INTERNATIONAL STANDARD

ISO 13617

Second edition
2001-11-15

Ships and marine technology — Shipboard incinerators — Requirements

Navires et technologie maritime — Incinérateurs de bord pour navires — Exigences

Reference number
ISO 13617:2001(E)

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Printed in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13617 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 3, *Piping and machinery*.

This second edition cancels and replaces the first edition (ISO 13617:1995). It was revised for continued consistency with International Maritime Organization provisions for shipboard incinerators.

Annexes A, B and D form a normative part of this International Standard. Annex C is for information only.

Ships and marine technology — Shipboard incinerators — Requirements

1 Scope

This International Standard 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 (i.e. maintenance, operational, domestic and cargo associated wastes).

This International Standard applies to incinerator plants with capacities up to 1 500 kW per unit.

This International Standard does not apply to systems on special incinerator ships, e.g. for burning industrial wastes such as chemicals, manufacturing residues, etc.

It does not address the electrical supply to the unit, nor the foundation connections and stack connections.

This International Standard provides emission requirements in annex A, and fire protection requirements in annex B. Provisions for incinerators integrated with heat recovery units and provisions for flue gas temperatures are given in informative annex C and normative annex D, respectively.

This International Standard may involve hazardous materials, operations, and equipment. It does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

International Maritime Organization, *International Convention on the Safety of Life at Sea, 1997 (SOLAS),* Chapter II-2, Regulations 3, 26, and 44.

International Maritime Organization, *International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78).*

IEC 92, *Electrical installations in ships*

IEC 60092-201:1980, *Electrical installations in ships — Part 201: System design — General*

IEC 60092-202:1994, *Electrical installations in ships — Part 202: System design — Protection*

IEC 60092-301:1980, *Electrical installations in ships — Part 301: Equipment — Generators and motors*

IEC 60092-352:1997, *Electrical installations in ships — Part 352: Choice and installation of cables for low-voltage power systems*

IEC 60092-503:1975, *Electrical installations in ships — Part 503: Special features — A.C. supply systems with voltages in the range above 1 kV and up to and including 11 kV*

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
cargo-associated waste
all materials which have become wastes as a result of use on board a ship for cargo stowage and handling, including, but not limited to, dunnage, shoring pallets, lining and packing materials, plywood, paper, cardboard, wire, and steel strapping

3.2
cargo residues
remnants of any cargo material on board that cannot be placed in proper cargo holds (loading excess and spillage) or which remains in cargo holds and elsewhere after unloading procedures are completed (unloading residual and spillage)

3.3
contaminated rags
rags that have been saturated with a substance defined as a harmful substance in certain annexes to MARPOL 73/78

3.4
domestic waste
all types of food wastes, sewage and wastes generated in the living spaces on board the ship

3.5
fishing gear
any physical device or part thereof or combination of items that may be placed on or in the water with the intended purpose of capturing, or controlling for subsequent capture, living marine or freshwater organisms

3.6
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 wastes, generated aboard ship, principally in the galley and dining areas

3.7
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, except those substances which are defined or listed in certain annexes to MARPOL 73/78

3.8
incinerators
shipboard facilities for incinerating solid wastes approximating in composition to household waste and liquid wastes arising from the operation of the ship, e.g., domestic waste, cargo-associated waste, maintenance waste, operational waste, cargo residues, and fishing gear, etc.

NOTE These facilities may be designed to use or not to use the heat energy produced.

3.9
maintenance waste
materials collected by the engine department and the deck department while maintaining and operating the vessel, such as soot, machinery deposits, scraped paint, deck sweeping, wiping wastes, oily rags, etc.

3.10
operational wastes
all cargo-associated wastes and maintenance waste (including ash and clinkers), and cargo residues defined as **garbage** (3.7)

3.11
oily rags
rags which have been saturated with oil as controlled in annex I to MARPOL 73/78

3.12
plastic
a solid material which contains, as an essential ingredient, one or more synthetic organic high polymers and which is formed (shaped) during either manufacture of the polymer or the fabrication into a finished product by heat and/or pressure

NOTE 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 (vapour-proof barriers, bottles, containers, liners), ship construction (fibreglass 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.

3.13
ship
a vessel of any type whatsoever operating in the marine environment and including hydrofoil boats, air-cushioned vehicles, and submersibles, floating craft and fixed or floating platforms

3.14
sludge oil
sludge from fuel and lubricating oil separators, waste lubricating oil from main and auxiliary machinery, waste oil from bilge water separators, drip-trays, etc.

