



The Transport of the Radioactive Material on the Sea-Technologies and Measures for Reduction of Radioactive Pollution in the Seas

C.S. Mihailovici¹

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ABSTRACT

Albert Einstein: "The phenomenon of radioactivity is the most revolutionary force of technical progress, the discovery of fire by prehistoric man until today".

The events occurred in the last years impose a special attention to the transport of radioactive material at sea. Radioactive pollution occurs due to the emission and propagation of radiation in space, capable of delivering chemical and biological undesirable physical effects on living organisms.

Radioactive contamination in the sea has many causes. It could occur in nuclear weapons, nuclear reactors and radioactive substances. The risk of potential terrorist attacks represents a reality too. If such an incident were to take place, people in the vicinity could be exposed to radiation or contaminated with radioactive materials. The exposed people could seek treatment for radiation exposure or reassurance that their health has not been affected. Most vessels and ports are not prepared to deal with a large number of people who could seek medical assistance in the event of radioactive contamination and possible exposure to radiation.

Measurement of natural radioactivity in soil is very important to determinate the amount of change in natural background with time as a result of any radioactive release. Monitoring of any release of radioactivity to the environment is important for environmental protection.

The important radiological concentration consequence of natural radioactivity in soil is the effects of gamma rays on the human body. The measurements show that the values of the absorbed dose rates in air in the investigated area are lower than the recommended limit by the Union Nation Scientific Committee on the Effect of Atomic Radiation – UNSCEAR 2000.

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1. The transport of the radioactive material on the sea

The ships that are used for the transport of the nuclear have a range of safety features far in excess of those found on conventional cargo vessels like double hulls to withstand collision damage; enhanced buoyancy to prevent the ship from sinking even in extreme circumstances; dual navigation, communications, cargo monitoring and cooling systems; satellite navigation and tracking; twin engines and propellers; additional fire fighting equipment, including a hold flooding system.

The half-tonne stainless steel canisters containing high-level waste are transported in specially-engineered, heavily shielded steel and resin containers called casks or flasks. Each weighs about 100 tonnes. Those used for the high-level waste are very similar to those for transporting the spent fuel from Japan to Europe in the first place, and the MOX on the return voyage. A flask holds up to 28 canisters of vitrified waste, each of about 500 kg.

Purpose-built vessel for transport of spent nuclear fuel

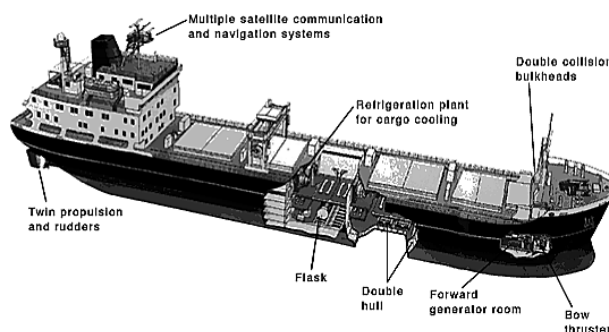


Fig. 1. Model of a ship used to transport radioactive material.

The regulation of the transport of radioactive material throughout the world is based on requirements published by the International Atomic Energy Agency (IAEA).

The Transport Code is a complex document designed to cover all transport of radioactive material ranging from bulk amounts of low activity material, small packages of medical isotopes, very high activity industrial sources through to spent

¹ Doctorando PHD, Universitat Politècnica Catalunya, Pla del Palau 18, 08003 Barcelona, Spain. Email: cristina_mihailovici@yahoo.es, Tel. +34 934017942.

reactor fuel. Many of the transports covered by the Transport Code are not performed in the world and many companies only transport a limited range of material, so only certain sections of the Transport Code will apply.

The Transport Code is completed by the Safety Guide complements which provides advice and guidance for a good radiation protection practice.

This Safety Guide aims to assist transport users in interpreting the detailed provisions in, and to facilitate compliance with, the Transport Code for their given situation. It explains the requirements for the consignor, the carrier and the consignee for transports of radioactive material and provides examples of how to prepare a transport consignment for some common radioactive sources.

2. The organisations or persons involved in a typical operation for the transport of radioactive materials

In the transport of radioactive materials are involved many organizations and persons, like:

- the consignor (shipper) – anyone who presents a consignment of radioactive materials for transport, and who is named as the consignor in the transport documents. The consignor may be an individual, company, government or other organisation and may require an authorisation from the relevant regulatory authority of the Australian jurisdiction in which the transport originates
- the consignee (recipient) – the addressee nominated in the documentation as the person or organisation or company responsible for the receipt of the consignment
- the carrier – any organisation or individual or company transporting radioactive materials
- the competent authority – the regulatory authority that administers the various statutory regulations governing the transport of radioactive materials, and controls emergency action in the event of an incident.

