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The INF Ship



fact sheet
no.5

Dedicated to the safe, efficient and
reliable transport of radioactive materials

The INF Ship

Introduction

The principal regulations for the transport of radioactive material are the International Atomic Energy Agency (IAEA) Safe Transport of Radioactive Material Regulations (TS-R-1:2005 Edition) which were first published in 1961. The Regulations have been revised regularly since then to keep pace with scientific and technological developments. The philosophy of the Regulations is that safety is ensured primarily by the package whatever the mode of transport. The regulations cover both normal and potential accident conditions of transport to protect people, property and the environment against the effects of radiation.

In 1993, the International Maritime Organization (IMO) introduced the voluntary Code for the Safe Carriage of Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes on Board Ships (INF Code), complementing the IAEA Regulations. This Code introduced recommendations for the design of ships transporting radioactive material and addressed such issues as stability after damage, fire protection, and structural resistance. In January 2001, the INF Code was made mandatory and renamed the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Waste on Board Ships.

The INF ship

Every aspect of ship construction, equipment, manning and operation must comply with domestic and international regulations. Domestic legislation is established from the many conventions and regulations agreed within the IMO, including the International Convention for the Safety of Life at Sea (SOLAS), the International Convention for the Prevention of Pollution from Ships (MARPOL) and the International Maritime Dangerous Goods Code (IMDG Code). These regulations apply to all types of vessels and collectively they cover just about every aspect of ship design and operation. In addition, the INF Code imposes more stringent regulations for vessels carrying radioactive cargoes. Consequently, an INF vessel must comply with INF, IMDG, MARPOL and SOLAS requirements.



