortar.

2.3.12 Refractory Wall Construction

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

2.3.13 Insulation

Where specified or indicated, insulation shall be insulating block conforming to ASTM C 612, containing no asbestos material, and designed to prevent damage to foundation and incinerator exterior due to excessive heat. Unless otherwise specified, insulation shall comply with the requirements of Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS. Insulation shall be Class 5 mineral fiber block. Insulating block shall be laid in approved mortar specially manufactured for this purpose or recommended by the insulating material manufacturer. Firebrick shall conform to ASTM C 27 or ASTM C 155 and be laid up in air-setting mortar. Insulating Firebrick shall conform to ASTM C 155. Firebrick shall be interpreted to include straight brick, radial brick, wedge brick, skew-type brick, cupola blocks, and other similar shapes. Each brick shall be dipped in mortar, rubbed, shoved into it's place, and then tapped with a wooden mallet until it touches the adjacent bricks. Mortar thick enough to lay with a trowel will not be permitted. Maximum mortar joint thickness shall not exceed 3.2 mm 1/8 inch and average joint thickness shall not exceed 1.6 mm. 1/16 inch. Main arches of the furnace and flue connection shall be insulated above the firebrick and, where exposed to the weather, shall be protected with a suitable sheath. Firebrick floors shall be insulated from

any supporting floors with insulating brick except that if the supporting floor has full bearing on earth, a 75 mm 3 inch layer of contained dry sand may be used in lieu of insulating brick. Minimum thickness for walls shall limit the temperature of the outer incinerator surface to 49 degrees C (120 degrees F) 120 degrees F in an ambient temperature of 21 degrees C (70 degrees F) 70 degrees F when the unit is operating at full rated capacity.

2.3.14 Expansion Joints

Joints shall be provided in the firebrick masonry [at approximately the locations as shown] [at spacings of approximately 2.4 m. 8 feet.] Joints shall be 12.7 mm (1/2 inch) 1/2 inch wide and shall completely separate the 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 and shall be changed as necessary, by offset or otherwise, to avoid weakening the arch over an opening.] No expansion joint shall 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, there shall be no bonding of the horizontal faces between the two courses of brick along the offset. In addition, to allow for expansion of the inner face, a series of 3.2 mm (1/8 inch) 1/8 inch wide vertical openings spaced 1.8 m (6 feet) 6 feet apart shall be provided on the furnace side of the wall. Proper provision shall be made for expansion and contraction between incinerator foundation and floor.

2.3.15 Exterior Walls of the Furnace

Walls shall be a plate steel shell at least 6.4 mm (1/4 inch) 1/4 inch thick separated from the firebrick by suitable insulation. Exterior walls of the flue connection shall be a plate steel shell at least [4.8 mm (3/16 inch)] [6.4 mm (1/4 inch)] [3/16] [1/4] inch thick separated from the firebrick by insulation. Shells shall be structurally reinforced as necessary to support burners, combustion air blowers, stack, refractories, and other components.

2.3.16 Primary Chamber

The primary chamber for dual chamber systems shall be constructed of a steel casing supported by a steel frame and provided with insulation and refractory as necessary to comply with the specified outer surface temperature requirements specified. Casing shall be not less than 2.657 mm (12 gauge) 12 gauge sheet steel reinforced to withstand internal pressures without deflection or damage to refractory or other components of the incinerator. Frame and all reinforcing members shall be constructed of structural steel. Frame shall be free standing and shall support the weight of all components of the incinerator, including doors, burners, breaching, stack connections, and appurtenant assemblies without binding or warping. Frame and casing shall be all-welded construction and shall be completed and erected prior to installation of the refractory and insulation. All access doors and parts shall be provided with seals to prevent emission of smoke or admission of significant amounts of air during incinerator operation. Primary chamber shall have no openings which would permit leakage of waste fluids.

2.3.17 Secondary Chamber

The secondary chamber of dual chamber systems shall be constructed of minimum 4.8 mm (3/16 inch) 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), 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.] Secondary chamber burner shall be capable of firing with [No. 2 fuel oil] [gas] with an electric ignition system and shall have a net output rating capable of reducing the emission of combustible gases and particulate material to meet the current local, State and Federal air pollution emission standards. Burners shall be equipped with an FM approved flame sensor and direct spark ignition. Combustion air supply for the secondary chamber shall be sufficient to ensure complete combustion of all volatiles in the flue gas. Combustion air supply fans shall be equipped with control dampers to vary the air supply as required to provide complete air pollution control. Temperature in the secondary chamber shall be controlled through the use of a temperature controller to vary the firing rate of the burner and combustion air supply.

2.3.18 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.

2.3.19 Grates

When so equipped, grates shall be constructed of cast iron of size and configuration to support the rated capacity of the type of waste specified. Grates shall be flat type, step type, or a combination of the two, as standard with the manufacturer of the incinerator and shall have a minimum weight of 195 kg per square meter (40 psf). 40 psf. Grates shall rest on supporting cast iron channels, I-beams, angles, or similar cast-iron shapes. Stoker grates made of heat-resistant alloy castings shall be metal surfaces with holes or slots through which combustion air enters. These openings, however, shall be sized to minimize plugging by ash or slag. Grates shall be designed to resist distortion, growth, cracking, and oxidation. Grates or internal ram shall be actuated 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. Stoker grate shall be [traveling,] [reciprocating,] [reverse reciprocating,] [rocking,] [or vibrating].

2.3.19.1 Stoker Design

The stoker or internal ram (when so equipped) shall be 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. Waste is admitted at one end while the ash falls off the other end continuously. Stoker and feed equipment shall be designed 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, the refuse shall be retained 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.

2.3.19.2 Stoker or Ram Operation

Operation shall be activated by means of hydraulic cylinders of adequate size with a minimum stroke of [_____] mm ([_____] inches) [_____] inches to ensure progressive movement of the refuse. Cylinders shall be mounted 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.

2.3.20 Furnace Doors

Doors shall be provided as necessary for inspection, stoking, cleanout, and charging areas. Door frames shall be securely attached to the frame of the incinerator, and shall have minimum edge thickness of 15.9 mm (5/8 inch) 5/8 inch increasing to 19.1 mm (3/4 inch) 3/4 inch around the door, to provide a seat for the door. Doors and frames shall be constructed of cast iron or steel. Doors shall have a minimum thickness of 9.5 mm (3/8 inch) 3/8 inch. Doors shall be gastight and when exposed to flame or direct heat of combustion gases shall be lined with the same type and thickness of refractory and insulation used in the combustion chamber to prevent excessive heat losses and warping. Refractory shall be secured to the doors and shall not sag. Refractory shall have tapered edges to clear door frames during the movement of swinging doors. Alloy steel hooked bars shall be welded to door cover to anchor the refractory. Doors shall be safely operable by one person. Temperature of door handles shall permit operation of doors without gloves or other protective devices. Charging doors shall be interlocked with primary burners and air supply so that burner ignition shuts off and under-fire air dampers close when doors open.

Door closure shall be gasketed with nonasbestos packing suitable for the service. Guillotine-type doors shall lift completely off the seals to effect opening. Doors shall be provided with hasps or brackets to permit locking. Provision shall also be made to lock the doors in an open position during maintenance to prevent accidental closure while someone is inside the incinerator.

2.3.20.1 Mechanical Charging Doors

Doors shall be of guillotine type. Charging door shall open with operation of the charger. Charging and feed hopper doors shall be interlocked to prevent simultaneous opening during operation of incinerator. Combustion chamber doors, including guillotine doors shall be insulated as specified above for furnace doors. Doors shall be provided with means for manual operation. Doors shall be 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. Doors shall be so constructed that when in closed position, they will rest tightly against the frames.

2.3.20.2 Stoking and Cleanout Doors

Cleanout and stoking mechanism access doors shall provide access for total cleanout and visual inspection of the entire interior of the incinerator and shall not permit leakage of waste fluids.

2.3.21 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. The number and location of the test holes shall conform to the requirements of the regulatory authority. In addition, test holes for monitoring operating efficiency shall be provided as needed.

[One] [Two] observation port[s] 75 mm (3 inches) 3 inches in diameter shall be provided on the access door for viewing the primary combustion chamber or zone during operation. Ports shall be no less than 2.7 mm (12 gauge) 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. The tube or duct shall extend from the exterior of the casing to not less than one-half the thickness of the refractory opening and shall be gastight. Provision shall be made for air purging of the port to avoid ash buildup.

