
**Ships and marine technology —
Shipboard incinerators —
Requirements**

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

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 2, *Marine environment protection*.

This third edition cancels and replaces the second edition (ISO 13617:2001), which has been technically revised.

The main changes compared to the previous edition are as follows:

- the document was revised for continued consistency with International Maritime Organization provisions for shipboard incinerators, which was updated in 2014;
- several updates were made to the definitions in [Clause 3](#) and to the references of standards cited in [Clause 5](#);
- updates also reflect changes in the regulations of the International Maritime Organization, *International Convention on the Safety of Life at Sea, 2014 (SOLAS)*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Ships and marine technology — Shipboard incinerators — Requirements

1 Scope

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

This document is applicable to incinerator plants with capabilities up to 4 000 kW per unit.

This document is not applicable 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 document provides emission requirements in [Annex A](#), location requirements in [Annex B](#), and flue gas temperature requirements in [Annex D](#). Recommendations for incinerators integrated with heat recovery units are given in [Annex C](#).

The activities associated with this document can 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 document to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

International Maritime Organization. *International Convention on the Safety of Life at Sea*, 2014 (SOLAS), Chapter II-2, Regulations 3 and 9

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

IEC 60092, *Electrical installations in ships*

IEC 60092-201:1994, *Electrical installations in ships — Part 201: System design — General*

IEC 60092-202:2016, *Electrical installations in ships — Part 202: System design — Protection*

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

IEC 60092-352:2005, *Electrical installations in ships — Part 352: Choice and installation of cables for low-voltage power systems*

IEC 60092-503:2007, *Electrical installations in ships — Part 503: Special features — A.C. supply systems with voltages in the range of 1 kV and up to and including 11 kV*

IEC 60529:1989 (Amd 1:1999, Amd 2:2013), *Degrees of protection provided by enclosures (IP Code)*

ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 administration

government of the state whose flag the ship is entitled to fly

3.2 cargo residues

remnants of any cargo material which are not covered by the annexes in MARPOL 73/78, except Annex V, and which remain on the deck or in holds following loading or unloading, including loading and unloading excess or spillage, whether in wet or dry conditions or entrained in wash water, but does not include cargo dust remaining on the deck after sweeping or dust on the external surfaces of the ship

Note 1 to entry: Dry bulk cargo residues may include substances that are harmful to the marine environment (HME) with special restrictions for discharges including HME entrained in cargo hold wash water. Port reception facilities for cargo residues considered to be HME may be required at loading or discharge ports handling bulk dry cargoes.

[SOURCE: MARPOL 73/78, Annex V reg. 1.2, modified — The wording “other annexes to the present (IMO) Convention” has been changed to “the annexes in MARPOL 73/78, except Annex V”.]

3.3 contaminated rag

rag that has been saturated with any substance defined in MARPOL 73/78 as potentially hazardous or harmful to human health and/or the environment

3.4 food waste

any spoiled or unspoiled food substances

EXAMPLE Fruits, vegetables, dairy products, poultry, meat products, food scraps, food particles and all other materials contaminated by such wastes, generated aboard ship.

3.5 garbage

all kinds of *food waste* (3.4), domestic waste and *operational waste* (3.9), all *plastics* (3.11), *cargo residues* (3.2), *incinerator ashes* (3.7), cooking oil, fishing gear and animal carcasses 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 the annexes in MARPOL 73/78, except Annex V

Note 1 to entry: Garbage does not include fresh fish and parts thereof generated as a result of fishing activities undertaken during the voyage, or as a result of aquaculture activities which involve the transport of fish including shellfish for placement in the aquaculture facility and the transport of harvested fish including shellfish from such facilities to shore for processing.

[SOURCE: MARPOL 73/78, Annex V reg. 1]

3.6 incinerator

shipboard facility designed for the primary purpose of incineration of waste, such as domestic waste, cargo-associated waste, *maintenance waste* (3.8), *operational waste* (3.9), *cargo residues* (3.2) and fishing gear

Note 1 to entry: These facilities may be designed to use or not use the heat energy produced.

3.7**incinerator ashes**

ash and clinkers resulting from shipboard *incinerators* (3.6) used for incineration of *garbage* (3.5)

[SOURCE: MARPOL 73/78, Annex V reg. 1.10]

3.8**maintenance waste**

materials collected by the engine department and the deck department while maintaining and operating the ship

EXAMPLE Soot, machinery deposits, scraped paint, deck sweepings, wiping wastes, *oily rags* (3.10), etc.

3.9**operational waste**

all solid waste (including slurries) not covered by the annexes in MARPOL 73/78, except Annex V, that are collected on board during normal maintenance or operations of a ship, or used for cargo stowage and handling, including *cargo residues* (3.2)

Note 1 to entry: Operational waste includes, but is not limited to, the following wastes associated with cargo stowage and handling: dunnage, shoring, *incinerator ashes* (3.7), pallets, lining, transit and packing materials, plywood, paper, cardboard, wire, plastic wrapping and steel strapping.

