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An American National Standard

Standard Specification for Shipboard Incinerators[1]

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1. Scope

1.1 This specification covers the design, manufacture, performance, operation, functioning, and testing of incinerators intended to incinerate garbage and other shipboard wastes generated during the ship's normal service (that is, maintenance, operational, domestic, and cargo-associated wastes).

1.2 This specification is a companion document to Guide F 1322.

1.3 This specification applies to those incinerator plants with capacities up to 1500 kW per unit.

1.4 Additional information is given in Appendix X1-Appendix X9.

1.5 This specification does not apply to systems on special incinerator ships, for example, for burning industrial wastes such as chemicals, manufacturing residues, and so forth.

1.6 This specification does not address the electrical supply to the unit nor the foundation connections and stack connections.

1.7 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. If an incinerator is to be operated in littoral regions, the strictest governing regulations for those countries in which the incinerator may operate would form the requirement basis.* See 5.11.

2. Referenced Documents

2.1 *ASTM Standards:*

F 1166 Practice for Human Engineering Design for Marine Systems, Equipment and Facilities[2]

F 1322 Guide for Selection of Shipboard Incinerators[2]

2.2 *ANSI Standard:*

B31.1 Power Piping[3]

ANSI/NFPA No. 70 National Electrical Code[3]

NEC Article 430-7[3]

2.3 *ASME Boiler and Pressure Vessel Code:*

Section I, Power Boilers[4]

Section IX, Welding and Brazing Qualifications[4]

2.4 *Safety of Life at Sea Convention:*

SOLAS 74 International Convention for the Safety of Life at Sea[5]

2.5 *Underwriter's Laboratory Standards:*

UL 506 Standard for Specialty Transformers[6]

UL 814 Standard for Gas-Tube Signs and Ignition Cables[6]

2.6 *Other Documents:*

International Convention for the Preventing of Pollution from Ships (1973), as modified by the Protocols of 1978 (73/78) and 1997 and associated Annexes[5]

NOTE 1—Incinerators designed and manufactured in accordance with alternative standards must show compliance with this specification.

3. Terminology

3.1 *Definitions:*

3.1.1 *cargo-associated waste*—all materials that have become waste as a result of use on board a ship for cargo stowage and handling. Cargo-associated waste includes but is not limited to dunnage, shoring pallets, lining and packing materials, plywood, paper, cardboard, wire, and steel strapping.

3.1.2 *cargo residues—for the purposes of this specification*, the remnants of any cargo material on board that cannot be placed in proper cargo holds (loading excess and spillage) or which remain in cargo holds and elsewhere after unloading procedures are completed (unloading residual and spillage). However, cargo residues are expected to be in small quantities.

3.1.3 *domestic waste*—all types of food waste, sewage, and waste generated in the living spaces on board the ship.

3.1.4 *fishing gear*—any physical device or part thereof or combination of items that may be placed on or in the water

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[2] *Annual Book of ASTM Standards*, Vol 01.07.

[3] Available from the American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[4] Available from the American Society of Mechanical Engineers, Three Park Ave., New York, NY 10016–5990.

[5] Available from the International Maritime Organization, 4 Albert Embankment, London SE1 7SR, UK.

[6] Available from Underwriter's Laboratories, Inc., 333 Pfingsten Rd., Northbrook, IL 60062.

with the intended purpose of capturing, or controlling for subsequent capture, living marine or freshwater organisms.

3.1.5 *food wastes*—any spoiled or unspoiled victual substances, such as fruits, vegetables, dairy products, poultry, meat products, food scraps, food particles, and all other materials contaminated by such waste, generated aboard ship, principally in the galley and dining areas.

3.1.6 *garbage*—all kinds of victual, domestic, and operational waste excluding fresh fish and parts thereof, generated during the normal operation of the ship and liable to be disposed of continuously or periodically. Those substances which are defined or listed in Annexes, other than Annex V, to the International Convention for the Preventing of Pollution From Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78) are excluded.

3.1.7 *graywater*—drainage from galleys, pantries, showers, laundries, baths, and handbasins as long as it is not mixed with sewage.

3.1.8 *incinerator*—shipboard facilities for incinerating solid wastes approximating in composition to household waste and liquid wastes arising from the operation of the ship, for example, domestic waste, cargo-associated waste, maintenance waste, operational waste, cargo residues, fishing gear, and so forth. These facilities may be designed to use or not to use the heat energy produced.

3.1.9 *maintenance waste*—materials collected by the engine department and the deck department while maintaining and operating the ship, such as soot, machinery deposits, scraped paint, deck sweeping, wiping wastes, oily rags, and so forth.

3.1.10 *oily rags*—rags that have been saturated with oil as controlled in Annex I to the Convention. Contaminated rags are rags that have been saturated with a substance defined as a harmful substance in the other Annexes to the Convention.

3.1.11 *operational wastes*—all cargo-associated wastes and maintenance waste (including ash and clinkers) and cargo residues defined as garbage in 3.1.6.