2.3.22 Test Holes

Incinerators shall be provided with test holes as indicated and shall be fitted with standard weight, 50 mm (2 inch) 2 inch diameter, black steel pipe. Sleeve shall extend from the exterior of the casing to not less than one-half the thickness of the refractory lining. Refractory opening shall be formed from the end of the pipe sleeve to the interior wall surface to shield the end of the sleeve from reflected heat. Sleeve shall be fitted with a brass screw cap. Each test pipe shall have 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.

2.3.23 Safety Devices

Incinerators shall be provided with safety devices to provide safe operation. Safety devices shall include automatic overheat shutdown and manual shutoff for each burner and main fuel supply. Equipment shall meet the requirements of the Occupational Safety and Health Administration (OSHA).

2.3.24 Freeze Protection

Low points of all piping and tubing shall be equipped with drains for freeze protection.

2.3.25 Incinerator Cooling System

All necessary equipment, piping, valves and control devices for the cooling system shall be the manufacturer's standard for the incinerator furnished.

2.4 INCINERATOR AUXILIARY EQUIPMENT

2.4.1 Charging Method

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 specification section based upon Section 14630A OVERHEAD ELECTRIC CRANES, may be required to adequately deal with the crane.

Incinerator shall be mechanically charged. The combustion chamber shall operate at negative air pressure when the loading door is open, to prevent injury to the operator and the escape of smoke and gases. A mechanical charger, including an inner door and an outer door, or other form of isolation from the combustion chamber, shall be provided to discharge the contents of the loading and holding chamber into the combustion chamber. Loader shall flange directly to the feed opening of the incinerator. Charger shall have a manual control and an adjustable timer to permit semi-automatic charging. The manual box shall be next to the ram loader opening as indicated. An indication light shall indicate when the incinerator can be charged and when the incinerator cannot be loaded due to insufficient temperature. The light shall be mounted on the control box, visible to the operator when the box is closed. An interlock shall be provided to prevent operation of the charger when a predetermined safe operating temperature is exceeded. Charger shall be located on the end of the incinerator. [Where cranes are provided to load the charger, they shall be as specified in Section 14630A OVERHEAD ELECTRIC CRANES.] Charging chambers shall have capacity of not less than [0.5] [1.0] [_____] cubic meter. [0.5] [1.0] [_____] cubic yard. A digital counter shall be installed to count the number of loads delivered by the automatic ram loader into the combustion chamber.

2.4.1.1 Feed Hopper

A hopper-type chamber shall be provided for top loading chargers. Construction shall be of heavy-duty welded steel plate and structural shapes throughout, fabricated of 6.4 mm (1/4 inch) 1/4 inch minimum thickness hot-rolled steel. Steel plates and shapes shall conform to ASTM A 36/A 36M. Hoppers loaded directly from the tipping floor shall be oriented to be loaded from the side of their longest dimension whenever physically possible, and the opening will be flush with the tipping floor.

2.4.1.2 Charging Ram

Ram shall be a hydraulically operated, self-contained type with directional control. Unit shall inject small loads of refuse at frequent intervals, to ensure relatively uniform burning rates. Unit shall limit the amount of air entering the primary chamber with each charge through the use of double gates or similar device. Ram shall continuously push the burning waste toward the cleanout area. Ram shall also be constructed to minimize the possibility of refuse becoming trapped in areas that would interfere with the operation of the ram and its seals. Sufficient cooling by either air or water shall be provided to preclude warpage or excessive thermal expansion of the ram. No part of the ram shall come in direct contact with or ride upon the combustion zone refractory or grating.

2.4.2 Auxiliary Burners

NOTE: Indicate if auxiliary fuel system is to be

gas and/or oil by deleting the inappropriate subparagraphs.

[Gas] [Oil] [Combination gas and oil] [LPG] burners shall be provided for the primary and secondary combustion zones. The burners shall meet the requirements set forth in UL 296, UL 726, UL 795, NFPA 8501, and NFPA 8502.

Each burner shall be a complete assembly including fuel and control systems, and accessories. Primary chamber burners shall be located so that the burner flame impinges directly on the waste materials when present during start-up. However, the flame shall not impinge directly on the refractory when waste is not present during warm-up. Primary burners shall have a capacity of not less than [_____] W ([_____] Btu per hour) [_____] Btu/hr and shall be able to maintain a minimum continuous temperature of 760 degrees C (1400 degrees F) 1400 degrees F and a maximum of 871 degrees C (1600 degrees F) 1600 degrees F in that chamber or zone. The secondary burners shall have a minimum capacity of [_____] J ([_____] Btu) [_____] Btu and shall be able to maintain a minimum continuous temperature in the secondary chamber of [982 degrees C (1800 degrees F)] [_____] degrees C ([_____] degrees F). [1800] [_____] degrees F. [A minimum continuous temperature of 760 degrees C (1400 degrees F) 1400 degrees F shall be maintained at the roof near the exit of the primary chamber.] Burners shall be electrically spark-ignited and regulated by a variable set point indicator-controller adjustable from 427 degrees C (800 degrees F) 800 degrees F to 1316 degrees C (2400 degrees F) 2400 degrees F to operate within the temperature limits recommended by the manufacturer. An on/off firing burner will be provided in the primary chamber. A modulating burner with continuous burning capability shall be provided for the secondary chamber. This burner will modulate from high-to low-fire to off, based on the temperature of the secondary chamber. Secondary burner shall cycle automatically as a function of the chamber temperature in order to minimize the consumption of auxiliary fuel and to minimize temperature peaks. Controllers shall be actuated by a thermocouple or shielded bimetallic sensor located in the upper 1/3 of the combustion chamber. Thermocouples located in the primary and secondary chambers shall be Type K, suitable for a maximum temperature of 1538 degrees C (2800 degrees F). 2800 degrees F. Burner controls shall incorporate FM-IRI components 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 shall be suitable for the incinerator chamber in which the burner is installed. Burners shall be easily moved out of firing position for inspection, cleaning, adjustment, and maintenance. On mechanically charged incinerators, an interlock shall be provided to prevent operation of the charger until secondary chamber or zone temperature has reached 871 degrees C (1600 degrees F). 1600 degrees F.

2.4.2.1 Oil Burners

Oil burners (when required) shall be of the air-atomizing or mechanical-pressure-atomizing type, capable of burning unheated Grade No. 2 fuel oil. All oil-burning equipment shall meet the requirements of UL Gas&Oil Dir and shall be installed in accordance with NFPA 30 and NFPA 31.

2.4.2.2 Mechanical Pressure Atomizer

When so equipped, mechanical pressure atomizers shall operate solely by the use of oil pressure and shall have no moving parts within the atomizer.

Unit shall be capable of completely atomizing the oil through a minimum capacity range of 4 to 1 without changing nozzles or sprayer plates and when furnished with oil at the manufacturer's required pressure. A constant volume of oil shall be supplied to the atomizer, with variable capacity obtained by adjusting a control valve on the return line. A diffuser provided to stabilize the flame shall be mounted near the furnace end of the atomizer but in such a position that oil will not strike it.

2.4.2.3 Air Jet Atomizer

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

2.4.2.4 Air Register

Air registers shall be a type most suitable for the atomizer furnished and shall be arranged for connection to the forced-draft fan duct. Register shall have adjustable air-volume louvers with all louvers operated by a single, easily accessible lever. Register shall support atomizer and closely related components, and shall be fastened directly to the front of the incinerator. Throat ring shall be properly sized to match the atomizer. A diffuser to stabilize the flame shall be mounted near the furnace end of the atomizer but in such a position that oil will not strike it. Design of the register and diffuser shall ensure complete mixing of air and fuel with a minimum of excess air.

2.4.2.5 Throat Openings

Burner throat openings shall be constructed of superduty plastic refractory or matched sections of refractory tile. Throat shall be 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. Burner shall be so positioned that the flame parallels the contour of the throat but avoids striking the refractory.

2.4.2.6 Electric Ignition System

Ignition system shall be suitable for operation with [No. 2 fuel oil] [gas]. Igniter assembly shall be furnished complete for each burner. A suitable ignition transformer and electrode rated for not less than 5,000 volts on the secondary side shall be included as a unit readily removable from the incinerator setting for repair. Provision shall be made in the igniter assembly for manual operation and for inspection of the pilot flame. Components shall be in conformance with NFPA 8501 requirements, as applicable.