Note 2 to entry: Operational waste also includes cleaning agents and additives contained in external wash water.

Note 3 to entry: Operational waste does not include grey water, bilge water or other similar discharges essential to the operation of a ship.

Note 4 to entry: Wooden material may be defined as quarantine waste in certain countries.

[SOURCE: MARPOL 73/78, Annex V reg. 1.12]

3.10**oily rag**

rag which has been saturated with oil as controlled in Annex I to MARPOL 73/78

3.11**plastic**

solid material which contains, as an essential ingredient, one or more high molecular mass 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 1 to entry: 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, synthetic rope and line, and *incinerator ashes* (3.7) from plastic products.

3.12**ship**

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

3.13**sludge oil**

sludge from the fuel oil lubricating oil separators, waste lubricating oil from main or auxiliary machinery, or waste oil from bilge water separators, oil filtering equipment or drip-trays, etc.

3.14**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. Non-metallic materials shall not be used for fuel lines. Valves and fittings may be threaded in sizes up to and including 60 mm outer diameter, but threaded unions shall not 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

Incinerator walls shall 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.

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).

The outside surface of the combustion chamber(s) shall be shielded from contact such that personnel are not 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 is 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 insured, e.g. by a supplementary burner using gas/diesel oil or equivalent.

4.6 Combustion chamber

The combustion chamber(s) shall be designed for easy maintenance of all the 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 can 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 is 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 moves to the combustion chamber. Such systems shall be designed such that both the operator and the 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 the combustion chamber: 1 200 °C;
- minimum flue-gas-outlet temperature of the combustion chamber: 850 °C;
- pre-heat temperature of the 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 Pre-purging and post-purging

Incinerator controls shall include the following purge cycles.

- Pre-purge, before ignition: at least four air charges in the chamber(s) and stack, but not less than 15 s.
- Time between restarts: at least four air charges in the chamber(s) and stack, but not less than 15 s.
- Post-purge, after the shut-off of the fuel oil: not less than 15 s after the closing of the fuel-oil valve.

4.14 Mass fraction of oxygen in the discharge gases

Incinerators shall be designed so that the incineration produces a minimum of 60 g/kg 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 the doors to the 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 shut-down 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 of 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 IEC 60092.

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 risks. This means of disconnecting 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 contacts.

5.4 Failure design

The electrical equipment shall be arranged so that a failure of this equipment causes 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 60092-201:1994, 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 facility meeting ISO/IEC 17025.

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 the combustion units.

5.10 Overcurrent protection

Conductors for the interconnecting wiring that are 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 60092-202:2016.

Overcurrent protection for the 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 60092-202:2016.

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

5.11 Motors

All electric motors shall have enclosures corresponding to the environment where they are located, at least IP 44, according to IEC 60529:1989 (Amd 1:1999, Amd 2:2013).

Motors shall be provided with a corrosion resistant nameplate specifying information in accordance with IEC 60092-301:1980.

Motors shall be provided with running protection by means of integral thermal protection, overcurrent devices, or a combination of both in accordance with a manufacturer's instruction that shall be in accordance with IEC 60092-202:2016.

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

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

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.

Ignition transformers shall have an enclosure corresponding to the environment where they are located, at least IP 44 according to IEC 60529:1989 (Amd 1:1999, Amd 2:2013).

The ignition cable shall conform to the requirements of IEC 60092-503:2007.

5.13 Wiring

All wiring on shipboard incinerators shall be rated and selected in accordance with IEC 60092-352:2005.

5.14 Bonding

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

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](#) prevent continued operation of the incinerator and cause the fuel supply to stop.

7.3.2 Safety thermostat

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

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

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 is opened and an alarm activated before the negative pressure rises to the atmospheric pressure.

7.3.3 Flame failure/low oil pressure

The incinerator shall have a flame safeguard control consisting of a flame sensing element and associated equipment for the shut-down of the unit in the event of ignition failure during the firing

cycle. The flame safeguard control shall be designed so that the failure of any component causes a safety shutdown.

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

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 a flame. If the flame is not established within 10 s, the fuel supply to the burners shall be immediately shut off automatically.

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

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

If the fuel oil pressure drops below that set by the manufacturer, a failure and a lockout of the programme relay shall occur. This also applies to a sludge oil burner. (This applies where the 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 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, a manual reset is required.

7.6 Fire box cooling

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

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

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

8 Other requirements

8.1 Instruction and maintenance manual

A complete instruction and maintenance manual with drawings, electrical 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 a 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](#)).