3.1.12 *plastic*—a solid material that contains as an essential ingredient one or more synthetic organic high polymers and is formed (shaped) during either manufacture of the polymer or the fabrication into a finished product by heat or pressure, or both. Plastics have material properties ranging from hard and brittle to soft and elastic. Plastics are used for a variety of marine purposes including, but not limited to, packaging (vapor-proof barriers, bottles, containers, liners), ship construction (fiberglass and laminated structures, siding, piping, insulation, flooring, carpets, fabrics, paints and finishes, adhesives, electrical and electronic components), disposable eating utensils and cups, bags, sheeting, floats, fishing nets, strapping bands, rope, and line.

3.1.13 *sewage*—human body waste and the waste from toilets and other receptacles intended to receive or retain body wastes. Sewage is drainage and other waste from toilets, urinals, and water closet scuppers as well as drainage from medical premises and from spaces containing living animals.

3.1.14 *ship*—a vessel of any type operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft, and fixed or floating platforms.

3.1.15 *sludge oil*—residues from fuel and lubricating oil separators, waste lubricating oil from main and auxiliary machinery, waste oil from bilge water separators, drip trays, and so forth.

3.1.16 *waste*—useless, unneeded, or superfluous matter which is to be discarded.

4. Ordering Information

4.1 Orders shall include the following information, in accordance with Guide F 1322:

4.1.1 Sizing requirements.

4.1.2 Processing rate requirements.

4.1.3 Additional control requirements.

4.1.4 Any additional requirements required by the purchaser to meet special needs.

5. Materials and Manufacture

5.1 Metal parts of the incinerator exposed to the combustion process shall be made of materials listed in Section I of the ASME Boiler and Pressure Vessel Code.

5.2 Where welded construction is used, welded joint design details, welding, and nondestructive testing of the combustion chamber shall be in accordance with Section I of the ASME Code. Welders and weld procedures shall be qualified in accordance with Section IX of the ASME Code.

5.3 Piping and piping components associated with incinerators for fuel, sludge, and liquid cargo residues shall comply with ANSI B31.1 for design and material requirements. Fuel oil pressure piping between service pumps and burners shall have a relief valve fitted which will discharge into the suction line or back into the tank. Pressure piping shall be of seamless steel with a thickness of at least Schedule 80. Short lengths of steel, or annealed copper nickel, nickel copper, or copper pipe and tubing may be used at the burners. The use of nonmetallic materials for fuel lines is prohibited. Valves and fittings may be threaded in sizes up to and including 2-in. normal pipe size (NPS) (60-mm outside diameter), but threaded unions are not to be used on pressure lines in sizes 1-in. NPS (33-mm outside diameter) and over.

5.4 If equipped with an electrically, hydraulically, or pneumatically activated valve, the valve shall be designed to fail closed or in the safe position on loss of power whichever is more appropriate to the applicable system.

5.5 All rotating or moving mechanical and exposed electrical parts shall be protected against accidental contact. All electrical devices shall be enclosed in drip-proof or watertight enclosures.

5.6 The coatings or paints shall not contain any heavy metals, such as, chromium, lead, tin, and so forth, or other materials banned by federal, state, or local authorities.

5.7 Asbestos, mercury, cadmium, polychlorinated biphenyls (PCBs), and chlorinated plastics shall not be used in the construction of the incinerator or any subsystem, including gaskets or lagging materials.

5.8 Refractory shall be resistant to thermal shocks and resistant to normal ship's vibration. The refractory design temperature shall be equal to the combustion chamber design temperature plus 20 % (see 6.1).

5.9 Incinerating systems shall be designed such that corrosion will be minimized on the inside of the systems.

5.10 In systems equipped for incinerating liquid wastes, safe ignition and maintenance of combustion shall be ensured, for example, by a supplementary burner using gas oil/diesel oil or equivalent.

5.11 The incinerating furnace may be charged with solid waste either by hand or automatically. In every case, fire dangers must be avoided and charging must be possible without danger to the operating personnel.

5.11.1 For instance, where charging is carried out by hand, a charging lock may be provided which ensures that the charging space is isolated from the fire box as long as the filling hatch is open.

5.11.2 Where charging is not affected through a charging lock, an interlock shall be installed to prevent the charging door from opening while the incinerator is in operation or while the furnace temperature is above 220°C (428°F).

5.12 Incinerators equipped with a feeding sluice shall ensure that the material charged will move from the sluice to the combustion chamber. Examples for accomplishing this are the use of a clear path down or a mechanical pusher.

5.13 Interlocks shall be installed to prevent ash removal doors from opening while burning is in progress or while the furnace temperature is above 220°C (428°F).

5.14 The incinerator shall be provided with a safe observation port of the combustion chamber to provide visual control of the burning process and waste accumulation in the combustion chamber. Neither heat, flame, nor particles shall be able to pass through the observation port. An example of a safe observation port is high-temperature glass with a metal closure.

5.15 The outside surface of the combustion chamber(s) shall be shielded from contact such that people would not be exposed to extreme heat (maximum 20°C (68°F) above ambient temperature) or direct contact of surface temperatures exceeding 60°C (140°F). Examples for alternatives to accomplish this are a double jacket with airflow in between or an expanded metal jacket.

5.16 Safety interlocks shall be provided to ensure that the incinerator cannot be operated if the shock cooling subsystem is not functioning properly.