2.4.3 Fuel Oil System

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

Fuel oil system (when applicable) shall be installed in strict accordance with NFPA 31 and Section 13202 FUEL STORAGE SYSTEMS, unless otherwise indicated.

2.4.3.1 Automatic Safety Shutoff Valve

Oil supply line to each burner shall be equipped with an automatically operated valve designed to shut off the oil supply in case of fire in the immediate vicinity of the burner. The valve shall be thermoelectrically actuated or thermomechanically actuated type and shall be located immediately downstream of the manual shutoff valve or other building shutoff devices where oil supply line enters the building. A thermoelectrical or thermomechanical detection device shall be located over the oil burner to activate the valve. A fire shutoff valve may be combined with other automatic shutoff devices if listed in UL Gas&Oil Dir.

2.4.4 Fuel-Oil Piping

Piping required between the oil storage tank, burners, and pumps shall be furnished complete with valves, strainers, traps, insulation, and accessories. All fuel oil piping shall conform to Section 13202 FUEL STORAGE SYSTEMS.

2.4.5 Fuel-Oil Storage Tank

Storage tanks shall be constructed of steel or fiberglass. Tank shall be suitable for underground installation and shall be constructed and labeled in accordance with NFPA 30, NFPA 31 and Section 13202 FUEL STORAGE SYSTEMS.

2.4.6 Gas Meter

Gas meters shall be furnished and installed where indicated. Meters shall have the full capacity indicated when receiving gas at [100 kPa (15 psig)] [_____] kPa ([_____] psig) [15] [_____] psig. Maximum differential pressure across any meter at full capacity shall be 3 kPa (0.5 psi). 0.5 psi. Meter housing shall be of pressed steel, cast aluminum or cast iron, suitable for natural gas at [172 kPa (25 psig)] [_____] kPa ([_____] psig) [25] [_____] psig. Meters shall have a 3-valve bypass. Valves and bypass shall be the same size as the gas line they are installed in. Meter shall be equipped with an accessory instrument that indicates a corrected volume reading and an uncorrected volume reading of the gas passed. Corrected volume reading shall be in standard cubic meters per second and cubic feet per minute. cubic feet per minute. Meter shall be installed in strict accordance with the manufacturer's recommendation. Meter shall be of the positive displacement type, either rotary or diaphragm type. Gas piping, fittings, valves, regulators, test, cleaning and adjustments shall be in accordance with Section 15190A GAS PIPING SYSTEMS. All requirements of ANSI Z21.13as applicable shall be complied with unless otherwise specified herein and certification submitted.

2.4.7 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 shall be limited to 49 degrees C (120 degrees F) maximum when personnel safety is involved. Spark arrester should be provided 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.

Sectional, energy recovery and heat dump stacks shall be provided and set on a concrete foundation or otherwise adequately supported. [Provisions shall be made 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.] Type, size, and number of sections shall be 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. Chimney shall be lined its entire height with refractory as specified for the furnace. Chimney shall be provided with a cleanout door frame and a protective cap. Where the chimney is in the open, a metal side-rail-and-rung ladder designed for a live load of 890 N (200 pounds) 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 shall be furnished. Ladder shall be provided with a [ladder cage or] safe climbing device. Stack shall conform to NFPA 82 and NFPA 211. Refractory shall be secured to the casing by steel anchors. [A corrosion-resistant steel spark arrester fabricated of 18 gauge, 12.5 mm (1/2 inch) 1/2 inch mesh wire screen shall be attached to the top of the stack.] A corrosion-resistant steel weather cap shall be provided. Temperature of the casing of any stack shall not exceed [] degrees C ([] degrees F) [] degrees F in an ambient temperature of 21 degrees C (70 degrees F) 70 degrees F while passing [] actual cubic meters per second ([] ACFM) [] ACFM of flue gas at [232 degrees C (450 degrees F)] [] degrees C. [450] [] degrees F. Fire stops, thimbles, and support assemblies shall conform to NFPA 211. Stacks shall extend 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. Each stack shall be designed and constructed to withstand winds up to [129 km per hour (80 mph)] [] km per hour ([] mph). [80] [] miles per hour. Adequate support, without placing any of the load on the refractory walls of the incinerator, must be provided for any stack installed on top of the incinerator. [Freestanding stacks shall be provided with painter's ring and trolley.] [Suitable aircraft markings will be provided.] Stack sampling ports consisting of two collars, at least 100 mm (4 inches) 4 inches in diameter, shall be welded into each stack. One hundred fifty millimeters (Six inch) Six inch collars shall be used if particle-size sampling is required. Collars shall be at a right angle to each other and located at least ten stack diameters downstream from a fan or change of direction for stack sampling. Ports shall be provided with suitable, removable, replaceable caps.

2.4.8 Breaching

Breaching shall be constructed of not lighter than 3.416 mm (0.1345 inch) 0.1345 inch thick, black-steel sheets conforming to ASTM A 568/A 568M. Breaching shall be adequately reinforced and braced with structural steel angles not smaller than 50.8 mm by 50.8 mm by 6.4 mm (2 by 2 inches by 1/4 inch) 2 by 2 inches by 1/4 inch and all joints and seams in the sheets and angles shall be welded. Expansion joints shall be of the flexible type requiring no packing and shall be installed where required. Breaching shall have angle flanges for connection to boilers or other equipment with breaching full size of opening. Breaching may be supplied in bolted or welded sections for ease of handling or erection. Connectors shall be in accordance with NFPA 211. Breaching shall be lined with a minimum of 76.2 mm (3 inch) 3 inch thick refractory. Breaching shall be sealed tight all around with a nonasbestos type rope and sealed with cement to form an airtight joint where required. Cleanout openings of suitable size shall be provided at approved locations for access to all sections of the breaching and shall have tight-fitting hinged doors with frame. [One 406 by 406 mm (16 by 16 inch) 16 by 16 inch inspection door shall be located in the side of the breaching just preceding the boiler unit.] [A similar inspection door shall be located in the side of the breaching just following the boiler unit.]

2.4.9 Draft Equipment

Combustion air in the primary and secondary zones shall be supplied by a motor-driven blower as specified for draft fans. Control circuits shall be designed to shut down incinerator in case of a power failure, and to purge the chamber prior to ignition of the burners. Should air be required for soot blowing or oil atomization, an air compressor shall be provided. Equipment shall provide the correct amount of air to permit complete, controlled combustion. Equipment shall include 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.

2.4.9.1 Combustion Air Damper

Controller actuated dampers shall regulate secondary, under-fire, and over-fire air. Dampers shall be constructed of black-sheet steel, and shall be not less than 1.519 mm (16 gauge). 16 gauge. Dampers shall operate without noise or flutter. Actuators shall be electric motor [at [110] [220] [440] volt ac], hydraulic, or pneumatic operated.

2.4.9.2 Flue Gas Damper

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

[A [guillotine-type] [butterfly] [shutter] damper [of the thickness indicated] [at least 63.5 mm (2 1/2 inches) 2 1/2 inches thick] and consisting of a steel frame enclosing refractory material shall be installed at the entrance of the waste heat recovery boiler for the purpose of isolation from the incinerator during emergency boiler repairs.] A damper shall also be installed in the dump stack and shall be opened on occurrence of [excess boiler steam pressure,] induced draft fan failure [, and boiler shutoff]. [Boiler damper shall be operated by a controller

actuated motor based on the [boiler steam pressure] [boiler water temperature.] When the boiler damper is open, the stack damper shall be closed. [A chain hoist for raising and lowering] [A manual lever for] [An electrical control for] the boiler damper shall be furnished and shall be of size and design to ensure freedom of movement by the damper. [The hoist cable shall be secured to the damper frame by means of shackles and bolts. Damper slot shall have a steel plate cover 6.4 mm (1/4 inch) 1/4 inch thick and of the length and width indicated or required. Cover shall have a slot to permit the passage of the cable for raising and lowering the damper, and for easy removal of the cover. Hoist shall be a product of a manufacturer regularly engaged in the manufacture of hoists. The hoist shall be spur geared. Unit shall be designed for high-speed lifting, have high mechanical efficiency, an automatic load brake and a built-in load limit.] The operator shall be able to move the required load freely and maintain the damper in any desired position within the limits of the flue opening. Maximum effort to operate the unit shall not exceed 311 N (70 pounds). 70 pounds.]