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 conditions. Tests shall include those described in [9.3](#).

9.2 Factory 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 conditions. 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 conditions. The requirements for pre-purge 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. The operation of the audible alarm (where applicable) and visible indicator shall be verified. The shutdown times shall be verified.

9.3.2 Limit controls

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

Other interlocks provided shall be tested for the 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 the 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 is automatically shut off before an incinerator malfunction results from the reduced voltage.

9.3.7 Switches

All switches shall be tested to verify the proper operation.

10 Certification

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

11 Marking

Each incinerator shall be permanently marked indicating the following:

- the manufacturer's name or trademark;
- the style, type, model or other manufacturer's designation for the incinerator; and
- the heat release capacity, in heat units per timed period.

The capacity shall be presented in SI units.

Additional units per time may also be given.

12 Quality assurance

The incinerator manufacturer shall have a quality system. The production quality system shall consist of the elements necessary to ensure that the incinerators are designed, tested and marked in accordance with this document. 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 requirements for shipboard incinerators with capacities of up to 4 000 kW on ships subject to MARPOL

A.1 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.2 Test measurements

The type-approval test shall include measuring and recording the parameters specified in [Table A.1](#).

Table A.1 — Parameters for the type-approval test

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 the combustion chamber/zone	% by volume
CO average in the 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 mass

A.3 Duration of the 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.4 Fuel/waste specification for the 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 from heavy fuel oil, 5 % lubricating oil and 20 % emulsified water.
- b) Solid waste (Class 2): 50 % food waste and 50 % rubbish containing approximately: 30 % paper, 40 % cardboard, 10 % rags and 20 % plastic.

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

The waste classes are defined in [Table A.2](#).

Table A.2 — 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 mass of plastic bags, coated paper, laminated paper, treated corrugated cardboard, oily 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 mass 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 mass. 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 (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 ships 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, solids, solvents, sludge, oil, waste oil, etc. from shipboard operations. Heat values shall 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 shall be determined by the individual materials to be destroyed.
NOTE 1 This table is for information purposes only.	
NOTE 2 Waste classes are in accordance with the Incinerator Institute of America.	

[Table A.3](#) gives calorific values for specific substances.

Table A.3 — 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.244(66).		

[Table A.4](#) gives densities for specific substances.

Table A.4 — 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.244(66).	

Table A.5 presents options for the incineration of garbage and includes considerations for special handlings by the ship's personnel, combustibility, the reduction in volume, residual materials, the exhaust and on-board storage space.

Table A.5 — Incineration options for ship-generated garbage

Examples of garbage	Special handling by the vessel personnel before incineration ^a	Incineration characteristics				On-board storage space
		Combustibility	Reduction of volume	Residual	Exhaust	
Paper Packing, food and beverage containers	Minor – easy to feed into the hopper	High	Over 95 %	Powder ash	Possibly smoky and not hazardous	Minimum
Fibre and paper board	Minor – reduce the material to size for feed, minimum manual labour	High	Over 95 %	Powder ash	Possibly smoky and not hazardous	Minimum
Plastics packaging, food and beverage containers, etc.	Minor – easy to feed into the hopper	High	Over 95 %	Powder ash	Possibly smoky and not hazardous based on the incinerator design	Minimum
Plastics sheeting, netting, rope and bulk material	Moderate – manual labour time to size the reduction	High	Over 95 %	Powder ash	Possibly smoky and not hazardous based on the incinerator design	Minimum
NOTE 1 This table is for information purposes only.						
NOTE 2 See IMO Resolution MEPC.219(463) Guidelines for the implementation of MARPOL Annex V.						
^a On-board incinerator operator(s) should be trained and familiar with the use of the equipment and the types of garbage that can be destroyed in the incinerator.						

Table A.5 (continued)

Examples of garbage	Special handling by the vessel personnel before incineration ^a	Incineration characteristics				On-board storage space
		Combustibility	Reduction of volume	Residual	Exhaust	
Rubber hoses and bulk pieces	Major – manual labour time to size the reduction	High	Over 95 %	Powder ash	Possibly smoky and not hazardous based on the incinerator design	Minimum
Metal food and beverage containers, etc.	Minor – easy to feed into the hopper	Low	Less than 10 %	Slag	Possibly smoky and not hazardous	Moderate
Metal cargo, bulky containers, thick metal items	Major – manual labour time to size the reduction (not easily incinerated)	Very low	Less than 5 %	Large metal fragments and slag	Possibly smoky and not hazardous	Maximum
Glass food and beverage containers, etc.	Minor – easy to feed into the hopper	Low	Less than 10 %	Slag	Possibly smoky and not hazardous	Moderate
Wood, cargo containers and large wood scraps	Moderate – manual labour time to size the reduction	High	Over 95 %	Powder ash	Possibly smoky and not hazardous	Minimum
NOTE 1 This table is for information purposes only.						
NOTE 2 See IMO Resolution MEPC.219(463) Guidelines for the implementation of MARPOL Annex V.						
^a On-board incinerator operator(s) should be trained and familiar with the use of the equipment and the types of garbage that can be destroyed in the incinerator.						