5.17 *Electrical Requirements*:

5.17.1 *General*—Installation requirements shall apply to controls, safety devices, and burners on incinerators.

5.17.1.1 A disconnecting means capable of being locked in the open position shall be installed at an accessible location at the incinerator so that the incinerator can be disconnected from all sources of electrical potential. This disconnecting means shall be an integral part of the incinerator or adjacent to it (see 7.1).

5.17.1.2 All rotating or moving parts that may cause injury shall be guarded to avoid accidental contact.

5.17.1.3 The electrical equipment shall be so arranged so that failure of this equipment will cause the fuel supply to be shut off.

5.17.1.4 The power supply to the electrical control system shall be from a two-wire branch circuit that has a grounded conductor; otherwise, an isolation transformer with a two-wire secondary shall be provided. When an isolation transformer is provided, one side of the secondary winding shall be grounded.

5.17.1.5 One side of all coils shall be electrically located in the grounded side of the circuit. All switches, contacts, and overcurrent devices shall be electrically located in the ungrounded or “hot” side of the circuit. All electrical contacts of every safety device installed in the same control circuit shall be electrically connected in series. However, special consideration shall be given to arrangements when certain devices are wired in parallel.

5.17.1.6 All electrical components and devices shall have a voltage rating commensurate with the supply voltage of the control system.

5.17.1.7 All electrical devices shall be at least NEMA Type 2 (Drip tight). Electric equipment exposed to the weather shall be at least NEMA Type 4.

5.17.1.8 All electrical and mechanical control devices shall be of a type tested and accepted by a nationally recognized testing agency.

5.17.1.9 The design of the control circuits shall be such that limit, and primary safety controls shall directly open a circuit that functions to interrupt the supply of fuel to combustion units.

5.17.2 *Overcurrent Protection*:

5.17.2.1 Conductors for interconnecting wiring that is smaller than the supply conductors shall be provided with overcurrent protection based on the size of the smallest interconnecting conductors external to any control box.

5.17.2.2 Overcurrent protection for interconnecting wiring shall be located at the point where the smaller conductors connect to the larger conductors. However, overall overcurrent protection is acceptable if it is sized on the basis of the smallest conductors of the interconnecting wiring.

5.17.2.3 Overcurrent protection devices shall be accessible and their function shall be identified.

5.17.3 *Motors*:

5.17.3.1 Motors exposed to dripping or spraying oil or water shall be of drip-proof construction. All motors shall be fully guarded as installed.

5.17.3.2 Motors shall be provided with a corrosion-resistant nameplate specifying information in accordance with NEC, Article 430-7.

5.17.3.3 Motors shall be provided with running protection by means of integral thermal protection, or by overcurrent devices, or a combination thereof, in accordance with the manufacturer’s instructions that shall be based on the requirements of National Electrical Code, ANSI/NFPA No. 70.

5.17.3.4 Motors shall be rated for continuous duty and shall be designed for an ambient temperature of 50°C (122°F) or higher.

5.17.3.5 All motors shall be provided with terminal leads or terminal screws in terminal boxes integral with, or secured to, the motor frames.

5.17.4 *Ignition System*:

5.17.4.1 When automatic electric ignition is provided, it shall be accomplished by means of either a high-voltage electric spark, a high-energy electric spark, or a glow coil.

5.17.4.2 Ignition transformers shall conform to requirements of the UL Standard 506.

5.17.4.3 Ignition cable shall conform to requirements of the UL Standard 814.

5.17.5 *Wiring*:

5.17.5.1 All wiring for incinerators shall be rated for the maximum operating temperature to which it may be exposed. Such wiring shall be in accordance with ANSI/NFPA No. 70. All wiring between components shall have copper conductors and be constructed in accordance with the ANSI/NFPA No. 70.

5.17.5.2 All electrical wiring shall have a voltage rating commensurate with the voltage of the power supply.

5.17.5.3 Conductors shall be protected from physical damage where appropriate.

5.17.5.4 Conductors shall be sized on the basis of the rated current of the load they supply.

5.17.6 *Bonding and Grounding*:

5.17.6.1 Means shall be provided for grounding the major metallic frame or assembly of the incinerators.

5.17.6.2 Noncurrent carrying enclosures, frames, and similar parts of all electrical components and devices shall be bonded to the main frame or assembly of the boiler. Electrical components that are bonded by their installation do not require a separate bonding conductor.

5.17.6.3 When an insulated conductor is used to bond electrical components and devices, it shall show a continuous green color, with or without a yellow stripe.

6. Operating Requirements

6.1 The incinerator system shall be designed and constructed for operation with the following conditions:

Maximum combustion chamber temperature	1200°C (2158°F)
Minimum combustion chamber temperature	850°C (1560°F)
Preheat temperature of combustion chamber	650°C (1200°F)

For batch-loaded incinerators, there are no preheating requirements. However, the incinerator shall be so designed that the temperature in the actual combustion space shall reach 600°C (1110°F) within 5 min after start.

Prepurge, before ignition	at least 4 air changes in the chamber(s) and stack, but not less than 15 s
Time between restarts	at least 4 air changes in the chamber(s) and stack, but not less than 15 s
Postpurge, after shutoff of fuel oil	not less than 15 s after the closing of the fuel oil valve

6.2 Incinerating systems are to be operated with underpressure (negative pressure) in the combustion chamber such that no gases or smoke can leak out to the surrounding areas.