2.4.9.3 Blowers

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

2.4.9.4 Draft Fans

Centrifugal, forced-draft fans shall be furnished as an integral part of incinerator design. Fans shall conform to AMCA 801, Type [I] [II] and AMCA 99, applicable to centrifugal furnace fans and shall be rated for flow rate, pressure, power, speed of rotation, and efficiency in accordance with AMCA 210 and ASME PTC 10. Fans shall be centrifugal with [backward curved blades] [forward curved blades]. Each fan shall be sized 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. These design conditions shall, at full combustion, include 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. Fan shall be driven by an electric motor. Motor shall be totally enclosed, fan-cooled. Fan may be directly or indirectly connected to the driving motor. If the fan is indirectly connected, a V-belt drive designed for 50 percent overload capacity shall be provided, and the motor shall be mounted on the base in a manner that will permit tightening of the belt. Noise levels for fans shall not exceed 85 decibels at 914.4 mm (3 foot) 3 foot station. Fan bearings shall be air-cooled and backward curved fan blade type with bearings not requiring water cooling may be of the self-aligning antifriction type. [Scroll sheets and rotor blades shall have liners.] Fans shall be factory painted with the manufacturer's standard finish. Control circuits shall be designed to shut down incinerator in case of power failure and to purge the chamber prior to ignition of the burners.

2.4.9.5 Control Equipment

Each motor shall be furnished with a manually operated starter. Starter shall be of the enclosed, across-the-line type with manually reset thermal-overload protection. A separate pole shall be provided for each ungrounded conductor.

2.4.9.6 Air Ducts

Ducts will supply over-fire and under-fire air from the blowers and shall conform to SMACNA Industry Practice. Combustion air shall be introduced to the primary chamber below the waste material by means of under-fire air lines or ducts. Over-fire air shall be regulated by controlled air ports located in the wall of the incinerator for completing combustion of combustible materials in the gases. Ducts shall be sized to minimize pressure drops and constructed of sheet steel. All seams and connections shall be air tight. Duct work shall be constructed of galvanized sheet metal. Galvanizing shall conform to ASTM A 123/A 123M and ASTM A 153/A 153M.

Access and inspection doors shall be provided as required. Duct walls shall be of thickness as follows:

<u>Ducts, Maximum Dimension</u>	<u>Steel, Gauge (Thickness)</u>
1200 mm (48 inches) thick	0.759 mm (0.0299 inch)
1225 mm (49 inches) thru 1500 mm (60 inches) thick	0.912 mm (0.0359 inch)
1525 mm (61 inches) thru 1800 mm (72 inches) thick	1.214 mm (0.0478 inch)
1825 mm (73 inches) and larger thick	1.519 mm (0.0598 inch)

<u>Ducts, Maximum Dimension</u>	<u>Steel, Gauge (Thickness)</u>
48 inches	22 gauge, 0.0299 inch thick
49 thru 60 inches	20 gauge, 0.0359 inch thick
61 thru 72 inches	18 gauge, 0.0478 inch thick
73 inches and larger	16 gauge, 0.0598 inch thick

2.4.10 Heat Recovery System

Boilers for the heat recovery system shall be as indicated in Section 15846A HEAT RECOVERY BOILERS.

2.4.11 Ash Removal

NOTE: Where required, the designer shall 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.

Unit shall have provision for mechanical removal of the ash. Ash or residue resulting from the combustion of the refuse is discharged from the far end of the incinerator, opposite the location where waste is introduced. Removal operation shall be by an ash plow or other device, automatically interlocked with the doors. Removal operation shall be combined with a water quench, spray, or bath which will extinguish live embers and control airborne dust. Unit shall have provisions for manual removal of ash for maintenance purposes upon completion of the cool-down cycle, through the access door. Waste liquids (ash water) will be treated as necessary to be compatible with, and discharged to, the sewage collection system. Ash and residue shall be removed from the area by mechanical conveyors and portable containers. Conveyor system shall be constructed of corrosion resistant metal. Each unit system shall be equipped with an independent ash removal and ash conveyor system designed to conform to the equipment arrangement shown.

2.4.11.1 Ash Pits

Ash pits shall be funnel shaped, shall contain receiving hoppers constructed of 6.4 mm (1/4 inch) 1/4 inch steel plate, minimum, and shall be covered with a heavy grating with openings approximately 50 mm² inches square for personnel protection. Ashes and clinkers shall be discharged from the incinerator into the ash hopper located directly below the ash discharge opening. A combination drag chain conveyor for horizontal conveying and an elevator conveyor for vertical conveying of ashes shall be arranged as indicated to take ashes from the bottom of the ash hopper for discharge into the ash container. Conveyors shall have a capacity of not less than [_____] kg per hour ([_____] pounds per hour) [_____] pounds per hour when handling ashes weighing approximately [_____] kg per cubic meter ([_____] pcf) [_____] pcf at a maximum speed of [0.5 meters per second (100 fpm)] [_____] meters per second ([_____] fpm). [100] [_____] fpm. Doors shall be provided for access to all parts as required. Electric motors shall be [totally enclosed, nonventilated type] [totally enclosed, fan-cooled type] [totally enclosed, fan-cooled type suitable for installation in a Class II, Division 1, Group F hazardous location in accordance with NFPA 70]. [Motor starter shall be [manual] [[magnetic] [across-the-line] [reduced voltage start]] type with [general-purpose] [weather-resistant] [watertight] [dust-tight] [explosion-proof] enclosure].

2.4.11.2 Drag Chain Conveyor

Drag chain conveyor shall be of a [single] [double] strand of wide, malleable iron, drag chain with a [_____] mm ([_____] inch) [_____] inch overall width, and [_____] N ([_____] pounds) [_____] poundsworking strength. The upper strand of the chain shall convey the ash in a trough constructed of 9.5 mm (3/8 inch) 3/8 inch cast iron, or other suitable material, extending from [_____] mm ([_____] inches) [_____] inches in front of the foot shaft to [_____] mm ([_____] inches) [_____] inches behind the head shaft and set flush with the floor. The return strand of chain shall be carried in angle runways set flush with the trench floor, and shall not pass through the falling ash.

2.4.11.3 Elevator Conveyor

Elevator conveyor shall be a double strand, chain type with head and takeup and an extended foot shaft to provide a drive for the drag conveyor. Casing shall be constructed of 2.657 mm (12 gauge) 12 gauge black steel, minimum, with 4.8 mm (3/16 inch) 3/16 inch thick boot plates. Head-end drive shall include a gear motor and steel roller chain complete with drive brackets, guards, and backstop. Elevator shall be equipped with head-end platform and ladder. Exposed metal surfaces shall be factory primed for field painting.

2.4.12 Steam Piping

Steam piping system will be considered to consist of those piping sections actually conducting steam, condensate return piping, and vent piping. Steam Piping unless otherwise specified shall conform to the provisions of Section 02554 ABOVEGROUND HEAT DISTRIBUTION SYSTEM and shall be designed for [] kPa ([] psi) [] psi steam.

2.5 COMBUSTION CONTROL EQUIPMENT

2.5.1 General

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

2.5.2 Equipment

Control equipment and instruments shall include 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. Control system shall be in accordance with FM P7825b. Control system shall provide proportioning control of the overfire and underfire air supply and of the air supply and fuel supply to the burners. Temperature indicator controllers or other indicators shall provide a visual indication for safe loading of the incinerator and excessive high temperature conditions which may require control or adjustment by the operator. Indicating and

recording instruments shall be provided for pressure, flow of air and liquids, as well as for alarm circuitry. Automatic control circuit systems and manual switches shall be interlocked to prevent hazardous conditions or the discharge of excessive amounts of air pollutants.

2.5.3 Combustion Control

Control of the products of combustion shall be based on maintaining a pre-set temperature, not to exceed limits as specified for minimum design requirements under paragraph INCINERATOR. The system shall be designed 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. Over-fire protection shall be provided by controlling the upper chamber or zone combustion air as a function of the chamber or zone temperature. Control system shall be fully integrated and automatic. When operating at near the design conditions, the system shall control at near constant temperature output.

2.5.4 Incinerator System Operation Sequence

A "START" button shall cause the secondary (pollution control) chamber or zone burner to ignite to preheat that area prior to charging the system. During the preheat period only auxiliary fuel shall be used as a heat source. Secondary burner, after ignition, shall be under the control of a modulating thermal controller which shall control the air/fuel ratio in the secondary chamber or zone. Burner for the primary chamber or zone may be either automatically or manually activated. Burner control circuit shall be interlocked with a timer or temperature sensor which shall function to shut off and lock out the burner after a predetermined and preset time or temperature has been achieved. After a predetermined warm-up period, the system shall be ready for loading. Feeder controls shall allow for two modes of operation, automatic cycle and manual. Automatic system shall be controlled by a timer or speed control, interlocked with limit switches and temperature sensors. Automatic feed cycle shall be initiated 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) shall open and the ram or other stoking device shall 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 will withdraw back into the hopper to a position where the charging door (when present) is allowed to close. Then the ram shall return to its original start position. Feeder shall be equipped with a charging ram water spray system.

