CONTENTS

INCINERATOR OPERATION & GARBAGE IDENTIFICATION

1. INTRODUCTION

Incinerator furnace and combustion equipment are to be properly maintained with regular testing of safety and interlocks as per planned maintenance and manufacturer's instructions. Combustion chamber and components of burner assembly are to be inspected/overhauled from time to time and records maintained.

All combustion related component parts including burner, igniter, combustion fan, booster pumps, pipelines, instrumentation, alarms, cut outs and furnace integrity must be verified prior to each operation. Door sealing arrangements and the associated safety functions are to be verified as applicable. Incinerator to be operated within its design criteria which includes maximum waste loads or supply of waste oil for burning. The operator is to verify the exhaust trunking is clear.

All ships are required to possess operation instruction manual and Chief Engineer Officer to ensure new on-signers have been trained on incinerator operations in accordance with the manufacturer's operating manual before assigning independent duty.

The warning notice, operating procedure and instructions are to be displayed at the unit.

The incineration should not be undertaken when the ship is in port or at offshore terminal. Some ports may have domestic laws that specify additional air emission restrictions. The use of a shipboard incinerator may require permission from the port authority concerned.

Incineration shall not be undertaken when ship is in the Baltic Sea Area.

The Second Engineer is responsible for the safe operation and loading of the Incinerator. The garbage mixes placed within the incinerator are to be strictly controlled by the Second Engineer in accordance with Marpol / Incinerator Instruction manual guidance.[1]

2. REGULATION 16 – SHIPBOARD INCINERATION (EXTRACT FROM MARPOL)[2]

2.1. Except as provided in paragraph 4 of this regulation, shipboard incineration shall be allowed only in a shipboard incinerator.

2.2. Incineration of the following substances shall be prohibited:

2.2.1. Residues of cargoes subject to Annex I, II or III or related contaminated packing materials.

2.2.2. Polychlorinated biphenyls (PCBs).

2.2.3. Garbage, as defined by Annex V, containing more than traces of heavy metals;

[1] W 32 / 2018
[2] W 32 / 2018 (Entire Section 2)

2.2.4. Refined petroleum products containing halogen compounds.

2.2.5. sewage sludge and sludge oil either of which are not generated on board the ship; and

2.2.6. exhaust gas cleaning system residues.

2.3. Shipboard incineration of polyvinyl chlorides (PVCs) shall be prohibited, except in shipboard incinerator for which an IMO Type Approval Certificates7 has been issued.

Type Approval Certificates issued in accordance with resolution MEPC. 59(33) or MEPC. 76(40).

The burning of arousals and cans containing aerosols is prohibited.

The burning of PVC and Polystyrene and Neoprene is prohibited. This must be landed for disposal as it produced dioxins when burnt. See guidance notes below on how to identify your plastics

Plastics are particularly attractive for burning, as they're made with petroleum and generate more energy when incinerated than almost any other material. Some oil-based plastics like polythene are an efficient fuel and burns in the same way oil does. The below is a guide of the calorific values in Kcal/kg of waste that can be generated on board.

2.4. PCB's

A polychlorinated biphenyl (PCB) is an organic chlorine compound with the formula C12H10−xClx. They were once widely deployed as dielectric and coolant fluids in electrical apparatus, carbonless copy paper and in heat transfer fluids. Because of their longevity, PCBs are still widely in use, even though their manufacture has declined drastically since the 1960s, when a host of problems were identified. Because of PCBs' environmental toxicity and classification as persistent organic pollutants, PCB production was banned by United States federal law in 1978 and by the Stockholm Convention on Persistent Organic Pollutants in 2001. The International Agency for Research on Cancer (IARC), rendered PCBs as definite carcinogens in humans. They do not easily break down or degrade, which made them attractive for industries. PCB mixtures are resistant to acids, bases, oxidation, hydrolysis, and temperature change. They can generate extremely toxic dibenzodioxins and dibenzofurans through partial oxidation. The compounds are pale-yellow viscous liquids. They are hydrophobic, with low water solubilities, but they have high solubilities in most organic solvents, oils, and fats. They have low vapor pressures at room temperature. They have dielectric constants of 2.5–2.7, very high thermal conductivity and high flash points from 170 °C to 380 °C.