6.3 The incinerator shall have warning plates attached in a prominent location on the unit, warning against unauthorized opening of doors to combustion chamber(s) during operation and against overloading the incinerator with waste.

6.4 The incinerator shall have instruction plate(s) attached in a prominent location on the unit that clearly addresses the following:

6.4.1 Cleaning ashes and slag from the combustion chamber(s) and cleaning of combustion air openings before starting the incinerator (where applicable).

6.4.2 Operating procedures and instructions. These shall include system diagrams (combustion/cooling air, fuel, electrical, and waste processing), and procedures for proper start-up, normal operation, normal shutdown, and emergency shutdown.

6.5 To avoid the buildup of dioxins, the flue gas should be shock cooled to a maximum 350°C (660°F) within 2.5 m from the combustion chamber flue gas outlet.

7. Operating Controls

7.1 The entire unit shall be disconnected from all sources of electricity by means of one disconnect switch located near the incinerator (see 5.17.1.1).

7.2 There shall be an emergency stop switch located outside the compartment that stops all power to the equipment. The emergency stop switch shall also be able to stop all power to the fuel pumps. If the incinerator is equipped with an induced draft fan, the fan shall be capable of being restarted independently of the other equipment on the incinerator.

7.3 The control equipment shall be so designed that any failure of the following equipment will prevent continued operations and cause the fuel supply to be cut off.

7.3.1 *Safety Thermostat/Draft Failure*:

7.3.1.1 A flue gas temperature controller, with a sensor placed in the flue gas duct, shall be provided that will shut down the burner if the flue gas temperature exceeds the temperature set by the manufacturer for the specific design.

7.3.1.2 A combustion temperature controller, with a sensor placed in the combustion chamber, shall be provided that will shut down the burner if the combustion chamber temperature exceeds the maximum temperature.

7.3.1.3 A negative pressure switch shall be provided to monitor the draft and the negative pressure in the combustion chamber. The purpose of this negative pressure switch is to ensure that there is sufficient draft in the incinerator during operations. The circuit to the program relay for the burner shall be opened and an alarm activated before the negative pressure rises to atmospheric pressure. This is applicable to incinerators fitted with induced draft fans.

7.3.2 *Flame Failure/Fuel Oil Pressure*:

7.3.2.1 The incinerator shall have a flame safeguard control consisting of a flame-sensing element and associated equipment for shutdown of the unit in the event of ignition failure and flame failure during the firing cycle. The flame safeguard control shall be so designed that the failure of any component will cause a safety shutdown and prevent automatic restarting.

7.3.2.2 The flame safeguard control shall be capable of closing the fuel valves in not more than 4 s after a flame failure.

7.3.2.3 The flame safeguard control shall provide a trial-for-ignition period of not more than 10 s during which fuel may be supplied to establish flame. If flame is not established within 10 s, the fuel supply to the burners shall be immediately shut off automatically. Where a light oil pilot is used, the flame safeguard control shall provide a trial-for-ignition period for the pilot of not more than 10 s. If flame is not established within 10 s, the fuel supply to the pilot shall be immediately shut off automatically.

7.3.2.4 Whenever the flame safeguard control has operated because of failure of ignition, flame failure, or failure of any

component, manual reset of the flame safeguard control shall be required for restart.

7.3.2.5 Flame safeguard controls of the thermostatic type, such as stack switches and pyrostats operated by means of an open bimetallic helix, are prohibited.

7.3.2.6 If fuel oil pressure drops below that set by the manufacturer, a failure and lockout of the program relay shall result. This also applies to a sludge oil used as a fuel. (Applies where pressure is important for the combustion process or where a pump is not an integral part of the burner.)

7.3.3 *Motor Overload*—All motors shall be protected in all phases by a thermal overload relay or circuit breaker with thermal overload protection that must be reset manually (see 5.17.3.3).

7.3.4 If there is a loss of power to the incinerator control/alarm panel (not remote alarm panel), the system shall shut down.

7.4 *Fuel Supply*—Two fuel control solenoid valves shall be provided in series in the fuel supply line to each burner. On multiple burner units, a valve on the main fuel supply line and a valve at each burner will satisfy this requirement. The valves shall be connected electrically in parallel so that both operate simultaneously.

7.5 *Alarms*:

7.5.1 When a failure occurs, an audible alarm shall be automatically sounded. A visible indicator shall show what caused the failure. (The alarm may be provided by the user and the indicator may cover more than one fault condition.)

7.5.2 Means shall be provided to silence the audible alarm. The visible indicators shall be designed so that, where failure is a safety related shutdown, manual reset is required.

7.6 After shutdown of the oil burner, the exhaust fan or ejector must continue to run until the fire box has cooled sufficiently. This does not apply in the case of an emergency manual trip.

8. Other Requirements

8.1 *Documentation*—A complete instruction and maintenance manual with drawings, electric diagrams, spare parts list, and so forth shall be furnished with each incinerator.