Loader control shall be equipped with a manual override system which shall enable the operator to override the automatic sequence if necessary to correct a malfunction of the loader. In the event of a malfunction, a flashing light and an audible alarm shall signal the operator that a problem has occurred. In the manual mode of operation, the motions of the charge door, hopper door and ram shall be individually controlled with selector switches.

2.5.5 Controllers

Controllers mounted on the instrument panel shall indicate and control measurement in the areas shown. Controllers shall be proportional type with reset, and shall have automatic/manual operation. The set point shall have a manual adjustment on the front of the instrument. Controllers shall be installed complete with wiring or piping between the controller, transmitter, and the final control device. Proportional type combustion control equipment shall be capable of maintaining optimum combustion

conditions. Set point controllers may be used for on/off functions only. Combustion efficiency will be maintained without appreciable manual adjustment.

2.5.5.1 Automatic Controller

Each automatic controller shall have a manual-to-automatic station and indicator on the control panel that will provide for selecting either automatic control or manual control and also will provide for manual operation. Manual controls shall be arranged 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. Manual control station shall be complete with all necessary indicators to facilitate changing from automatic control to manual control and vice versa.

2.5.5.2 Fuel-Flow, Air-Flow Type

Combination fuel-flow, air-flow type combustion control equipment for the auxiliary burners shall be the proportional and reset type and shall position the feed or air flow and then adjust one to the other by a ratio controller operating from airflow and feed. Controls shall include fuel-flow measuring elements and airflow measuring elements which shall be field-mounted and separate from panel devices. Separate fuel feed and air-flow controllers shall be panel-mounted 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 will not be acceptable.

2.5.6 Damper Control

Power units for the damper movement shall be sized to operate the device to be positioned and shall be so mounted that a rigid mechanical connection to the device being operated can be used. Automatic draft control shall be provided by controlling the main damper or uptake damper. Main damper or uptake damper shall open to allow air purging of the incinerator and control draft to suit burner operation. Units shall automatically close in event of failure of the operating medium except for any dump stack damper which shall fail open. Manual operation of the controller shall not necessitate disconnecting the linkages during power failure or other emergency. Position switches shall be included on fuel and air-drive units for interlock with safety systems. Retransmitting devices shall be placed 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, gear trains on the units shall be oil-immersed.

2.5.7 Fuel Feed Controls

Automatic feed cycle shall be controlled by an adjustable timer for rams and a speed control for feed grates. This automatic cycle will be interrupted by an interlock in the event of an emergency such as an extreme overtemperature condition in the primary chamber or zone.

2.5.8 Burner Controls and Safety System

Burner control and safety system shall provide for the start, purge, ignition, main flame supervision, safe shutdown and alarm of the incinerator fuel burning equipment. Burner malfunction at any time shall prevent the burners from operating by tripping a burner relay. Control of

the burner and incinerator system shall be integrated to ensure overall safety. Safety shutoff valves and fuel trains for main burners shall be provided as required by FM P7825a, FM P7825b, and NFPA 8501. Sequence of burner operation shall be automatically controlled by programming relays providing a mandatory pre-purge cycle with full protection against flame failure during both electric spark ignition and normal burner operation. Normal cycling of burners shall not require system pre-purge. Operation of the programming relays shall be governed 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 shall cause the burner to shut down on safety and shall require a manual reset before the burner can be restarted. Normal cycling shall be controlled by means of temperature switch as described earlier.

2.5.8.1 Incinerator Burners

Incinerator burners shall be designed for fully automatic nonrecycling operation, and shall have a combustion-safety control system conforming to FM P7825a, FM P7825b, or NFPA 8501, as appropriate. Safety control manufacturer shall certify that the installed control system conforms to FM P7825a FM P7825b, or NFPA 8501. System components shall be UL listed and FM approved and designed for use with industrial grade burners. Combustion-safety control system shall include the following with all accessories for a complete system.

2.5.8.2 Combustion-Safety Controls System

Combustion-safety control system shall include a flame safeguard relay or control unit shall have solid state electronic circuitry and continuous self-check feature. Relay or control unit shall have 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. Cabinet shall be made of steel, 1.897 mm (14 gauge) 14 gauge minimum thickness and gray enamel finish throughout or any other color selected by the Contracting Officer. Door shall have piano hinges with latch. Components and supporting chassis shall be easily removed for replacement and repair. Plug-in or similar units will be provided. Flame safeguard relay or control unit shall check 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 shall 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. Flame safeguard relay or control unit shall program the burner operation to conform to FM P7825a, FM P7825b, or NFPA 8501.

2.5.8.3 Purge Timer

Purge timer shall prevent the operation of the flame safeguard relay or control unit until the minimum purges as required in NFPA 8501, FM P7825a, or FM P7825b have been completed. Volume to be purged shall include the volume of the combustion chamber, boiler passes and breachings. Purge timer shall be interlocked with the airflow differential pressure switch and igniter and main firing valves to ensure that all fuel lines are closed. A green indicating light as specified above shall be provided to indicate purge completion.

2.5.8.4 Safety Shutdown Interlocks

Safety shutdown interlocks shall be provided in the flame safeguard relay or control unit for the conditions specified by FM P7825a, FM P7825b, or NFPA 8501. Low and high fuel pressure interlock switches shall be provided and interlocked with the flame safeguard relay or control unit to prevent burner operation if low or high fuel pressure is detected.

2.5.9 Combustion Temperature Control

There shall be a separate temperature control for each combustion chamber that will control the firing rate within that chamber. Temperature sensors shall be Type "K" thermocouples in a ceramic protection tube, and shall be suitable for operation up to 1538 degrees C (2800 degrees F). 2800 degrees F. Temperature is to be transmitted to the controller mounted in the control panel. Controllers shall be of a type that they can be operated in the automatic or manual mode. Controllers shall 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.

2.5.9.1 Primary Combustion Chamber or Zone Controller

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

2.5.9.2 Secondary Combustion Chamber or Zone Controller

The controller in the secondary chamber shall be a temperature controller to maintain the required temperature for complete combustion of the gases and reduction of particulates. This controller shall vary the firing rate of the burner and the flow of combustion air to the secondary chamber or zone.

2.5.10 Draft Fan Control

Forced-draft centrifugal fans shall have inlet vane controls [and shall have variable speed control where indicated]. [Axial propeller fans shall have variable propeller pitch control.] Inlet vanes shall be suitable for use with combustion control equipment. Means shall be provided for operating the draft fans for 15 minutes after last charge in the incinerator has burned down.

2.5.11 Draft Fan Drives

Fan shall be driven by [an electric motor] [or] [a steam turbine]. [Electric motor shall 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 shall be magnetic [across-the-line] [reduced voltage start] type with [general-purpose] [weather resistant] [watertight] [dust-tight] [explosion-proof] enclosure and shall be furnished with four auxiliary interlock contacts.] [Steam turbine shall have horizontally-split, centerline supported casings, water-cooled bearing housings with ring-oiled, babbitt-lined, bronze packing sleeve bearings. Turbine shall also be 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. Turbines shall conform to NEMA SM 23.]

2.5.12 Ash System Control

Controls for the ash discharge system shall allow for two modes of operation, automatic and manual. Automatic cycle shall be manually initiated and controlled by cycle programmers or automatically initiated by the charging system programmer. Lights, controls and interlocks as described earlier for automatic ash removal control shall be installed in and on the main cabinet with manual controls installed near the ash removal equipment of each incinerator.

2.5.13 Soot Blower

All controls, lights, switches, and indicator provided for operation of soot blower shall be mounted on the control cabinet.

2.5.14 Incinerator Shutdown

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

2.5.15 Control Panel

Wall mounted cabinets shall conform to UL 50 and free standing cabinets or panels shall conform to NEMA ICS 6, Type 6 or Type 4. Panel shall be prewired, of steel, and weathertight. Unless enclosed in a booth or separate room, the panel shall also be constructed to protect the instruments and controls from dust. Wiring of all instrument connectors and cable termination connectors shall be done in the factory by the instrumentation fabricator. All controls, instruments, and other equipment shall be flush mounted at the factory and assembly-tested prior to shipment. A lock and two keys shall be furnished. All controls and instruments shall be identified with nameplates. [A heater to prevent condensation shall be provided.]