2.5. Heavy Metals

Common sources of heavy metals include mining and industrial wastes; vehicle emissions; lead-acid batteries; fertilisers; paints; and treated timber. Toxic heavy metal is any relatively dense metal or metalloid that is noted for its potential toxicity, especially in environmental contexts. The term has particular application to cadmium, mercury, lead and arsenic, all of which appear in the World Health Organisation's list of 10 chemicals of major public concern.

Other examples include manganese, chromium, cobalt, nickel, copper, zinc, selenium, silver, antimony and thallium.

Heavy metals are found naturally in the earth. They become concentrated as a result of human activities and can enter plant, animal, and human tissues via inhalation, diet, and manual handling. Then, they can bind to and interfere with the functioning of vital cellular components. Some elements otherwise regarded as toxic heavy metals are essential, in small quantities(trace), for human health.

Chromium, arsenic, cadmium, mercury, and lead have the greatest potential to cause harm on account of their extensive use, the toxicity of some of their combined or elemental forms, and their widespread distribution in the environment. Hexavalent chromium, for example, is highly toxic as are mercury vapour and many mercury compounds. These five elements have a strong affinity for sulphur; in the human body they usually bind, via thiol groups (–SH), to enzymes responsible for controlling the speed of metabolic reactions. The resulting sulphur-metal bonds inhibit the proper functioning of the enzymes involved; human health deteriorates, sometimes fatally.

Chromium (in its hexavalent form) and arsenic are carcinogens; cadmium causes a degenerative bone disease; and mercury and lead damage the central nervous system.

Lead is the most prevalent heavy metal contaminant. Levels in the aquatic environments of industrialised societies have been estimated to be two to three times those of pre-industrial levels. As a component of tetraethyl lead, (CH3CH2)4Pb, it was used extensively in gasoline during the 1930s–1970s.

Other heavy metals noted for their potentially hazardous nature, usually as toxic environmental pollutants, include manganese (central nervous system damage); cobalt and nickel (carcinogens); copper, zinc, selenium and silver (endocrine disruption, congenital disorders, or general toxic effects in fish, plants, birds, or other aquatic organisms); tin, as organotin (central nervous system damage); antimony (a suspected carcinogen); and thallium (central nervous system damage).

Trace amounts of some heavy metals, are required for certain biological processes. These are iron and copper (oxygen and electron transport); cobalt (complex syntheses and cell metabolism); zinc (hydroxylation); vanadium and manganese (enzyme regulation or functioning); chromium (glucose utilisation); nickel (cell growth); arsenic (metabolic growth in some animals and possibly in humans) and selenium (antioxidant functioning and hormone production). The heavier elements tend to be less abundant and therefore the scarcer elements are less likely to be nutritionally essential.

Molybdenum is required for the catalysis of redox reactions; cadmium is used by some marine diatoms for the same purpose; and tin may be required for growth in a few species. Tungsten is required by some archaea and bacteria for metabolic processes. A deficiency of any of the essential heavy metals may increase susceptibility to heavy metal poisoning (conversely, an excess may also have adverse biological effects). An average 70 kg human body is about 0.01% heavy metals (trace ~7 g, equivalent to the weight of two dried peas, with iron at 4 g,

zinc at 2.5 g, and lead at 0.12 g comprising the three main constituents), 2% light metals (~1.4 kg, the weight of a bottle of wine) and nearly 98% non-metals (mostly water).

A few non-essential heavy metals have been observed to have biological effects. Gallium, germanium (a metalloid), indium, and most lanthanides can stimulate metabolism, and titanium promotes growth in plants (though it is not always considered a heavy metal).

2.6. Refined Halogen Compounds

A halogen is an element in the seventh column of the periodic table of elements, e.g. fluorine, chlorine, bromine or iodine. A halogenated volatile organic compound (VOC) is a VOC with one of those elements. Both synthetic and organic compounds that include a halogen are considered to be halogenated compounds; this includes compounds like carbon tetrachloride. Some of these halogenated compounds, especially those that are considered halogenated volatile organic compounds, are very dangerous and can be highly a harmfully toxic, carcinogenic or mutagenic to humans and other animals. For example, there are several pesticides, including the notoriously dangerous chemical pesticide, DDT, that are halogenated compounds. Nonhalogenated compounds are generally more easily degraded by bacteria.