3.15
waste
useless, unneeded or superfluous matter, which is to be discarded

4 General design requirements

4.1 Piping

Piping for fuel and sludge oil shall be constructed of seamless steel of adequate strength and to the satisfaction of the Administration. Short lengths of steel, or annealed copper nickel, nickel copper, or copper pipe and tubing may be used at the burners. The use of non-metallic materials for fuel lines is prohibited. Valves and fittings may be threaded in sizes up to and including 60 mm outer diameter, but threaded unions are not to be used on pressure lines in sizes 33 mm outer diameter and over.

4.2 Rotating parts

All rotating or moving mechanical and exposed electrical parts shall be protected by guards or shields against accidental contact by personnel in the vicinity of the incinerator.

4.3 Insulation and cooling

4.3.1 Incinerator walls are to be protected with insulated fire bricks/refractory and a cooling system. The outside surface temperature of the incinerator casing being touched during normal operations shall not exceed 20 °C above the ambient temperature.

4.3.2 The 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 4.12).

4.3.3 The outside surface of combustion chamber(s) shall be shielded from contact such that personnel will not be exposed to extreme heat of more than 20 °C above the ambient temperature, or direct contact with surface temperatures exceeding 60 °C.

EXAMPLE 1 Double jacketing with an air space between jackets

EXAMPLE 2 Expanded metal jacketing

4.4 Corrosion

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

4.5 Liquid waste incineration

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

4.6 Combustion chamber

The combustion chamber(s) shall be designed for easy maintenance of all internal parts including the refractory and insulation.

4.7 Combustion pressure

The pressure in the furnace under all circumstances shall be lower than the ambient pressure in the space where the incinerator is installed to ensure that the combustion process takes place under negative pressure. A flue gas fan may be fitted to provide negative pressure.

4.8 Charging solid waste

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

EXAMPLE 1 Where charging is carried out by hand, a charging lock could be provided which ensures that the charging space is isolated from the fire box as long as the filling hatch is open.

EXAMPLE 2 Where charging is not effected through a charging lock, an interlock could be installed to prevent the charging door from opening while the incinerator is in operation with burning of garbage in progress, or while the furnace temperature is above 220 °C.

4.9 Feeding system

Incinerators equipped with a feeding sluice or system shall ensure that the material charged will move to the combustion chamber. Such systems shall be designed such that both the operator and environment are protected from hazardous exposure.

4.10 Ash removal

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.

4.11 Observation port

The incinerator shall be provided with a safe observation port of the combustion chamber in order 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.

EXAMPLE An example of a safe observation port is high-temperature glass with a metal closure.

4.12 Design temperature values

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

— maximum flue-gas-outlet temperature of combustion chamber: 1 200 °C;

— minimum flue-gas-outlet temperature of combustion chamber: 850 °C;

— preheat temperature of combustion chamber: 650 °C.

Preheating is not required in batch-loaded incinerators. However, in batch-loaded incinerators without preheating, the incinerator shall be so designed that the temperature in the actual combustion space reaches 600 °C within 5 min after starting.

4.13 Prepurging and post-purging

Incinerator controls shall include the following purge cycles.

— Prepurge, before ignition: at least four air changes in the chamber(s) and stack, but not less than 15 s.

— Time between restarts: at least four air changes in the chamber(s) and stack, but not less than 15 s.

— Post-purge, after shut-off of fuel oil: not less than 15 s after the closing of the fuel-oil valve.

4.14 Volume fraction of oxygen in discharge gas

Incinerators shall be designed so that incineration produces a minimum of 6 % mass fraction of oxygen (measured in dry flue gas) in the discharge gases.

4.15 Warning plate(s)

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 garbage.

4.16 Instruction plate(s)

The incinerator shall have (an) instruction plate(s) attached in a prominent location on the unit that clearly explain(s) the procedures for the following operations:

— cleaning ashes and slag from the combustion chamber(s) and cleaning of combustion air openings before starting the incinerator (where applicable);

— operating procedures and instructions, including proper start-up procedures, normal shut-down procedures, emergency shutdown procedures, and procedures for loading garbage (where applicable).

4.17 Flue-gas cooling

To avoid building up of dioxins, the flue gas shall be shock-cooled to a maximum (350 °C) within 2,5 m from the flue-gas outlet of the combustion chamber.

5 Electrical requirements

5.1 General requirements

Incinerator electrical components and installations, including controls, safety devices, cables, and burners, shall comply with International Electrotechnical Commission (IEC) Standards, particularly IEC 92.

5.2 Disconnects

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 potential. This disconnecting means shall be an integral part of the incinerator or adjacent to it (see 7.1).

5.3 Live parts

All uninsulated live metal parts shall be guarded to avoid accidental contact.