2.5.15.1 Panel Details

Panels shall be sized to contain all controls, instruments, gauge, and meters. Panels shall be free standing with faceplate of not less than 6.4 mm (1/4 inch) 1/4 inch reinforced steel plate and shall be coated with an approved laminated plastic suitable for the duty and finished with the manufacturer's standard finish coating. Controls and instrumentation shall be mounted flush on the panel as far as practicable. Back of panel shall be enclosed with sheet metal and with adequate access panels for maintenance and removal of any component without interfering with other components. Door-latching equipment and hardware shall be provided. Each recorder, indicator, and control unit shall be identified with engraved

metal or laminated plastic nameplates secured to the panel. Panel shall have continuous rapid-start fluorescent light fixtures mounted with reflectors providing suitable shielding to illuminate all controls, instruments, gauges, and meters. Field piping connections for each panel shall terminate in one bulkhead-mounted manifold located to conform with the installation requirements of the system. Field electrical connections shall terminate in a mounted color-coded terminal strip located to conform with the installation requirements of the system. If a pneumatic control system is provided, the panel air supply filter and regulator set shall be mounted on the rear of the panel with properly identified pneumatic terminal blocks. No high pressure lines will be 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. Controllers and indicators specified or required shall be panel mounted and tested at the factory complete with relays, transformers, switches, wiring, valves, and piping. Thermocouple and low energy signal conductors shall be completely isolated from power and alarm conductors, subject to approval by the Contracting Officer. Visual and audible alarms shall be provided to protect personnel and equipment. Annunciator system shall be mounted on each control panel. Visual signals shall be backlighted nameplates for each point. A common audible alarm signal and a common acknowledge pushbutton shall be provided for each control panel. Malfunctions shall be indicated on the annunciator panel as specified [in Section 15846A HEAT RECOVERY BOILERS] plus the following as a minimum:

- a. Loader
- b. Burner (each)
- c. Ash Discharge System
- d. Ash Transfer Rams (if used)
- e. Ash Conveyor

The panel shall also include 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, the incinerator/[boiler] panel shall [be as specified in Section 15846A HEAT RECOVERY BOILERS plus] include the following:

- a. Temperature Recorder (lower chamber, upper chamber)
- b. Clock with minimum 200 mm (8 inch) 8 inch diameter face (one panel only)

2.5.15.2 Identification

All field items shall be furnished with a permanent metal tag suitable for tag number or service identification; back-of-panel items shall be included in this category. Front-of-panel items shall be identified by panel nameplates affixed to the item or panel surface. Nameplates shall be consistent in appearance from panel to panel and shall include the service function of the item involved. All wiring and piping within the panel shall be color coded or otherwise identified. Wires and cables shall be installed without joints or splices except at terminal points. Wires shall be labeled at each end.

2.5.15.3 System Diagram

Laminated, color-coded system diagram shall be mounted on the control panel indicating all system components and location of all sensors and alarm points.

2.5.16 Indicating Lights

Lights shall be mounted on the door of the control cabinet. Components will be integrated through appropriate electromechanical devices with push-to-test type indicating lights. Industrial oiltight construction shall be provided in the following colors for the indication functions:

- a. Amber for power on the system
 - b. Green for incinerator/boiler purge completion (one per unit)
 - c. White or manufacturer's standard color for energizing main fuel valves
 - d. Red for alarms
 - (1) High temperature in primary chamber
 - (2) High temperature in secondary chamber
 - (3) High temperature at induced draft fan inlet
 - (4) System operation
 - (5) Emergency damper open
- Operating ranges for each indicator shall be as shown. Indicators shall be installed complete with all necessary wiring and conduit between the indicator and the transmitter in the equipment room.

2.5.17 Selector Switches

As a minimum, the following hand-auto-off selector switches will be provided:

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

2.5.18 Clock

Clock shall be recess mounted and shall be single synchronous 120-volt ac, motor-driven, with shatterproof, crystal-covered white dial, a minimum of 200 mm (8 inches) 8 inches in diameter with black Arabic numerals, black hour and minute hands, red sweep hand, and anodized brushed aluminum bezel. Clock motor and mechanism shall be totally enclosed in a heavy plastic cover.

2.5.19 Recorders

Recorders mounted on the instrument panel shall record and indicate measurement in the areas shown. The record shall be made in ink on a [24-hour] [31-day], [100 mm (4 inch) 4 inch linear] [circular] [strip] chart driven by an electric-clock mechanism. Each recorder point shall be made with a different colored ink. Recorders shall be installed complete with all necessary wiring or pipe between the recorder and the transmitter. The unit shall be provided with sufficient blank charts and ink for 1 year's operation.

2.5.20 Water Meters

Meters shall conform to AWWA C700 and be the disk type with reinforced disk for hot water above 66 degrees C (150 degrees F), 150 degrees F, and a rubber or carbon disk for cold water. Meters shall be constructed of bronze composition and cast iron protected by noncorrosive coating. Moving parts subject to wear shall be easily replaceable.

2.5.21 Annunciator

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

An engraved, back-lit window annunciator complete with pushbuttons and alarm horn shall be provided to indicate abnormal operating conditions of the incinerator. A common alarm silencing relay shall be included 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. One [____]-point annunciator for each incinerator shall be furnished and installed in the annunciator and pump control panel. Nameplates for alarm modules shall be nominal 70 mm (2-3/4 inches) 2-3/4 inches high by 75 mm (3 inches) 3 inches wide in translucent white acrylic plexiglass. All nomenclature shall be engraved on front surface in black lettering. Flasher module shall be mounted and prewired with silence and test pushbuttons. Alarm points and window engraving shall be as [specified in Section 15846A HEAT RECOVERY BOILERS plus the additional points] shown below. Annunciator shall be of the same manufacture and type as furnished by the supplier of other control panels; spare parts shall be interchangeable 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

ALARM POINT

LSH- [_____]

WINDOW ENGRAVING

High flue gas opacity

2.5.22 Flame Sensor

An ultraviolet flame-sensing device shall be provided for each burner and installed in accordance with the manufacturer's recommendations. The flame-sensing device shall not respond to ignition spark, hot refractory, reflection of flame on atomizing media or oil spray. Flame safeguard sensor shall be sighted to detect only the burner flame for which it is designed. A pilot turndown test, spark response test for ultraviolet detector, and manufacturer's approved test for rectification detectors shall be performed to verify reliable sensor installation. Sensor mount shall be welded or fixed, to prevent altering orientation to flame being proven.

2.5.23 Temperature Indicators

Temperature gauges shall match pressure gauges in appearance and shall match requirements of the transmitters supplied. The Contractor may use any of the following temperature sensors unless otherwise specified. Remote temperature indicators shall include:

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

2.5.23.1 Thermometers

Thermometers shall conform to ASME PTC 19.3, Type 1, Class 3, with wells and separable corrosion-resistant steel sockets and temperature range suitable for the use encountered. Dial type thermometers shall be 90 mm (3-1/2 inch) 3-1/2 inch diameter chromium-plated case, remote-type bulb or direct-type bulb as required, with plus or minus 1 degree C (2 degree F) one degree F accuracy and white face with black digits graduated in 2-degree increments. Mercury shall not be used in thermometers. Thermometers shall be installed as indicated. Thermometers shall be installed so as to be easily read from the operating floor.

2.5.23.2 Thermocouples

Thermocouples shall conform to ISA MC96.1, Type K and shall indicate gas passage temperatures. Thermocouples shall control burner operation. Thermocouples shall be suitable for continuous operation up to 1538 degrees C (2800 degrees F), 2800 degrees F, and shall be accurate to 0.75 percent of the operating and indicating temperature range. Thermocouples shall be provided in the combustion chamber or as otherwise directed and shall be long enough to be inserted 150 mm 6 inches into the furnace. Thermocouple shall be provided 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. Thirty meters One hundred feet of 1.519 mm (16 gauge) 16 gauge compensating lead wire with a weatherproof braid shall be supplied for connecting the thermocouple to the instrument. Temperature shall be transmitted to the instrument in the control panel as shown.