Chlorofluorocarbons (CFCs) are fully halogenated paraffin hydrocarbons that contain only carbon (C), chlorine (Cl), and fluorine (F), produced as volatile derivative of methane, ethane, and propane. They are also commonly known by the DuPont brand name Freon. The most common representative is dichlorodifluoromethane (R-12 or Freon-12). Many CFCs have been widely used as refrigerants, propellants (in aerosol applications), and solvents. Because CFCs contribute to ozone depletion in the upper atmosphere, the manufacture of such compounds has been phased out under the Montreal Protocol, and they are being replaced with other products such as hydrofluorocarbons HFCs R-410A and R-134a.

CALORIFIC VALUES MEASURED IN SOME WASTE PRODUCTS SHOWN IN KCAL/KG

Kitchen waste	945	Acetone	6,667
Acetic acid	3,490	Natural rubber	6,672
Glass fiber	3,615	Disposable plastics	6,783
Wallpaper	3,695	Bakelite	6,950
Cardboard	3,786	Neoprene	7,065
Corrugated paper	3,916	Ethanol	7,400
Wrapping paper (brown)	4,034	Nylon	7,573
Cellulose	4,200	Car rubber tyres	8,123
Cotton	4,216	Waste oil	8,333
Chips from joiners shop	4,281	Butane	8,768
Carbon paper	4.361	ABS plastic	9,200
Shoe factory waste	4,380	Pork, lard	9,300
Newspapers	4,437	Olive oil	9,335
Dry cortex from spruce	4,500	Turpentine	9,444
Wool	4,590	Polyethylene remains	9,700
Dry cortex from fir	4,750	Paraffin	9,800
telex paper	4,758	Polystyrene	9,840
Uppers of shoes	4,882	Benzene/Benzol	10,116
PVC film	5,365	Wax paraffin	10,345
Dry cortex from birch	5,450	Kerosene	10,500
Polymeric film	5,542	Glass fiber strengthened by synthetic resin	10,840
Tar acid	5,600	White spirit	10,960
Methylated alcohol	5,695	Polythenes	11,000
Car motor oil	5,722	Polypropylene	11,040
Lienin	6,100	Polyethylene bottles	11,111
Cork waste	6,300		
Laminated paper	6,311		
Polystyrene	6,438		

IMO defines Solid Waste Class Ⅱ as follows expressed in percentages:
50% Food waste
50% Rubbish containing approx 30% paper, 40% cardboard, 10% rags, 20% plastic
The mixture will have up to 50% moisture and 7% incombustible solids.

Incinerators should only be used to incinerate materials that are specified by the incinerator manufacturer.

The incinerator was developed for burning a mix of waste, please refer to the IMO-specification of mixed waste below. The temperature in the combustion chamber will be much more stable, if the plastic is mixed up with other waste, that does not ignite rapidly thus reducing the rapid rise in temperature.

Note that in general, the calorific value of waste is far below the calorific value of sludge oil, so it must be foreseen, that while the waste is burning out, the diesel oil burners should operate. A good practice of operating the incinerator is to burn sludge oil for some hours, so the incinerator is preheated, then change to solid waste. When the temperature starts dropping because the

comestibles in the waste have been consumed, change back to sludge burning to ensure all the waste is turned into ash. This will reduce the diesel oil consumption and ensure efficient burning of the waste.

The incineration of garbage that contains a large amount of plastic involves very specific incinerator settings such as higher oxygen injection and higher temperatures (850 to 1,200°C). If these special conditions are not met, depending on the type of plastic and conditions of combustion, some toxic gases can be generated in the exhaust stream, including vaporized hydrochloric (HCl) and hydrocyanic (HCN) acids. These and other intermediary products of combustion of waste containing plastics are toxic to humans and marine life.

Incinerator ash is to be discharged to shore reception facility.

Record of incineration operation is to be maintained in Oil Record Book and/or Garbage Log Book as required.

2.6.1. Protocol of 1997 to amend MARPOL 73/78

Appendix IV
Type approval and operating limits for shipboard Incinerators (Regulation 16)

i. Shipboard Incinerators described in regulation 16(2) shall possess an IMO type approval certificate for each incinerator. In order to obtain such certificate, the incinerator shall be designed and built to an approved standard as described in regulation 16(2). Each model shall be subject to a specified type approval test operation at the factory or an approved test facility, and under the responsibility of the Administration, using the following standard fuel/waste specification for the type approval test for determining whether the incinerator operates within the limits specified in paragraph (2) of this appendix:

   Sludge oil consisting of:

   - 75% Sludge oil from HFO;
   - 5% waste lubricating oil; and
   - 20% emulsified water