8.2 *Installation*—All devices and components shall, as fitted in the ship, be designed to operate when the ship is upright and when inclined at any angle of list up to and including 15° either way under static conditions and 22.5° under dynamic conditions (rolling) either way and simultaneously inclined dynamically (pitching) 7.5° by bow or stern.

8.3 *Incinerator*:

8.3.1 Incinerators are to be fitted with a pilot burner or spark ignition with sufficient energy to ensure a safe ignition and combustion. The combustion is to take place at sufficient negative pressure in the combustion chamber(s) to ensure no gases or smoke leaking out to the surrounding areas (see 7.3.1.3).

8.3.2 A drip tray is to be fitted under each burner and under any pumps, strainers, and so forth that require occasional examination.

9. Test Methods

9.1 *Prototype Test Methods*—An operating test method for the prototype of each design shall be conducted, with a test report completed indicating results of all test methods. The test methods shall be conducted to ensure that all of the control components have been properly installed and that all parts of the incinerator, including controls and safety devices, are in satisfactory operating condition. Test methods shall include those described in 9.3.

9.2 *Factory Test Methods*—For each unit, if preassembled, an operating test method shall be conducted to ensure that all of the control components have been properly installed and that all parts of the incinerator, including controls and safety devices, are in satisfactory operating condition. Test methods shall include those described in 9.3.

9.3 *Installation Test Methods*—An operating test method after installation shall be conducted to ensure that all of the control components have been properly installed and that all parts of the incinerator, including controls and safety devices, are in satisfactory operating condition. The requirements for prepurge and time between restarts referred to in 6.1 shall be verified at the time of the installation test method.

9.3.1 *Flame Safeguard*—The operation of the flame safeguard system shall be verified by causing flame and ignition failures. Operation of the audible alarm and visible indicator shall be verified. The shutdown times shall be verified.

9.3.2 *Limit Controls*—Shutdown as a result of the operation of the limit controls shall be verified.

9.3.2.1 *Oil Pressure Limit Control*—The lowering of the fuel oil pressure below the value required for safe combustion shall initiate a safety shutdown.

9.3.2.2 *Air Pressure Limit Control*—Systems using compressed air-oil atomization shall be tested to verify that the air pressure is above the minimum required for proper atomization.

9.3.2.3 *Other Interlocks*—Other interlocks provided shall be tested for proper operation as specified by the unit manufacturer.

9.3.3 *Combustion Controls*—The combustion control shall be stable and operate smoothly.

9.3.4 *Programming Controls*—Programming controls shall be verified as controlling and cycling the unit in the intended manner. Proper pre-purge, ignition, post-purge, and modulation shall be verified. A stopwatch shall be used for verifying intervals of time.

9.3.5 *Fuel Supply Controls*—The satisfactory operation of the two fuel control solenoid valves for all conditions of operation and shutdown shall be verified.

9.3.6 *Low-Voltage Test Method*—A low-voltage test method shall be conducted on the incinerator unit to demonstrate satisfactorily that the fuel supply to the burners will be automatically shut off before an incinerator malfunction results from the reduced voltage.

9.3.7 *Switches*—All switches associated with the unit shall be tested to verify proper operation.

10. Inspection

10.1 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being furnished in accordance with this specification. Inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations. All examinations and inspections shall be made at the place of manufacture, unless otherwise agreed upon.

11. Certification

11.1 Manufacturer's certification that an incinerator has been constructed in accordance with this specification shall be provided (by letter or certificate).

12. Product Marking

12.1 Each incinerator shall be permanently marked indicating the following:

12.1.1 Manufacturer's name or trademark.

12.1.2 Style, type, model, or other manufacturer's designation for the incinerator.

12.1.3 Capacity to be indicated by net designed heat release of the incinerator in heat units per timed period; for example, British thermal units per hour, megajoules per hour, or kilocalories per hour.

12.1.4 ASTM designation of this specification (F 1323).

12.1.5 IMO certification, if required.

12.1.6 Other applicable nonmandatory requirements.

13. Quality Assurance

13.1 Incinerators shall be designed, manufactured, and tested in a manner that ensures they meet the requirements of this specification.

13.2 The incinerator manufacturer shall maintain the production quality of the incinerators that are designed, tested, and marked in accordance with this specification. At no time shall an incinerator be sold with this specification designation that does not meet the requirements herein (see Certification).

14. Keywords

14.1 incinerators; shipboard wastes; ships

SUPPLEMENTARY REQUIREMENTS

S1. For U.S. Government Procurement Only

S1.1 Except as otherwise specified in the contract, the contractor is responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser at time of purchase. The purchaser shall have the right to perform any of the inspections and tests at the same frequency as set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

S2. Referenced Documents

MIL-STD-882 System Safety Program Requirements[7]

MIL-STD-901C Grade B Shock Requirements for Shock Tests, Shipboard Machinery, Equipment, and Systems[7]

SNAME T&R Bulletin No. 3-37 Design Guide for Shipboard Airborne Noise Control[8]

S3. Design Considerations

S3.1 The services that are available for the incinerator are as follows:

S3.1.1 440-V, 60-Hz, three-phase electrical power.

S3.1.2 *Seawater*—at 690 to 1.206 kPa (100 to 175 psig) (actual value will vary over time and depending on shipboard location).