2.5.23.3 Pyrometers

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

2.5.24 Pressure and Vacuum Gauges

Gauges shall conform to ASME B40.100, Type I, Class 1 or 2, as applicable, style as required. They shall be heavy-duty industrial type, suitable for pressure or vacuum specified, with minimum 150 mm 6 inch diameter dial, except as otherwise specified. Gauge piping shall be copper tubing conforming to ASTM B 68M ASTM B 68, Type K or L.

2.5.25 Draft Indicator and Control

Draft Gauges shall conform to ASME B40.100, Style I, with approved operating ranges, and with a diaphragm or bellows actuating system and a circular scale. Gauges shall have a zero adjustment screw and a connection to atmosphere. Suitable shutoff cocks shall be provided. Gauges shall be remote-reading to the control panel. Gauges shall be installed complete with all necessary piping between them and the points at which the drafts are measured. An indicator continuously indicating pressure in primary chamber shall be provided. A separate draft controlling instrument maintaining a constant 0.10 to 0.15 inch negative pressure in the primary chamber shall also be provided.

2.5.26 Opacity Alarm

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 stack gas opacity alarm indicator and recorder system consisting of a stack unit, control or transmitter unit, chart recorder, red alarm, and manufacturer's standard color Power On signal lights and alarm bell shall be provided on the instrument panel for each incinerator. System shall be self compensating, and shall provide continuous measurement, indication, and recording of smoke opacity from the incinerator. Stack units shall

include 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. Control or transmitter unit shall have electronic solid-state circuitry and meter or digital indicator. Indicator shall indicate smoke density by 0 to 100 percent opacity. In addition, the control unit shall have calibration and alarm adjustments. The control or transmitter unit and recorder shall have dust-tight metal enclosure. A purging air system shall be provided to clean light source lens and light detector lens. Control unit shall be adjustable for various smoke densities at which alarm bell will sound and at which warning lights will operate. Warning bell shall sound in conjunction with the red light. The recorder shall be the electrical or electronic type having a 250 mm10 inch minimum diameter recorder chart having 24-hour rotation scale. The chart shall be graduated in 0 to 100 percent smoke density. Smoke alarm indicator and recorder system shall have provisions to field-check 0 and 100 percent smoke density calibration points without shutdown of incinerator or removal of stack units, indicator, and recorder. Equipment shall be suitable for ambient temperatures not more than [_____] degrees C ([_____] degrees F) [_____] degrees F and up to 100 percent humidity. Smoke alarm indicator and recorder, including air purging system, shall be suitable for operation on 115-volt, single-phase, 60 Hz electric power. Four hundred blank charts and a 1-year ink supply shall be provided.

2.6 TOOLS

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 shall be provided. Special wrenches as required for opening [boiler manholes], handholes, and cleanouts shall also be provided. Smoke pipe cleaner shall be provided to clean the breaching and smoke connections. Cleaner shall have jointed handle of sufficient length to clean breaching and smoke connections without dismantling.

2.7 PAINTING AND FINISHING

2.7.1 Treatment

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, shall be cleaned 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. External surfaces shall be smooth and all edges shall be rounded or beveled, unless sharpness is required to perform a necessary function.

2.7.2 Incinerator Coating

Incinerator shall be painted in accordance with the manufacturer's standard practice with a minimum of one primer coat and two finish coats. Metal subject to heat shall be painted with heat resistant (up to 648 degrees C 1200 degrees F) silicone aluminum paint. Paint shall be applied directly to clean bare metal surfaces and shall attain a minimum dry film thickness of 1 mil per coat. Paint shall not be applied when the temperature is 10 degrees C 50 degrees F or below or above 32 degrees C. 90 degrees F.

2.7.3 Equipment Coating

Equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish if located within buildings. Items located outside shall have weather-resistant finishes that will withstand 500 hours of exposure to the salt spray test specified in ASTM B 117, 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 shall show no sign of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3.2 mm 1/8 inch on either side of the scratch mark. All exposed pipe covering shall be painted as specified in Section 09900 PAINTS AND COATINGS. Aluminum sheath over insulation shall not be painted.

2.8 FACTORY TESTS

Initial capacity and performance tests of factory assembled incinerator components shall be conducted at the manufacturer's plant. Any material and equipment rejected shall be either corrected or replaced before installation.

PART 3 EXECUTION

3.1 INCINERATOR INSTALLATION

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

Equipment and material shall be installed as indicated and in accordance with the manufacturer's written instructions, industry standards, and NFPA 82. Combustion air supply and ventilation shall be in accordance with NFPA 31 or NFPA 54.

3.1.1 Gas Systems

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

Gas service shall be as specified in Section 15190A GAS PIPING SYSTEMS.

3.1.2 Fuel Oil System

Fuel oil system shall be installed in accordance with NFPA 31 and Section 13202 FUEL STORAGE SYSTEMS, unless otherwise indicated.

3.1.3 Foundation

Foundations for the incinerator and for other heating equipment specified, when required, shall be constructed as indicated and recommended by the manufacturer. Incinerator foundation shall be constructed of [3000] [_____] psi concrete as specified in Section 03300A CONCRETE FOR BUILDING CONSTRUCTION. Anchor bolts shall be set accurately and shall be of adequate length to install the incinerator. When embedded in concrete,

anchor bolts shall be provided with plates welded on the head and shall be protected against damage until the equipment is installed.

3.1.4 Steel Ladders

Steel ladder shall be provided where the depth of manhole exceeds 3.6 m. 12 feet. The ladder will be not less than 406 mm (16 inches) 16 inches in width, with 19 mm (3/4 inch) 3/4 inch diameter rungs spaced 300 mm (12 inches) 12 inches apart. The two stringers shall be a minimum 10 mm (3/8 inch) 3/8 inch thick and 50 mm (2 inches) 2 inches wide. Ladder shall be rigidly affixed 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. Stringers shall be installed to provide at least 150 mm 6 inches of space between the wall and the rungs. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A 123/A 123M. The wall along the line of the ladder shall be vertical for its entire length.

3.1.5 Stack Support

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

Stack support shall be in accordance with NFPA 82 and NFPA 211, as applicable. Vertical and lateral supports for exterior chimneys shall withstand wind forces of [129] km per hour [_____] km per hour . [80] [_____] mph.

3.1.6 Equipment Structural Support

**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. Sections
13080 and 15070A, properly edited, must be included
in the contract documents. Designer should
investigate bearing requirements of several
manufacturers and design footings accordingly.**

Structural steel equipment supports shown shall be designed in accordance Section 05120 STRUCTURAL STEEL. Support steel shall be designed to resist all applicable dead loads, live loads, and seismic loads as [specified in Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT] [indicated].. A complete loading and support diagram shall be shown 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. Support steel shall be fabricated in accordance with the provisions of AWS D1.1/D1.1M or field bolted using ASTM A 325M ASTM A 325 high strength bolts.

3.1.6.1 Column Base Plates

Column base plates shall be designed to bear on a [21] [_____] MPa [3000] [_____] psi concrete floor slab.

3.1.6.2 Anchor Bolts

Anchor bolts shall be ASTM A 307 anchor bolts. Anchor bolt sizes and locations shall be shown on the detail drawings.

3.1.7 Insulation

Shop and field applied insulation shall be as specified in Section 15080A THERMAL INSULATION FOR MECHANICAL SYSTEMS unless otherwise specified. Breaching [and dust collectors] shall be insulated with magnesia, mineral wool, calcium silicate, or approved mineral insulation. Insulation may be either block or blanket type. Joints in the insulation shall be filled with magnesia, mineral wool, or other equally suitable cement.

3.1.8 Catwalks and Access Platforms

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

3.1.9 Control System Installation

Equipment shall be installed in accordance with the manufacturer's instructions and approved. All control conduit, wiring and/or tubing shall be provided under this section of the specifications, except as specified elsewhere. Copper, stainless steel, or non-metallic tubing may be used as appropriate. Copper shall be ASTM B 88M ASTM B 88, Type K with flare type, cast brass, or wrought copper fittings. Pneumatic tubing shall be 6.4 mm (1/4 inch) 1/4 inch OD with a minimum wall thickness of 0.762 mm (0.030 inch) 0.030 inch unless otherwise indicated. Where 9.5 mm (3/8 inch) 3/8 inch or 12.7 mm (1/2 inch) 1/2 inch O D tubing is used, the wall thickness shall be a minimum of 1.245 mm (0.049 inch) 0.049 inch. Extent, general location, and arrangement of the system shall be as indicated. Control panels shall be located 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. Equipment, instruments, piping, wiring and tubing shall fit into the space allotted and allow adequate clearances for entry, servicing, and maintenance. Locally mounted instruments shall be installed 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. 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, shall be provided and installed, whether or not the items required are specifically specified or shown. Installation of the instrumentation system shall be carefully coordinated with the work of other trades.

