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Standard Guide for Selection of Shipboard Incinerators[1]

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1. Scope

1.1 This guide covers selection criteria to assist procurers in selecting the appropriate incinerator for their needs.

1.2 This guide is a companion document to Specification F1323.

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

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]
F1323 Specification for Shipboard Incinerators
2.2 *Other Document:*[3]
MARPOL 73/78

3. Terminology

3.1 *Definitions:*

3.1.1 *batch feeding, n*—non-continuous feeding incinerator where the combustion chamber shall be cooled down between placing solid waste into the combustion chamber.

3.1.2 *continuous feeding, n*—pump transfer of sludge oil into the incinerator combustion chamber on a continuous basis; also, the feeding of solid waste into the combustion chamber by a screw conveyor or sluice system.

3.1.3 *sludge oil, n*—residual from fuel and lubricating oil separators, oily waste from machinery and hydraulic power units, drip trays, and oil-water separators.

3.1.4 *sluice system, n*—trap door system, whereby it is possible in a safe manner to feed solid waste into the combustion chamber while the incinerator is operating at high temperature.

3.1.5 *solid waste, n*—combustible trash, garbage, and rubbish (see also 7.4).

3.1.6 *waste, n*—unneeded or useless matter which is to be discarded.

4. Selecting the Incinerator Size and Installed Location

4.1 A number of factors will govern the selection of the size and type of shipboard incinerator and full consideration must be given to each. The installed operating location of the unit is of equal importance to ensure low-cost operating, ease of charging, ease of cleaning, and so forth. Consideration should be given to the following:

4.1.1 Maximum amount of each type of waste that will be incinerated each day (see Section 5).

4.1.2 The normal number of hours per day that the incinerator will be in operation.

4.1.3 Loading procedure (batch/continuous) over operating hours.

4.1.4 Can wet and dry material be loaded into the incinerator so that a large volume of auxiliary fuel is not required?

4.1.5 Can the incinerator be installed on the ship in a location near the major source of refuse so as to minimize the manpower requirements during loading operations?

4.1.6 Ash removal, if the incinerator is installed in the machinery space or on a lower deck.

4.1.7 Will ash removal be manual (shoveling) or semiautomatic (plow)?

5. Estimating Daily Quantities of Waste to Be Incinerated

5.1 *Size of Ship's Crew:*

5.1.1 Galley and crew quarters waste estimate: 1.5 kg (3.3 lb) per crew member per day.

5.2 *Number of Passengers Carried:*

5.2.1 Galley and passenger quarters waste estimate: 2.5 kg (5.5 lb) per passenger per day.

5.3 *Stores*—Estimated amount of packaging for food and other items that, during the underway period, will become

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from International Maritime Organization (IMO), 4, Albert Embankment, London, UK, SEI 7SR, http://www.imo.org.

waste in the form of rubbish or trash; 0.5 kg (1.1 lb) per crew member or passenger per day.

5.4 Sludge oil generation (see 8.3).

6. Other Factors for Selection

6.1 *Type of Unit* (for example: solid waste only, solid waste and sludge oil).

6.2 Capacity of unit in kW or BTU/hr (based on waste generation estimate, heat content of waste, and operating hours).

6.3 Sludge oil capacity.

6.4 Loading considerations (batch loading or continuous feed).

6.5 Installation considerations (indoor/outdoor).

6.6 Environmental considerations (incinerators are normally required to meet the emission limits specified in IMO MARPOL 73/78, Annex VI).

6.7 Heat recover options (amount of steam or hot water).

6.8 Ash removal.

6.9 Induced draft fan requirements.

6.10 Modular/package construction.

6.11 Dimensions/weight.

7. Classification of Shipboard Wastes and Incinerators

7.1 The basis for satisfactory incinerator operation is the proper analysis of the waste to be destroyed and the selection of proper equipment to best destroy that particular waste.

7.2 As a guide, mixtures of waste most commonly encountered have been classified into types of waste, together with the British Thermal Unit (Btu) values and moisture contents of the mixtures.[4] A concentration of one specific waste in the mixture may change the Btu value or the moisture content, or both, of the mixture. A concentration of more than 10 % by weight of catalogs, magazines, or packaged paper will change the density of the mixture and affect burning rates.

7.3 Similarly, incinerators have been classified by their capacities and by the types of wastes they are capable of incinerating.

7.4 *Classification of Shipboard Wastes*—The following classification of shipboard wastes differs from the definition of garbage as found in Annex V of MARPOL 73/78, which includes all of the types listed on this page.

7.4.1 *Type 0*—Trash, a mixture of highly combustible waste, such as paper, cardboard, cartons, wood boxes, and combustible floor sweepings from commercial and industrial activities. The mixtures contain up to 10 % by weight of plastic bags, coated paper, laminated paper, treated corrugated cardboard, oil rags, and plastic or rubber scraps.

7.4.1.1 This type of waste contains 10 % moisture, 5 % incombustible solids, and has a heating value of 19 730 kJ/kg (8500 Btu/lb) as fired.

7.4.2 *Type 1*—Rubbish, a mixture of combustible waste, such as paper, cardboard cartons, wood scrap, foliage, and combustible floor sweepings, from domestic, commercial, and industrial activities. The mixture contains up to 20 % by weight of galley or cafeteria waste, but contains little or no treated papers, plastic, or rubber wastes.

7.4.2.1 This type of waste contains 25 % moisture, 10 % incombustible solids, and has a heating value of 15 100 kJ/kg (6500 Btu/lb) as fired.

7.4.3 *Type 2*—Refuse, consisting of an approximately even mixture of rubbish and garbage by weight.