   Solid waste consisting of:

   - 50% food waste
   - 50 % rubbish containing. approx. 30% paper, 40% cardboard, 10% rags, 20% plastic
   - The mixture will have up to 50% moisture and 7% incombustible solids.

ii. Incinerators described in regulation 16(2) shall operate within the following limits:

   - O2 in combustion chamber: 6-12%;

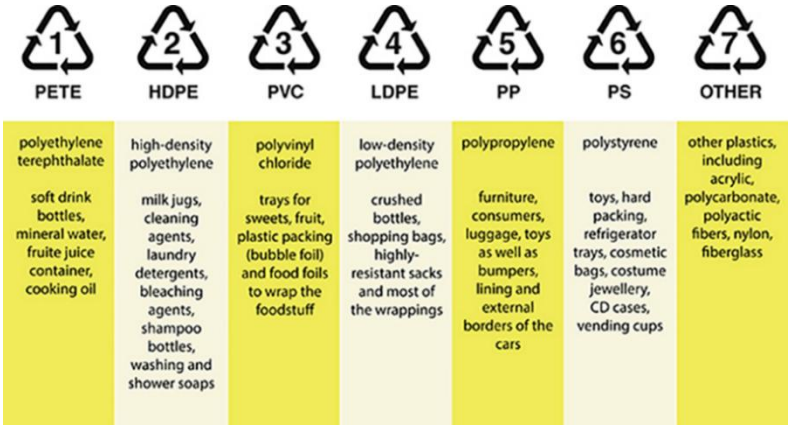
- CO in flue gas maximum average: 200 mg/MJ
- Soot number maximum average: Bacharach 3 or Ringelman 1 (20% opacity) (A higher soot number is acceptable only during very short periods such as starting up)
- Unburned components in ash residues: maximum 10% by weight
- Combustion chamber flue gas outlet temperature range: 850-1200°C

2.7. Introduction to Plastics

In an ideal world it would be great to land all plastics for potential recycling, but this generally proves to be problematic either due to port regulations, if left uncontrolled it ends up cluttering the aft decks therefore incineration does become necessary. Plastics are particularly attractive for burning, as they're made with petroleum and generate more energy when incinerated than almost any other material. Some oil-based plastics like polythene are an efficient fuel and burns in the same way oil does.

It's best if possible to avoid using all plastics if you're able. But at the very least: Avoid recycling symbols 3, 6, and 7. While Number 1 is considered safe, it is also best to avoid this plastic. Look for symbols 2, 4, and 5, as these plastics are considered to be safest. These are the plastics to look for in terms of storage of food for human and animal consumption.

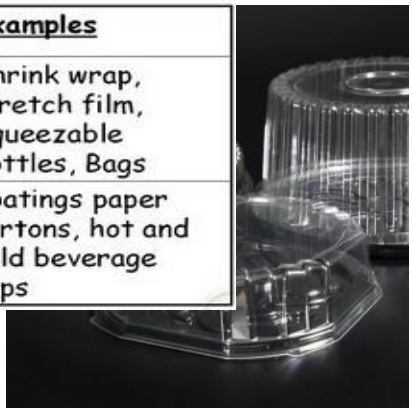
2.7.1. Understanding the Signs - Your guide to Plastic



2.7.1.1. Polyethylene Terephthalate (PET)

It's found mostly in soda bottles, water bottles, beer bottles, salad dressing containers, mouthwash bottles, and peanut butter containers and some packaging. It is recycled into tote bags, furniture, carpet, paneling, fiber, and polar fleece. It is intended for single use applications; repeated use increases the risk of leaching and bacterial growth. PET plastic is difficult to decontaminate, and proper cleaning requires harmful chemicals. Polyethylene terephthalates may leach carcinogens.

Properties	Examples
Toughness, flexibility	Shrink wrap, stretch film, Squeezable bottles, Bags
Relative transparency	
Excellent resistance to acids, bases, vegetable oils	Coatings paper cartons, hot and cold beverage cups



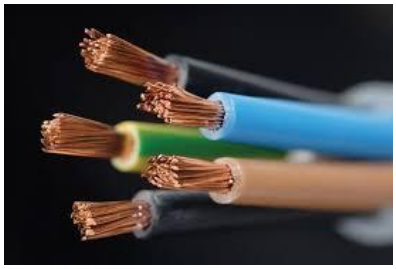
2.7.1.2. High Density Polyethylene (HDPE)