S3.1.3 *Fresh Water*—414 kPa (60 psig) up to 3.8 LPM (10 GPM); 21°C (70°F).

S3.1.4 *Ship Service Compressed Air*—at 862 kPa (125 psig) (air supply to the space at a maximum temperature of 32°C (90°F) with a wet bulb temperature of 27°C (81°F).

S3.1.5 *Aviation Turbine Fuel Oil*—Marine diesel, JP-5, or NATO designation F-44.

S3.1.6 *Compartment Ventilation*—As required.

S4. Materials and Manufacture

S4.1 Refractory material shall have a life expectancy of at least three years (see also 5.8).

S5. Operational Requirements

S5.1 To avoid building up of dioxins, the flue gas shall be shock-cooled to a maximum of 200°C (390°F) within 2.5 m (8.2 ft) from the combustion chamber flue gas outlet. (Replaces 6.5).

S5.2 The shock cooling subsystem shall also neutralize acidic gases to a pH of not less than 5.0 and sufficiently reduce the relative humidity to ensure that condensation will not occur in the exhaust stack or at the stack exhaust point.

S5.3 Stack emissions shall be measured including, but not limited to, carbon monoxide, oxygen, and smoke opacity.

S5.4 The incinerator shall have an internal pressure no greater than 125 Pa (0.018 psi) below ambient pressure for all rates of operation.

S5.5 The system shall not exhibit a visible steam plume from the output stack at 0°C (32°F) ambient. The stack shall operate without the emission of visible sparks or fly ash particles from the exhaust gas outlet.

[7] Available from the Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120.

[8] Available from the Society of Naval and Marine Engineers, 601 Pavonia Ave., Jersey City, NJ 07306.

S5.6 A method for evacuation of any smoke or combustible gases entering the charging lock while the trash is transferred into the combustion chamber shall be provided.

S5.7 The reliability and maintainability characteristics of the thermal destruction system shall be such to ensure that the crew of a ship can, with a high degree of confidence, consistently dispose of the waste stream as defined by purchaser. The system shall be designed for an operational life at least ten years.

S5.8 Routine cleaning and preventive maintenance shall not require more than 1 h per day. The design of all components shall be consistent with an at-sea working environment. The incinerator shall have an operational availability (A_o) of not less than 0.90 over a six-month operating profile.

S5.9 For organizational level corrective maintenance, the incinerator shall have a geometric mean time to repair ($MTTR_g$) of less than 4 h 95 % of the time and a maximum repair time (M_{max}) of less than 12 h 95 % of the time. Repair times do not include the time required to cool down or heat up the incinerator. Organizational maintenance shall include any maintenance required during ship deployments, which are up to six months in duration. Organizational maintenance shall not require skills beyond that which is expected of an enlisted sailor with a twelfth-grade level of education. All other maintenance required to maintain the incinerator functioning for the six-year life expectancy shall be performed by an intermediate level maintenance organization. Intermediate level maintenance is to be performed by trained government repair specialists or contractors and is to include the replacement of refractory material and any other major maintenance required to ensure safe and reliable operation for a six-month deployment.

S5.10 Airborne noise shall meet the noise limits recommended in SNAME T&R Bulletin No. 3-37 that provides design guidance on shipboard airborne noise control.

S5.11 The system shall be free from vibration that could result in damage or the potential of damage to the ship structure, machinery, equipment, and systems, or interferes with the operation of the ship, its cargo systems, or any ship component. It shall have no resonant frequencies of its parts or structure below 40 Hz. The system shall be in accordance with MIL-STD-901C for Grade B shock.

S5.12 The incinerator shall be safe under both normal and unplanned conditions in accordance with the requirements of MIL-STD-882. As part of this study, a Failure Modes and Effects Criticality Analysis shall be performed to evaluate the impact and likelihood of all conceivable failures. This shall include as a minimum, accidental introduction of materials that are not recommended for processing and loss of any or all services.

S5.12.1 The following types of failures are not acceptable as part of the incinerator:

S5.12.1.1 Catastrophic failures that result in death or system loss and are of remote likelihood to occur.

S5.12.1.12 Critical failures that cause severe injury, illness, or major system damage and are of probable likelihood to occur.

S5.12.1.3 Marginal failures that cause minor injury or illness or system damage and are expected to occur frequently.

S5.12.2 The following failures shall be minimized to the greatest possible extent:

S5.12.2.1 Catastrophic failures that are of improbable likelihood to occur.

S5.12.2.2 Critical failures that are of occasional likelihood to occur.

S5.12.2.3 Marginal failures that are of probable likelihood to occur.

APPENDIXES

(Nonmandatory Information)

X1. LOCATION REQUIREMENTS FOR INCINERATORS

X1.1 Incinerators for sludge oil may be installed in the engine room or in a separate room. Incinerators for garbage installed in the engine room should receive due attention to size and location of the incinerator. If the incinerator is installed in a separate room outside the engine room, bulkheads and decks of this room are to be A-class boundaries insulated in accordance with the requirements for Category A machinery spaces, as defined by SOLAS 1974, as amended in Chapter II-2, Regulation 3. This requirement shall apply regardless of the type of vessel construction used (that is, Methods IC, IIC, IIIC as defined in SOLAS II-2, Regulation 42) and regardless of whether the vessel is required to meet SOLAS or to be approved or certified by the cognizant government authority.