3.1.10 Field Tubing

Tube fittings shall be compression type and compatible with tubing material. Fittings for tubing shall be of materials suited to the tubing (brass for copper tubing, stainless steel for stainless steel tubing, and nonmetallic for nonmetallic). Each tubing connection shall be checked for proper tightness and installation. All piping between primary connections and instruments shall be a minimum of 9.5 mm (3/8 inch) 3/8 inch OD tubing.

All copper instrument connecting lines that require only a single line shall be provided with brass, ASTM B 61, 21 MPa (3000 psi) 3000 psi rating, forged body screw or tube ends.

3.1.10.1 Tubing Supports

PVC coated expansion metal troughs or epoxy coated vertical unistrut racks shall be used as tubing supports. No elbows, tees, or crosses shall be used. Where the trough changes direction or branches, a suitable gap for the transition will be acceptable; the tubing shall be unsupported over the gap.

3.1.10.2 Air Supply

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

3.1.11 Electrical

Instrumentation and power-interconnecting wiring shall be as [shown] [recommended by the manufacturer] and as specified in NFPA 70. All external wiring to the control panels shall terminate on terminal boards or on devices in the panels. All cable wire and cable runs shall be carried in conduit or wireways. All signal-wiring used for alarm or measurement of control circuits shall be run 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. Instruments shall not be fed from lighting branch circuits. Termination of all wires on instrument binding screws shall be made with solderless type insulated shoulder ring-tongue lugs of the proper size for the wire and binding screw use. Lugs shall be properly and securely crimped to the wire using the tool recommended by the lug manufacturer. Any termination which is improperly made shall be cut off and a new lug installed. Stripping of all wire shall be done with an approved stripping tool or in such a manner as not to damage the conductor.

3.1.11.1 Cable-Conductor Identification

Identification shall be permanently attached to each wire terminating on a terminal board or binding screw to facilitate maintenance. Identification shall be by means of plastic sleeving with printed markings, permanently attached stamped foil markers, or by other approved means. Wire numbers shall correspond to wire numbers shown.

3.1.11.2 Relays

Relays of the industrial type shall be provided for interlocking circuits. Contacts and coils shall be accessible for cleaning and replacement.

3.1.12 Field Painting

Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, shall be as specified in Section 09900 PAINTS AND COATINGS.

3.2 TESTING

3.2.1 General

Prior to requesting commencement of the performance and acceptance test, final checking of system installation shall be conducted in accordance with the manufacturer's recommendations and the requirements of the other sections of the project specifications. Final checking shall include preliminary operation testing and adjustments of facilities as necessary to ensure completeness of installation and satisfactory operation of all systems. All tests shall be scheduled in advance and conducted at times approved. Testing shall be performed in the presence of the Contracting Officer.

3.2.1.1 Schedule for Testing

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

3.2.1.2 Visual Inspection

Each incinerator shall be examined 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

3.2.1.3 Repairs

The Contractor shall 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.

3.2.2 Instrumentation

All instrument systems shall be tested after completing the following activities:

- a. Inspect complete work and make any nonoperating 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 S7.0.01.
- 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, the Contractor shall advise the Contract Officer in writing 2 weeks before testing.

3.2.3 Dielectric Tests

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

3.2.4 Fuel Systems Test

Auxiliary fuel piping will be hydrostatically tested at a pressure of 1-1/2 times the working pressure. Gauges and other apparatus that may be damaged by the test pressure shall be removed from the system prior to on-site testing. Required test pressure shall be maintained for not less than 2 hours to provide sufficient time for inspection of joints and connections in all piping systems. All defects that develop during testing shall be corrected, and the system retested until no defects or leaks are found.

3.2.5 Fuel Burning Equipment Test

Test of fuel burning equipment shall demonstrate that the equipment installed meets the requirements of the specifications.

3.2.6 Controls Test

Incinerator shall be tested under actual firing conditions. Test shall verify that all controls function within the maximum and minimum limits for temperature or timing. Unsafe conditions such as high temperatures and flame failure shall be simulated by reducing the settings for the activation of limit and safety controls. The stoking mechanism shall be tested to demonstrate control and operational conformance with the requirements of the specification under varying load conditions.

3.2.7 Performance Testing

Upon completion of all related work and prior to acceptance, the

incinerator [heat recovery] and associated equipment and instrumentation shall be tested to demonstrate indicated performance. Stack sampling for compliance with applicable emission limits shall be performed by [the AEHA or] an approved independent qualified testing laboratory. All equipment and controls shall be adjusted before the scheduled operating test. Testing shall be in accordance with the test procedures indicated below and shall be in accordance with the requirements of ASME PTC 19.10. All pressure measurements are to be taken in accordance with ASME PTC 19.2, and all temperature measurements are to be taken in accordance with ASME PTC 19.3. The Contractor shall furnish all instruments, equipment, and personnel required for the tests. The Government will supply fuel, water, electric power, and waste materials. Two instruction manuals shall be available at all times during the tests.

3.2.7.1 Procedure

NOTE: Indicate performance requirements.

Incinerators shall be preheated for [4] [_____] hours to reach the firing temperature of [982] [_____] degrees C. [1800] [_____] degrees F. Incinerator shall be charged with waste at the rated burning capacity in pounds per hour for a minimum of 72 hours and shall be operated in accordance with the manufacturer's written instructions. Performance testing shall include 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. Testing shall be full-scale, consisting of three 24-hour runs accomplished within five days. Performance shall be monitored 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 will 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 shall be able to maintain this efficiency during the entire test period.] Waste shall be reduced to a fine ash residue. Normal burnout procedure shall be followed. After the residue has cooled, samples taken during testing shall be analyzed. [The residue shall 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 shall not exceed [_____] percent.] After cleanout, the incinerator shall be inspected for deterioration such as slagged or spalling refractory, warping of parts, and discolored exterior paint.

3.2.7.2 Efficiency and Operating Tests Procedures

An efficiency and capacity test shall be run on one incinerator and conducted in accordance with ASME PTC 4 and ASME PTC 33 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. [Water meter used in the test shall be suitable for hot water. Efficiency shall be not less than specified in paragraph Heat Recovery Boiler. Maximum moisture content of saturated steam leaving the boiler shall be as specified in Section 15846A HEAT RECOVERY BOILERS.] Efficiency and general performance tests on the incinerators [and boilers] shall be conducted by a qualified test engineer. 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 shall be furnished before the test. All indicating instruments shall be read at half-hour intervals unless otherwise directed.

3.2.7.3 Alternate Efficiency Testing Procedures

If equipped with a full-size, backup burner of its own, the heat recovery boiler may be tested for thermal efficiency independent of the incinerator using hot gases supplied by that burner. Ash from the incinerator will be analyzed and shall show no more than [_____] percent carbon by weight. The entire system shall still be 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.

3.2.7.4 Shell Temperature

Incinerator shall be operated under normal load conditions for not less than [4] [_____] hours. After [4] [_____] hours, temperature readings of the outer shell, taken at not less than five random locations, shall not exceed the temperature limitation specified.

3.2.8 Emission Test

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.

One incinerator shall be tested for excessive emissions in accordance with 40 CFR 60, methods 1, 2, 3, and 5 for incinerators or as required by local authorities. Emissions shall not exceed the limits specified. Stack emissions sampling shall be required for a minimum period of [_____] continuous hour[s] of incinerator operation and shall be done concurrently with the efficiency tests. Emissions tests will be performed 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 will be responsible for correcting the problem by modifying the equipment or by adding air pollution control equipment. Manufacturer will also be responsible for any additional testing required to prove compliance.

3.3 QUALITY CONTROL

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

3.4 FRAMED INSTRUCTIONS

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, shall be posted where directed. 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 shall be prepared in typed form, framed as specified above for the wiring and control diagrams, and posted beside the diagrams. Framed instructions shall be posted before acceptance testing of the systems.

3.5 DEMONSTRATION

The Contractor shall conduct a training course for the operating, maintenance, and supervising staff as designated by the Contracting Officer. The training period, a total of [_____] hours of normal working time, shall start after the system is functionally complete but prior to final acceptance tests. Field instructions shall cover all of the items contained in the Operating and Maintenance Instructions, and shall also include recommendations for total staffing and job descriptions.

-- End of Section --