Safety features of INF3 Class ship

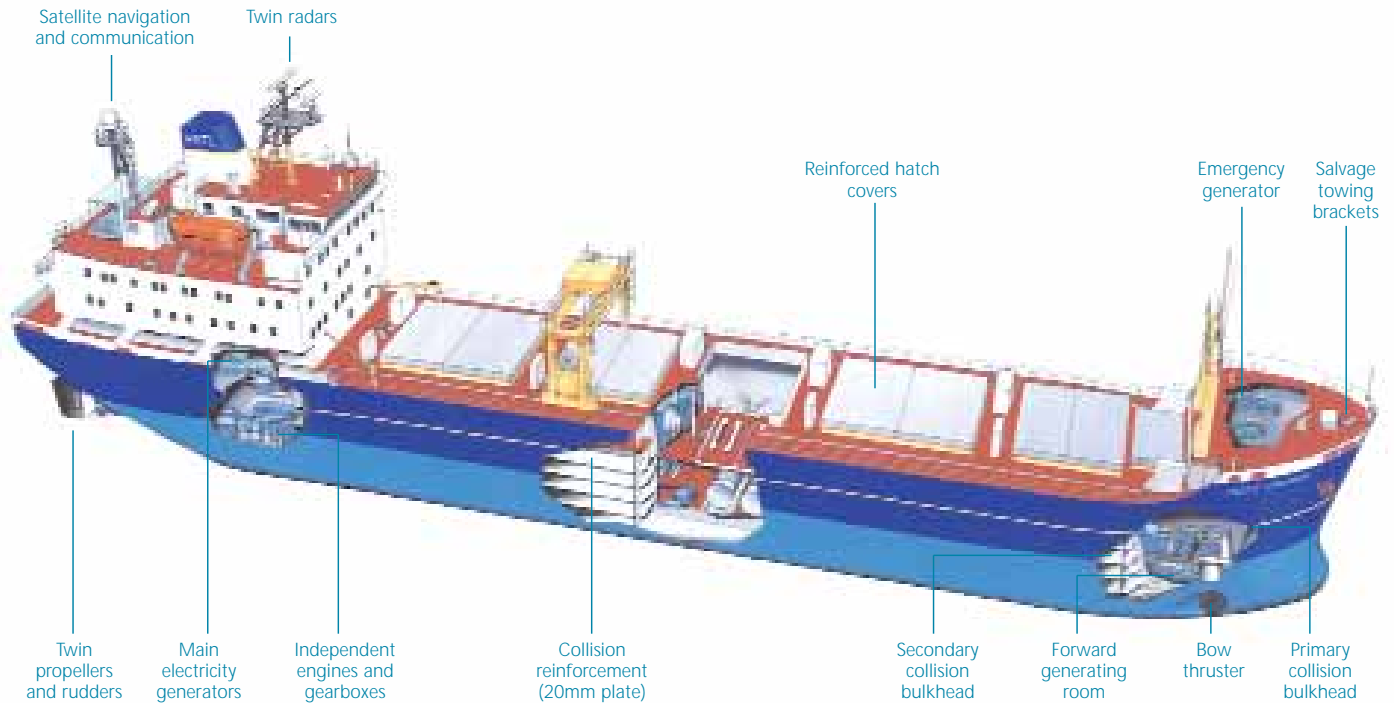


Table 1: Classes of INF Ship

Class of ship	Criteria
Class INF 1 ship	Ships which are certified to carry materials with an aggregate radioactivity less than 4,000 TBq*
Class INF 2 ship	Ships which are certified to carry irradiated nuclear fuel or high-level radioactive wastes with an aggregate radioactivity less than 2×10^6 TBq and ships which are certified to carry plutonium with an aggregate radioactivity less than 2×10^5 TBq
Class INF 3 ship	Ships which are certified to carry irradiated nuclear fuel or high-level radioactive wastes, and ships which are certified to carry plutonium with no restriction on the aggregate radioactivity of the materials

* TBq = Tera-becquerels is the SI unit of disintegration of a radioactive nuclei per second e.g. 9×10^{12} Bq can be expressed as 9 TBq

SOLAS Convention

SOLAS (SOLAS 74 Revised) sets standards for the safe operation of vessels and covers sub-division, stability, machinery, electrical installation, fire safety requirements, life saving, radio communication, safety of navigation, and carriage of dangerous goods. There are additional requirements as prescribed in Table 2 concerning damage stability, fire protection, temperature control of cargo spaces, structural considerations, cargo securing arrangements, electrical supplies, radiological protection equipment, and management, training and shipboard emergency plans. The IMDG Code provisions also apply, which specify appropriate markings and labelling for packages and the requirements for securing the package to the vessel's structure.

MARPOL Convention

MARPOL protects the marine environment from pollution by vessels and requires that a report be made to the nearest coastal state of any incident involving the loss or likely loss of any dangerous or polluting goods. Any serious threat to a vessel's safety would also have to be reported under these regulations. International regulations apply exclusively to packages used for carrying radioactive materials. These codes and regulations are subject to continual review.

Table 2: INF Ship Criteria

Ship class	Damage stability		Fire protection		Temperature control of cargo spaces	Structural considerations	Cargo securing arrangements	Electrical supplies	Radiological protection equipment	Management, training and shipboard emergency plan
	Passenger ships*	Cargo ships	Passenger ships*	Cargo ships						
INF 1	1	1	5	5	8 + 9 + 10	11	12 + 13	14	18	19
INF 2	2	3	7	7	8 + 9 + 10	11	12 + 13	15 + 16	18	19
INF 3	N/A	4	N/A	6 + 7	8 + 9 + 10	11	12 + 13	15 + 16 + 17	18	19

Note: The numbers in the table correspond to the numbered paragraphs below. Points in brackets and italics are a brief description of the contents of the regulations referred to in the INF Code.

Note: N/A - INF3 is not allowed for passenger vessels.

* As defined in SOLAS 74, chapter 1, part A, regulation 2(f). (A ship is defined to be a passenger ship if it carries more than 12 passengers. A cargo ship is any ship that is not a passenger ship.)

Damage stability

- To the satisfaction of the relevant government bodies.
- Complying with part B, chapter II-1 of SOLAS 74. (*Part B chapter II-1 contains information regarding passenger ships and cargo ships regarding subdivision and stability. These include items [but not limited to] permissible length of compartments, stability of passenger ships in damage condition, construction and initial testing of watertight bulkheads, watertight doors etc, bilge pumping arrangements, stability information and damage control.*)
- Complying with part B-1, chapter II-1 of SOLAS 74. (*Part B-1 contains regulations on the sub-division and damage stability of cargo ships, including [but not limited to] formulae to determine subdivision, stability information, openings in watertight bulkheads and external opening.*)
- Complying with requirements for INF Class 1 ship survival capability and location of cargo spaces in chapter 2 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code) or, regardless of the length of the ship, the requirements in part B-1, chapter II-1 of SOLAS 74 with subdivision index R_{INF} , as given below:

$$R_{INF} = R + 0.2(1 - R)$$
(R is the required subdivision index)