X1.2 On certified vessels or those meeting SOLAS, both fire-detection and extinguishing systems must be approved by the cognizant government authority. Ventilation ducts should be capable of being closed by means of fire dampers, controlled from outside the incinerator room, of sufficient construction to maintain the A-class boundary. Emergency stop of oil burner and oil-booster pumps shall also be arranged outside the room.

X1.3 Flue gas-uptakes and surfaces of incinerators are not to be less than 500 mm (20 in.) from fuel, oil tanks, or accommodation bulkheads. Flue gas-uptake and exhaust pipe are to be insulated and located well away from electrical

installations and inflammable items. Exhaust pipes in the casing are to be led to the top of the funnel. Exhaust uptakes from incinerators, which are installed in separate rooms outside the engine room, are to be approved in each case.

X1.4 Incinerators and flue gas uptakes are to be located outside of hazardous areas as defined by the applicable rules.

X1.5 The flue lines of incinerating systems shall not open into the flues or exhaust lines of other equipment but must be arranged separately to the point of discharge.

X1.6 Garbage chutes shall comply with the same fire standards as incinerator rooms outside engine rooms.

X2. INCINERATORS INTEGRATED WITH HEAT RECOVERY UNITS

X2.1 The flue gas system, for incinerators in which the flue gas is led through a heat recovery unit (economizer), should be designed so that the incinerator can continue operation with the economizer coils dry. This may be accomplished with bypass dampers if needed.

X2.2 The incinerator unit should be equipped with a visual and audible alarm in case of loss of feed water.

X2.3 The gas side of the economizer should have equipment for proper cleaning. Sufficient access should be provided for adequate inspection of external heating surfaces.

X3. FLUE GAS TEMPERATURE

X3.1 When deciding upon the type of incinerator, consideration should be given as to what the flue gas temperature will be. The flue gas temperature can be a determining factor in the selection of materials for fabricating the stack. Special high-temperature material may be required for use in fabricating the stack when the flue gas temperatures exceed 413°C (775°F).

X4. DESIGN FOR FUTURE RETROFITS OF AIR EMISSION CONTROL EQUIPMENT

X4.1 Though not a requirement, it is recommended that incinerators be provisioned with an ability for future retrofits of air emission control equipment to accommodate emission standards for shipboard incinerators as they are developed.

X4.2 The Environmental Protection Agency (EPA) does not currently have emission standards for small shipboard incinerators as described in this specification. However, the EPA has indicated it intends to publish emission standards eventually. In addition, emission standards for state and local jurisdictions vary.

X5. SPARK ARRESTORS

X5.1 The incinerator should be so constructed or so equipped as not to permit from the exhaust the passage of spherical objects having a diameter larger than 13.7 mm (½ in.) nor block the passage of spherical objects having a diameter of less than 9.5 mm (⅜ in.).

X5.2 Means should be provided for securely attaching the spark arrestors to chimneys to provide adequate support and prevent movement of the arrestor.

X5.3 Means should be provided to replace spark screens.

X6. HUMAN ENGINEERING

X6.1 The system should comply with Practice F 1166.

X6.2 The incinerator should conform to human engineering principles to the degree that it can be operated and maintained by a 152-cm (5-ft) tall person as well as a 185-cm (6-ft 1-in.) tall person.

X6.3 Its design should also reflect system and personnel safety factors, including the elimination or minimization of the potential for human error during operation and maintenance, under both routine and nonroutine or emergency conditions. Machinery, systems, equipment, and fixtures should be intrinsically safe as far as practicable, and in the event of failure, should fail to a safe mode.

X6.4 Man-machine interfaces should minimize both the potential for and the consequence of human error.

X6.5 The level of training required for operating personnel should be no more than 2 h of on-the-job training; training required for maintenance personnel should be no more than 5 h.

X7. ASH/SLAG COLLECTION

X7.1 The incinerator should provide for the safe collection and removal of both bottom and fly ash from the incinerator with minimal interference to the combustion process. The incidental introduction of metal or glass into the incinerator should not negatively impact incinerator operation, maintenance, or the ash removal processes.

X7.2 The process for the collection and removal of bottom and fly ash or slag can be either of the following: (*1*) automatic and continuous without requiring shutdown or (*2*) manual and require system shutdown. In either case, operator handling of ash should be required to occur no more than once per day.

X7.3 For automatic ash removal systems, the ASTM interlock requirements to prevent ash removal until the combustion chamber cools to 220°C (428°F) is hereby waived, provided the automated ash removal process does not create hazardous or unsafe conditions and the combustion zone is isolated from the outside work space at all times.

X7.4 The incinerator architecture should not require undue exposure of the operator to temperatures above 60°C (140°F), ash, hazardous gases, or other incinerator by-products during the process of transferring ash or slag into a container for storage or disposal.

X7.5 The ash or slag will be transferred to and stored in 55-gal drums or other size containers dependent on type and size of incinerator and size of ship it is installed upon. The temperature of the ash being transferred should be less than 220°C (428°F).