A.5 Acceptance criteria for type-approval testing

Emissions from incinerators designed, manufactured, tested and marked in accordance with this document shall meet the emission requirements shown in [Table A.6](#).

Table A.6 — Emission requirements for incinerator type-approval testing

Measurement item	Acceptance criteria
O ₂ in the combustion chamber	6 % to 12 %
CO in the 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 mass
Flue gas temperature 2,5 m from the flue gas outlet of the combustion chamber	Maximum 350 °C
Combustion chamber flue outlet temperature range	850 °C to 1 200 °C

The flue-gas-outlet temperature and O₂ 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.

The unburned components are determined by removing the ash residues from the combustion chamber after type testing. A representative sample is then selected and the unburned fraction is measured as loss of ignition (e.g. according to EN 15169).

The acceptance criteria in [Table A.6](#) are minimum requirements which shall be met without additional means for flue gas cleaning such as scrubbers or filter technologies.

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 dioxins, VOC (Volatile Organic Compounds) and emissions.

A.6 Fuel-related emissions

A.6.1 Oxides of sulphur

Even with good incineration technology, the emissions from an incinerator depend on the type of material being incinerated. If, for instance, a ship has bunkered a fuel with a high sulphur content, then the sludge oil from separators which is burned in the incinerator will lead to the 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 the main and auxiliary engines.

A.6.2 Principal organic hazardous constituents

Principal organic hazardous constituents (POHC) cannot be measured on a continuous basis. Specifically, there are no instruments with provisions for continuous time telemetry that measures POHC, 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 a considerable amount of time to complete. Thus, continuous emission control can only be assured by secondary measurements.

A.6.3 On board operation/emission controls

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

- control/monitor the O₂ content in the flue-gas-outlet of the combustion chamber (spot checks only); an O₂ analyser is not required to be kept on board;
- control/monitor the temperature in the flue-gas-outlet of the combustion chamber.

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

A.7 Passenger/cruise ships with incinerator installations having a total capacity of more than 1 500 kW

A.7.1 Typical conditions

On-board this type of ship, the following conditions 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 ship is often operating in very sensitive coastal areas.

A.7.2 Flue gas scrubbing

In view of the fuel-related emission from a plant of such high capacity, the 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 sulphur (SO_x), and
- particulate matter (PM).

A.7.3 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 ship's total pollution, i.e., main and auxiliary machinery, boilers, etc.

Annex B (normative)

Location requirements for incinerators

B.1 Application of International Maritime Organization (IMO) documents

For the purpose of construction, arrangement and insulation, incinerator spaces and waste stowage spaces shall be treated as category A machinery spaces in accordance with SOLAS II-2/3.31, and trash stowage rooms shall be treated as service spaces (high risk) in accordance with SOLAS II-2/3.45, respectively. To minimize the fire hazards that these spaces represent, the SOLAS requirements in chapter II-2 given in [B.2](#) and [B.3](#) shall apply.

B.2 Passenger ships

- Regulation 9.2.2.3.2.2 (12) shall apply to incinerator and combined incinerator/waste storage spaces, and the flue uptakes from such spaces; and
- Regulation 9.2.2.3.2.2 (12) shall apply to the waste storage spaces and garbage chutes connected thereto.

B.3 All other ships, including ships not carrying more than 36 passengers

The incinerator space shall meet either:

- Regulation 9.2.3.3.2.2 (6), which shall apply to incinerator and combined incinerator/waste storage spaces, and the flue uptakes from such spaces; and
- Regulation 9.2.3.3.2.2 (9), which shall apply to waste storage spaces and garbage chutes connected thereto.

B.4 Location on the open deck

Incinerators and waste storage may be located on the open deck without being structurally separated or required to have any fire detection or fixed fire-extinguishing system, provided both the incinerator and waste storage areas are

- located as far aft as possible on the ship;
- not less than 3 m from entrances, air inlets and openings to accommodations, service spaces and control stations;
- not less than 5 m away from the nearest hazardous area, or vent outlet from a hazardous area; and
- the distance of separation between the incinerator and waste material storage area is not less than 2 m, unless some structural fire barrier exists between them.

B.5 Underdeck fire-fighting equipment

A fixed fire detection and fire-extinguishing system shall be installed in enclosed spaces containing incinerators, in combined incinerator/waste storage spaces, and in any waste storage space in accordance with [Table B.1](#).