Fire protection

- To the satisfaction of the Administration.
- Accommodation spaces, service spaces, control stations and machinery spaces of category A, as defined in regulation II-2/3.19 of SOLAS 74 shall be fitted either forward or aft of the cargo spaces, due regard being paid to the overall safety of the ship. (*Category A space is one that contains internal combustion machinery used for main propulsion or for purposes other than main propulsion where aggregate output is not less than 350kW or a space with any oil fired boiler or fuel unit.*)
- Regardless of size, the vessel shall be fitted with the following systems and equipment:
 - a water fire-extinguishing system complying with regulation II-2/4 of SOLAS 74 (*covering fire pumps, fire mains, hydrants and hoses*);
 - a fixed fire-extinguishing system in the machinery spaces of category A, as defined above, complying with the requirements of regulation II-2/7 of SOLAS 74 (*covering the types of extinguishing systems for spaces containing oil fired boilers, internal combustion machinery, steam turbines or enclosed steam engine, other machinery spaces, machinery spaces of category A in passenger ships and extinguishing systems not required by this chapter*);
 - fixed cargo space cooling arrangements, complying with the requirement of regulation II-2/54.2.1.3 of SOLAS 74 (*requires ships to have a means of effectively cooling the under-deck cargo space by copious quantities of water, either by a fixed arrangement of spray nozzles or flooding the cargo spaces with water*);





- a fixed fire-detection and fire-alarm system, protecting the machinery spaces, accommodation and service spaces complying with the requirements of regulation II-2/13 of SOLAS 74 (*describes the design and installation requirements for fixed fire detection and fire alarm systems*).

Temperature control of cargo spaces

8. Adequate ventilation or refrigeration of enclosed cargo spaces shall be provided so that the average ambient temperature within such spaces does not exceed 55°C at any time.
9. Ventilation or refrigeration systems serving cargo spaces intended for the transport of INF cargo shall be independent of those serving other spaces.
10. Those items essential to operation, such as fans, compressors, heat exchangers and cooling water supply shall be provided in duplicate for each cargo space and spare parts shall be available to the satisfaction of the Administration.

Structural considerations

11. The structural strength of deck areas and support arrangements shall be sufficient to withstand the load, which is to be sustained.

Cargo securing arrangements

12. Adequate permanent securing devices shall be provided to prevent movement of the packages within the cargo spaces. In designing permanent devices, due consideration shall be given to the orientation of the packages and the following ship acceleration levels shall be taken into account:
 - 1.5g longitudinally;
 - 1.5g transversely;
 - 1.0g vertically up;
 - 2.0g vertically down;

or alternatively, where packages are carried on the open deck or a vehicle deck, they shall be secured in accordance with the principles of safe stowage and securing of heavy unitised and wheel-based (rolling) cargo approved by the Administration, based on guidelines developed by the IMO in the Code of Safe Practice for Cargo Stowage and Securing, taking into account the information given in the Guidelines for Securing Arrangements for the Transport of Road Vehicles on Ro-Ro Ships and the Provisions to be included in the Cargo Securing Manual to be carried on board ships.

13. Collision chocks, where used, shall be so arranged that they will not interfere or prevent cooling air flow which is necessary under 8, 9 and 10.

Electrical supplies

14. To the satisfaction of the relevant government bodies.
15. An alternative source of electrical power, complying with the requirements of the International Electrotechnical Commission (IEC), shall be provided so that damage involving the main supply would not also affect the alternative source.
16. The power available from the alternative source shall be sufficient to supply the following services for at least 36 hours:
 - the equipment provided for the flooding and cooling arrangements referred to above;
 - all emergency services required by the Convention.
17. The alternative source referred to in 15 shall be located outside the extent of any damage envisaged in 1, 2, 3 and 4.

Radiological protection

18. Depending upon the characteristics of the INF cargo to be carried and upon the ships, additional arrangements or equipment for radiological protection shall, if necessary, be provided to the satisfaction of the relevant government bodies.



Management, training and shipboard emergency plan

19. Management, training and shipboard emergency plan for a ship carrying INF cargo shall be to the satisfaction of the Administration, taking into account developments in the IMO. Every ship carrying INF cargo shall carry a shipboard emergency plan.

Survey and certification

A ship that is certified for the carriage of INF cargoes is subject to inspections and surveys, as required in SOLAS 74, chapter 1. Prior to transporting INF cargoes the ship must be internally surveyed, including a complete examination of its structure, equipment, fittings, arrangements and material. On passing an initial survey, an International Certificate of Fitness for the Carriage of INF Cargo is issued. This Certificate ceases to be valid if surveys have not been carried out or if the ship no longer complies with this Code when the Certificate has expired.

References

These excerpts have been taken with the permission of the International Maritime Organization (IMO), London from the IMO sales publication "Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes in Flasks on Board Ships (INF Code) and Guidelines for Developing Shipboard Emergency Plans for Ships Carrying Materials Subject to the INF Code – 1998 Edition".

The full text is available from the IMO Publishing Service, London
Tel: +44 (020) 7735 7611
Fax: +44 (020) 7587 3241
e-mail: publications-sales@imo.org

Photographs

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