X7.6 There should be no obstructions around the ash removal door that can cause accidental exposure of maintenance personnel to ash either directly or through the air.

X8. PROCESS MONITORING

X8.1 The system should provide for sufficient process monitoring and the automated controls necessary to maintain the set point operating conditions.

X8.2 Set points for low/high temperature, carbon monoxide, oxygen, smoke opacity, and any other parameter required by the manufacturer to control the incineration process are to be determined by the manufacturer.

X8.3 The incinerator control/operator interface should clearly communicate all information to the operator that is required to ensure efficient and safe operation of the incinerator process.

X9. EMISSION REQUIREMENTS FOR SHIPBOARD INCINERATORS

X9.1 *An IMO Type Approval Certificate* should be required for each shipboard incinerator. To obtain such certificate, the incinerator should be designed and built to an IMO-approved standard. Each model should go through a specified type approval test operation at the factory or an approved test facility, and under the responsibility of the administration.

X9.2 *The Type Approval Test* should include measuring of the following parameters:

Maximum capacity	kW or kcal/h kg/h of specified waste kg/h per burner
Pilot fuel consumption	kg/h per burner
O_2 average in combustion chamber/zone	%
CO average in flue gas	mg/MJ
Soot number average	Bacharach or Ringelman Scale
Combustion chamber flue gas outlet temperature average	°C
Amount of unburned components in ashes	% by weight

X9.3 *Duration of Test Operation*:

For sludge oil and solid waste burning	6 to 8 h

X9.4 *Fuel/Waste Specification for Type Approval Test (% by Weight)*:

Sludge oil consisting of:	75 % sludge oil from heavy fuel oil 5 % waste lubricating oil 20 % emulsified water
Solid waste (Class 2) consisting of:	50 % food waste 50 % rubbish containing approximately 30 % paper, 40 % cardboard, 10 % rags, and 20 % plastic. This mixture will have up to 50 % moisture and 7 % incombustible solids.

Classes of Waste:

Class 0 Trash, a mixture of highly combustible waste such as paper, cardboard, wood boxes, and combustible floor sweepings, with up to 10 % by weight of plastic bags, coated paper, laminated paper, treated corrugated cardboard, oil rags, and plastic or rubber scraps. This type of waste contains up to 10 % moisture, 5 % incombustible solids, and has a heating value of about 19 700 kJ/kg as fired.

Class 1 Rubbish, a mixture of combustible waste such as paper, cardboard, cartons, wood scrap, foliage, and combustible floor sweepings. The mixture contains up to 20 % by weight of galley or cafeteria waste, but contains little or no treated papers, plastic, or rubber wastes. This type of waste contains 25 % moisture, 10 % incombustible solids, and has a heating value of about 15 100 kJ/kg as fired.

Class 2 Refuse, consisting of approximately even mixture of rubbish and garbage by weight. This type waste is common to passenger ships' occupancy, consisting of up to 50 % moisture, 7 % incombustible solids, and has a heating value of about 10 000 kJ/kg as fired.

Class 3 Garbage, consisting of animal and vegetable wastes from restaurants, cafeterias, galleys, sick bay, and like installations. This type of waste contains up to 70 % moisture, up to 5 % incombustible solids, and has a heating value range from about 2300 kJ/kg as fired.

Class 4 Aquatic life forms and animal remains, consisting of carcasses, organs, and solid organic wastes from vessels carrying animal-type cargo, consisting of up to 85 % moisture, 5 % incombustible solids, and having a heating value range from about 2300 kJ/kg as fired.

Class 5 By-product waste, liquid or semiliquid, such as tar, paints, solvents, sludge, oil, waste oil, and so forth, from shipboard operations. The Btu values must be determined by the individual materials to be destroyed.

Class 6 Solid by-product waste, such as rubber, plastics, wood waste, and so forth, from industrial operations. The Btu values must be determined by the individual materials to be destroyed.

Calorific values	kJ/kg	kcal/kg
Vegetable and putrescibles	5 700	1360
Paper	14 300	3415
Rag	15 500	3700
Plastics	36 000	8600
Oil sludge	36 000	8600

Calorific values	kJ/kg	kcal/kg
Sewage sludge	3 000	716

Densities	kg/m^3
Paper (loose)	50
Refuse (75 % wet)	720
Dry rubbish	110
Scrap wood	190
Wood sawdust	220

Density of loose general waste generated on board ship will be about 130 kg/m^3.

Reference: Waste classification from Incinerator Institute of America.

X9.5 *Required Emission Standards to be Verified by Type Approval Test*:

O_2 in combustion chamber	6 to 12 %
CO in flue gas maximum average	200 mg/MJ
Soot number maximum average	Bacharach 3 or Ringelman 1 (A higher soot number is acceptable only during very short periods such as starting up)
Unburned components in ash residues	maximum 10 % by weight
Combustion chamber flue gas outlet temperature range	850–1 200°C

A high temperature in the actual combustion chamber/zone is an absolute requirement to obtain a complete and smoke-free incineration, including that of plastic and other synthetic materials while minimizing dioxin, VOC (volatile organic compounds), and emissions.