7.4.3.1 This type of waste is common to passenger ships occupancy, consisting of up to 50 % moisture, 7 % incombustible solids, and has a heating value of 10 000 kJ/kg (4300 Btu/lb) as fired.

7.4.4 *Type 3*—Garbage, consisting of animal and vegetable wastes from restaurants, cafeterias, galleys, sick bays, and like installations.

7.4.4.1 This type of waste contains up to 70 % moisture, up to 5 % incombustible solids, and has a heating value of 5800 kJ/kg (2500 Btu/lb) as fired.

7.4.5 *Type 4*—Aquatic life forms and animal remains, consisting of carcasses, organs and solid organic wastes from vessels carrying animal type cargos, consisting of up to 85 % moisture, 5 % incombustible solids, and having a heating value range of 2300 kJ/kg (1000 Btu/lb) as fired.

7.4.6 *Type 5*—By-product waste, liquid or semi-liquid, such as tar, paints, solvents, sludge, oil, waste oil, and so forth, from shipboard operations. Energy values (kJ/kg or BTU/lb) must be determined by the individual materials to be destroyed.

7.4.7 *Type 6*—Solid by-product waste, such as rubber, plastics, wood waste, and so forth, from industrial operations. Energy values (kJ/kg or BTU/lb) must be determined by the individual materials to be destroyed.

8. Incinerator Operations and Sludge Oil Estimation

8.1 The normal incineration procedure should be described for a vessel in the technical specifications and waste management plan, to define how the incinerator is to be used under normal operating conditions, and to make sure it has enough capacity for the intended use. Reports from tests performed to meet IMO MARPOL Annex VI or Specification F1323 emission requirements should be considered in capacity calculations. The sizing of the incinerator should take into consideration the expected daily operational hours, the uncertainty in the calculation of the waste amount , and the mixture of the waste. Also, sufficient time for normal repair and service of the incinerator should be taken into account.

8.2 *Solid Waste Capacity Calculation*—For solid waste generation, the values in Section 5 should be considered. It should be taken into account if the incinerator will be batch fed or has the capability to be sluice fed continuously, or a combination of both. Batch feeding reduces the daily capacity, since the chamber shall be cooled between batches before opening and reloading.

[4] The original source of data for these classifications is the Incinerator Institute of America Waste Classification, available from the Incinerator Institute of America, 60 E. 42nd St., New York, NY 10017.

8.3 *Machinery Sludge Oil Generation Calculation*—For engines using heavy fuel oil (HFO), it can be estimated that about 1–2 % of the fuel consumption will end up in the sludge oil tank for incineration, depending on separator capabilities and operational procedures. The daily generation of sludge oil (SO, in litres) for two-stroke engines can also be estimated by the following calculation:

$$SO\ (daily, litres) = 0.182 \times kW \times (PCT/100) \times 24hrs \quad (1)$$

where:

0.182 = a typical constant for two-stroke engines with units of [litres/(kW hr)],
kW = the ship engine power in brake kW, and
PCT = the estimated sludge oil generation.

The calculation estimates the amount of sludge generated daily under 24 hour transit. If engine size is in horsepower, divide result by 1.36. Suggested minimum PCT value is 1 or 2. If the main engine runs on marine diesel oil or distillate fuel, the daily generation of sludge is limited, and sludge oil generation should be positively verified in each case. Other sources for sludge oil, such as lubricating oil and hydraulic oil, should also be added.

8.4 *Capacity Calculation When Burning Both Solid Waste and Sludge Oil:*

8.4.1 The estimated capacity calculation should be the sum of the estimates generated by 8.2 and 8.3 above. The service tanks for sludge oil should at least have sufficient capacity to hold the daily generation of such waste, as defined by 8.3, received via the sludge oil holding tank.

8.4.2 The flue gas extraction system shall have sufficient capacity to handle stack back pressure under all circumstances, to secure full effect of theoretical incinerator capacity, and to provide personnel and property protection.

8.4.3 Back pressure calculations shall be presented and compared with system abilities.

8.4.4 It is recommended to consult the equipment supplier for advice and verification of calculations.

8.4.5 For optimum efficiency, and to reduce the amount of unburned components in the ashes, it is recommended to incinerate sludge oil first, then all solid waste, and then switch back to sludge oil.

9. Keywords

9.1 incinerators; selection; shipboard incinerators

APPENDIX

(Nonmandatory Information)

X1. ALTERNATIVE DISPOSAL OF CONTAMINATED WATER

X1.1 Incinerators can be equipped to utilize heat generated during normal operation to dispose of contaminated water, through injection directly into the chamber.

X1.1.1 The water can be what normally is destined to end up in the oily water separator or holding tank for sludge oil.

X1.1.2 The water can be contaminated with the same components as found in sludge oil, mainly oil, and chemicals. No solids.

X1.1.3 The water is transferred to a water service tank before injection in the combustion process, where levels and consumption can be monitored (for oil record book recording, if necessary) and necessary pre-treatment, if any.

X1.2 Water injection shall be monitored and controlled by the incinerator controls (for example, programmable logic controller (PLC)), and not by a separate system.

X1.2.1 If the system fails to stabilize the chamber temperature at a level where injection can proceed, the water injection should be automatically shut down by the PLC.

X1.2.2 Injection of water in the combustion chamber should not increase fuel consumption after stabilization.

X1.2.3 Injection of water should not significantly reduce the incinerator capacity, compared to capacity without this optional equipment.

X1.3 An incinerator with such optional equipment should be tested and certified according to normal IMO procedures.

X1.4 It is recommended to seek advice on installation and use of any water injection equipment with the supplier.