5.4 Failure design

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

5.5 Control-circuit connections

All electrical contacts of every safety device installed in the control circuit shall be electrically connected in series. However, special consideration shall be given to arrangements when certain devices are wired in parallel.

5.6 Component voltage ratings

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

5.7 Weather endurance

All electrical devices and electric equipment exposed to the weather shall be designed and installed according to IEC 92-201:1980, Table V.

5.8 Control device testing and acceptance

All electrical and mechanical control devices shall be of a type tested and accepted by a nationally recognized testing agency, according to International Standards.

5.9 Control-circuit design

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.

5.10 Overcurrent protection

5.10.1 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, according to IEC 92-202 (1980 edition with amendment).

5.10.2 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, or according to IEC 92-202.

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

5.11 Motors

5.11.1 All electric motors shall have enclosures corresponding to the environment where they are located. At least IP 44, according to IEC 60-529.

5.11.2 Motors shall be provided with a corrosion-resistant nameplate specifying information in accordance with IEC 92-301.

5.11.3 Motors shall be provided with running protection by means of integral thermal protection, by overcurrent devices, or a combination of both in accordance with a manufacturer's instruction that shall be in accordance with IEC 92-202.

5.11.4 Motors shall be rated for continuous duty and shall be designed for an ambient temperature of 45 °C or higher.

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

5.12 Ignition systems

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

5.12.2 Ignition transformers shall have an enclosure corresponding to the environment where they are located. At least IP 44 according to IEC 529.

5.12.3 The ignition cable shall conform to the requirements of IEC 92-503.

5.13 Wiring

All wiring on shipboard incinerators shall be rated and selected in accordance with IEC 92-352.

5.14 Bonding

5.14.1 Means shall be provided for grounding the major metallic frame or assembly of the incinerators. Noncurrent carrying enclosures, frames, and similar parts of all electrical components and devices shall be bonded to the main frame or assembly of the incinerator. Electrical components that are bonded by their installation do not require a separate bonding conductor.

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

6 Materials

The materials used in the individual parts of the incinerator shall be suitable for the intended application with respect to heat resistance, mechanical properties, oxidation, corrosion, etc. as in other auxiliary marine equipment.

7 Operating controls

7.1 Disconnect switch

The entire unit shall be capable of being disconnected from all sources of electricity by means of one disconnect switch located near the incinerator (see 5.2).

7.2 Emergency stop switch

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 a flue gas fan, the fan shall be capable of being restarted independently of the other equipment on the incinerator.

7.3 Control equipment failures

7.3.1 General provisions

Control equipment shall be designed so that any failure of the equipment listed in 7.3.2 to 7.3.4 will prevent continued operation of the incinerator and cause the fuel supply to stop.

7.3.2 Safety thermostat/draft

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

7.3.2.2 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.

7.3.2.3 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/negative pressure in the incinerator during operations. The circuit to the program relay for the burner will be opened and an alarm activated before the negative pressure rises to atmospheric pressure.

7.3.3 Flame failure/low oil pressure

7.3.3.1 The incinerator shall have a flame safeguard control consisting of a flame sensing element and associated equipment for shut down of the unit in the event of ignition failure and flame failure during the firing cycle. The flame safeguard control shall be designed so that the failure of any component will cause a safety shut down.

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

7.3.3.3 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.

7.3.3.4 Whenever the flame safeguard control has operated because of failure of ignition, flame failure, or failure of any component, only one automatic restart may be provided. If this is not successful then manual reset of the flame safeguard control shall be required for restarting.

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

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

7.3.4 Loss of power condition

A loss of power to the incinerator control/alarm panel (not remote alarm panel), shall cause the system to shut down.

7.4 Fuel-control valves

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 and indicators

An outlet for an audible alarm shall be provided for connection to a local alarm system or a central alarm system When a failure occurs, a visible indicator shall show what caused the failure. (The indicator may cover more than one fault condition.) The visible indicators shall be designed so that, where failure is a safety-related shutdown, manual reset is required.

7.6 Fire box cooling

After shutdown of the oil burner, provision shall be made for the fire box to cool sufficiently.

EXAMPLE The exhaust fan or ejector could be designed to continue to operate.

An exhaust fan or ejector, if installed, should not continue to operate after an emergency manual shut down.

8 Other requirements

8.1 Instructions and maintenance manual

A complete instruction and maintenance manual with drawings, electric diagrams, spare parts list, etc. shall be furnished with each incinerator.