Is typically opaque and is one of the 3 plastics considered to be safe and has a lower risk of leaching. It's found mostly in milk jugs, household cleaner containers, juice bottles, shampoo bottles, cereal box liners, detergent bottles, motor oil bottles, yogurt tubs, and butter tubs. Milk jugs, detergent bottles, juice bottles, butter tubs, and toiletries bottles are made of this. It is usually opaque. This plastic is considered safe and has low risk of leaching. HDPE plastic is very hard-wearing and does not break down under exposure to sunlight or extremes of heating or freezing. For this reason, HDPE is used to make picnic tables, plastic lumber, waste bins, park benches, bed liners for trucks and other products which require durability and weather-resistance. It is also used for Wilhelmsen chemical storage drums.

Properties	Examples
Moisture barrier	Soft drinks beer bottles etc.
Gas Barrier	
Impact resistance	Food jars for jam, butter etc.
Shatter resistance	
High melt temp.	Oven trays, ready meals

2.7.1.3. Polyvinyl Chloride (PVC)

It is used to make food wrap, plumbing pipes, and detergent bottles, and is seldom accepted by curbside recycling programs. These plastics used to, and still may, contain phthalates, which are linked to numerous health issues ranging from developmental problems to miscarriages. They also contain DEHA, which can be carcinogenic with long-term exposure. DEHA has also been linked to loss of bone mass and liver problems. Don't cook with or burn this plastic. It's found in shampoo bottles, clear food packaging, cooking oil bottles, medical equipment, piping, and windows. It is recycled into paneling, flooring, speed bumps, decks, and roadway gutters.



Properties	Examples
Barrier to grease, oil and chemicals	Deli foods, cakes, meat etc.
Brilliant clarity	Blister packs, clamshells
Excellent processing performance	Cheap trays

2.7.1.4. Low Density Polyethylene (LDPE)

Low density polyethylene is most found in squeezable bottles, shopping bags, clothing, carpet, frozen food, bread bags, and some food wraps. Curbside recycling programs haven't been known to pick up this plastic, but more are starting to accept it. Plastic #4 rests among the recycling symbols considered to be safe.

This plastic is recycled into compost bins, paneling, trash can liners and cans, floor tiles, and shipping envelopes.

Low Density Polyethylene Market

Properties	Examples
Toughness, flexibility	Shrink wrap, stretch film, Squeezable bottles, Bags
Relative transparency	
Excellent resistance to acids, bases, vegetable oils	Coatings paper cartons, hot and cold beverage cups

2.7.1.5. Polypropylene (PP)

It is one of the safer plastics to look for. It is typically found in yogurt containers, ketchup bottles, syrup bottles, and medicine bottles. Polypropylene is recycled into brooms, auto battery cases, bins, pallets, signal lights, ice scrapers, and bicycle racks.

Properties	Examples
Brilliant clarity in films and stretch blow moulded containers	Containers for yogurt, margarine, takeout meals, & deli foods.
Moisture Barrier	Bottle caps, closures.
Inert towards acids, alkalis, solvents	Medicine bottles.

2.7.1.6. Polystyrene (PS)

Polystyrene is Styrofoam, which is notorious for being difficult to recycle, and thus, bad for the environment. This kind of plastic also poses a health risk, leaching potentially toxic chemicals, especially when heated. Most recycling programs won't accept it. It is found in compact disc cases, egg cartons, meat trays, and disposable plates and cups. It is recycled into egg cartons, vents, foam packing, and insulation.

Properties	Examples
Excellent Moisture barrier (for short shelf life products)	Cups, plates, cutlery, food containers (e.g. yogurt)
Brilliant Clarity	meat and poultry trays.
Significant stiffness	Protective foam packaging and "loose fill"
Excellent insulation (as foam)	

2.7.1.7. Other

All of the plastic resins that don't fit into the other categories are placed in the number 7 category. It's a mix bag of plastics that includes polycarbonate, which contains the toxic bisphenol-A (BPA). These plastics should be avoided due to possibly containing hormone disruptors like BPA, which has been linked to infertility, hyperactivity, reproductive problems, and other health issues. It is found in sunglasses, iPod cases, computer cases, nylon, 3- and 5-gallon water bottles, and bullet-proof materials. It is recycled into plastic lumber and other custom-made products.

Properties	Examples
Dependent on resin, or combination of resins	Oven-baking bags, barrier layers, custom packaging