8.2 Operation while inclined

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 Energy source

Incinerators shall be fitted with an energy source with sufficient energy to ensure a safe ignition and complete combustion. The combustion shall take place at sufficient negative pressure in the combustion chamber(s), to ensure that no gases or smoke leak out to the surrounding areas (see 7.3.2.3).

8.4 Drip trays

A drip tray shall be fitted under each burner and under any pumps, strainers, etc. that require occasional inspection according to the manufacturer's maintenance instructions.

9 Testing

9.1 Prototype testing

An operating test for the prototype of each design shall be conducted, with a test report completed indicating the results of all tests. The tests 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. Tests shall include those described in 9.3.

9.2 Unit testing

For each unit, if preassembled, an operating test 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. Tests shall include those described in 9.3.

9.3 Installation tests

An operating test 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 4.13 shall be verified at the time of the installation test.

9.3.1 Flame safeguard system

The operation of the flame safeguard system shall be verified by causing flame and ignition failures. Operation of the audible alarm (where applicable) and visible indicator shall be verified. The shutdown times shall be verified.

9.3.2 Limits controls

9.3.2.1 Reducing the fuel oil pressure below the value required for safe combustion shall initiate a safety shutdown.

9.3.2.2 Other interlocks provided shall be tested for proper operation as specified by the unit manufacturer.

9.3.3 Combustion controls

The combustion controls 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.

9.3.5 Fuel control valves

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 controls

A low voltage test should be conducted on the incinerator unit to satisfactorily demonstrate 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 shall be tested to verify proper operation.

10 Certification

The manufacturer's certification that an incinerator has been constructed in accordance with this International Standard shall be provided (by letter or certificate, or in the instruction manual).

11 Marking

Each incinerator shall be permanently marked indicating the following:

— manufacturer's name or trademark;

— style, type, model or other manufacturer's designation for the incinerator;

— heat release capacity, in heat units per timed period.

The capacity shall be presented in SI units.

NOTE Additional units per time may also be given.

12 Quality assurance

12.1 Compliance with this International Standard

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

12.2 Quality assurance system

The incinerator manufacturer shall have a quality system. The production quality system shall consist of elements necessary to ensure that the incinerators are designed, tested and marked in accordance with this International Standard. At no time shall an incinerator that does not meet the requirements herein be sold with this standard designation (see clause 10).

Annex A
(normative)

Emission standard for shipboard incinerators with capacities of up to 1 500 kW on ships subject to MARPOL 73/78

A.1 Term and definition

Administration
a Government of the state whose flag the ship is entitled to fly

A.2 Type approval

An International Maritime Organization (IMO) Type Approval Certificate shall be required for each shipboard incinerator. In order to obtain such a certificate, the incinerator shall be designed and built to an IMO approved standard. Each model shall go through a specified type-approval test operation at the factory or an approved test facility, and under the responsibility of the Administration.

A.3 Test measurements

The type-approval test shall include measuring and recording the following parameters.

Parameter	Unit of measurement
Maximum capacity	kW/h or kCal/h
	kg/h of specified waste
	kg/h of specified sludge oil
Pilot fuel consumption	kg/h per burner
O_2 average in combustion chamber/zone	% by volume
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

A.4 Duration of test operation

The type-approval test duration shall be as follows for the sludge oil burning or solid waste burning:

— Sludge oil burning 6 h to 8 h

— Solid waste burning 6 h to 8 h

A.5 Fuel/waste specification for type approval test

The sludge oil or solid waste used for the type approval test shall have the following makeup.

a) Sludge oil: 75 % sludge oil from heavy fuel oil,

5 % lubricating oil,

20 % emulsified water.

b) Solid waste (Class 2): 50 % food waste,

50 % rubbish containing approximately:

- 30 % paper
- 40 % cardboard
- 10 % rags
- 20 % plastic

The mixture will have up to 50 % moisture and 7 % incombustible solids.

The waste classes are defined in Table A.1.

Table A.1 — Waste classes

Class	Definition
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 19 771 kJ/kg (8 500 BTU/lb) as fired.
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 15 119 kJ/kg (6 500 BTU/lb) as fired.
2	Refuse, consisting of an approximately even mixture of rubbish and garbage by weight. 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 10 001 kJ/kg (4 300 BTU/lb) as fired.
3	Garbage, consisting of animal and vegetable wastes from restaurants, cafeterias, galleys, sick bays and like installations. This type of waste contains up to 70 % moisture, up to 5 % incombustible solids and has a heating value range of 2 326 kJ/kg (1 000 BTU/lb) as fired.
4	Aquatic life forms and animal remains, consisting of carcasses, organs and solid organic wastes from vessels carrying animal-type cargoes, consisting of up to 85 % moisture, 5 % incombustible solids and having a heating value range of 2 326 kJ/kg (1 000 BTU/lb) as fired.
5	By-product waste, liquid or semi-liquid, such as tar, paints, solvents, sludge, oil, waste oil, etc., from shipboard operations. Heat values must be determined by the individual materials to be destroyed.
6	Solid by-product waste, such as rubber, plastics, wood waste, etc., from industrial operations. Heat values must be determined by the individual materials to be destroyed.
NOTE 1	This table is for information purposes only.
NOTE 2	Waste classes according to the Incinerator Institute of America. See IMO Resolution MEPC.(59)33.

Table A.2 gives calorific values for specific substances.

Table A.2 — Sample calorific values for specific substances

Substance	Calorific value (kJ/kg)	Calorific value (kcal/kg)
Vegetable and putrescibles	5 700	1 360
Paper	14 300	3 415
Rags	15 500	3 700
Plastics	36 000	8 600
Oil sludge	36 000	8 600
Sewage sludge	3 000	716
NOTE 1 This table is for information purposes only. NOTE 2 See IMO Resolution MEPC.76(40).		

Table A.3 gives densities for specific substances.

Table A.3 — Sample densities for specific substances

Substance	Density (kg/m^3)
Paper (loose)	50
Refuse (75 % wet)	720
Dry rubbish	110
Dry wood	190
Wood sawdust	220
General loose waste on ship	130
NOTE 1 This table is for information purposes only. NOTE 2 See IMO Resolution MEPC.76(40).	

A.6 Acceptance criteria for type-approval testing

Emissions from incinerators designed, manufactured, tested, and marked in accordance with this International Standard shall meet the emission standards shown in Table A.4.

Table A.4 — Emission standards for incinerator-type-approval testing

Measurement item	Acceptance criteria
O_2 in combustion chamber	6 % to 12 % by volume
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 during start-up)
Unburned components in ash residues	Maximum 10 % by weight
Combustion chamber flue outlet temperature range	850 °C to 1 200 °C

Flue-gas outlet temperature and O_2 content shall be measured during the combustion period, and not during the preheating or cooling periods. For a batch-loaded incinerator, it is acceptable to carry out the type-approval test by means of a single batch.

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

A.7 Fuel-related emissions

A.7.1 Oxides of sulfur

Even with good incineration technology, the emissions from an incinerator will depend on the type of material being incinerated. If, for instance, a vessel has bunkered a fuel with high sulfur content, then sludge oil from separators which is burned in the incinerator will lead to emission of SO_x. However, the SO_x emission from the incinerator would only amount to less than 1 % of the SO_x discharged with the exhaust from main and auxiliary engines.

A.7.2 Principle organic constituents

Principal organic constituents (POC) cannot be measured on a continuous basis. Specifically, there are no instruments with provision for continuous time telemetry that measures POC, HCl or waste destruction efficiency, to date. These measurements can only be made using grab sample approaches where the sample is returned to a laboratory for analysis. In the case of organic constituents (undestroyed wastes), the laboratory work requires considerable time to complete. Thus, continuous emission control can only be assured by secondary measurements.

A.7.3 On-board operation/emission controls

For a shipboard incinerator with IMO Type Approval, emission control/monitoring shall be limited to the following.

— Control/monitor O_2 content in combustion chamber (spot checks only); an O_2 analyser is not required to be kept on board.

— Control/monitor temperature in flue-gas outlet of the combustion chamber.

Continuous (auto) control of the incineration process ensures that the two above-mentioned parameters are kept within the prescribed limits. This mode of operation will ensure that particulate and ash residue contain only traces of organic constituents.

A.8 Passenger/cruise ships with incinerator installations having a total capacity of more than 1 500 kW

A.8.1 Typical conditions

On board this type of vessel, the following conditions will probably exist.

— Generation of huge amounts of burnable waste with a high content of plastic and synthetic materials.

— Incinerating plant with a high capacity operating continuously over long periods.

— This type of vessel will often be operating in very sensitive coastal areas.

A.8.2 Flue gas scrubbing

In view of the fuel-related emission from a plant of such high capacity, installation of a flue-gas seawater scrubber should be considered. This installation can perform an efficient after-cleaning of the flue gases, thus minimizing the content of

— hydrogen chloride (HCl),

— oxides of sulfur (SO_x), and

— particulate matter (PM).

A.8.3 Oxides of nitrogen

Any restriction on oxides of nitrogen (NO_x) should only be considered in connection with possible future regulations on pollution from the vessel's total pollution, i.e. main and auxiliary machinery, boilers, etc.