It is very important that the Transport Code and the companion advisory material to the IAEA Regulations be read carefully to ensure optimum conditions for transporting radioactive material.

3. The role of the consignor in the transport of the radioactive materials

The consignor is responsible for ensuring that the consignment of radioactive materials is properly:

- packaged
- labelled
- certified
- documented

Also he must ensure safe carriage and prompt delivery.

To achieve this, the consignor should make a careful study of the Transport Code and be familiar with the relevant requirements of the Transport Code and all aspects of his or her

area of operations relating to the consignment of radioactive materials.

Along with the goods, the consignor is required to supply information, sometimes known as a 'consignor's declaration', outlining details of the consignment, such as: the name and activity of the radionuclides; the type of packaging; the hazard category of the package; and the transport index (TI).

The TI is the maximum radiation level at 1 metre from any external surface of the package in mSv/h $\times 100$ and rounded up to the first decimal place. A value of 0.05 or less may however be considered as zero. The TI is used to provide control over radiation exposure during transport.

The consignor's declaration, which is often called the consignor's certificate, the shipper's certificate or even the dangerous goods certificate, also needs to contain a signed statement to certify that the consignment conforms to applicable regulations.

The level of potential hazard arising from the transport of radioactive material will vary with the radionuclide and the physical form and quantity involved.

4. Example of a case that prepare particular materials for shipment

In order to prepare a shipment, the consignor first needs to define the radioactive material to be transported with reference to:

- the type of radioactive material (isotope or mixture of isotopes)
- the total activity of the consigned material
- the chemical and physical form, for example:
 - solid, liquid, or gas
 - size, mass, encapsulation;
- ensure that non-fixed external contamination does not exceed 4 Bq/cm² (some carriers may require certified measurements)
- measure the radiation level at all surfaces of the package, including the top and base
- determining A1 and A2 limits for the radionuclide. There are defined in the Transport Code and are used to determine package activity limits for special form and non-special form radioactive material.



Fig. 1. Radioactive Material Shipping and Transportation.

It should be noted that in the case of uranium or thorium ores and concentrates there exists an inconsistency between the definitions provided in the IAEA Transport Regulations (and therefore the Transport Code) and those in the IAEA Basic Safety Standards.

5. Handling rules and the role of the competence authorities

Radioactive materials presented for transportation are packaged in accordance with the Transport Code to ensure that they are safe to handle under normal conditions.

To prevent unnecessary exposure to radiation there are certain basic rules that should be followed as the radiation exposure that a person receives depends on how long and how close that person stays near the packages containing radioactive materials. To minimise radiation exposures:

- contact time with the package should be kept short;
- a package of radioactive material should be handled without delay and kept moving;
- nobody should be permitted to stand around, sit near or sit on a package containing radioactive material;
- time-consuming tasks, such as paperwork, should not be carried out near a package;
- all persons should be kept as far away as practicable from packages containing radioactive material;
- packages should be stored well away from offices, rest rooms and occupied work areas;
- a vehicle transporting packages containing radioactive material needs to provide sufficient separation between the packages and any personnel to ensure that no person will receive a dose in excess of the radiation protection limits;
- packages should not be placed on the passenger seat;
- the Transport Code also requires that category II or III packages are not carried in the passenger compartment of vehicles unless the compartment is specifically designed for that purpose;
- packages should be secured so that they will not move during transport — small, light packages can be stored in a basket while larger, heavy packages should be properly blocked and braced;
- groups of packages with transport that add up to more than 50 cannot be stored in the one location unless there is a separation of at least 6 metres between each such group.

On receipt of the package(s), the consignee should ensure that the consignment is: intact; in agreement with the information entered in the documentation for the consignment.

In the event of damage to a package or any likelihood of loss of radioactive material during transportation which might pose a radiation hazard to people or the environment, the consignee should advise the competent authority immediately.

The role of the competent authority is to receive and assess applications for:

- shipment approval;
- special form approval;

- package design approval / validation approval;
- shipment approval certificates;
- special form certificates;
- package design approval certificates;
- validation of package design approval certificates from other countries;
- evaluate package designs and special form radioactive materials and issue certificates of compliance;
- provide information to package designers, consignors, carriers and consignees;
- receive notification of proposed shipments.

Competent authorities are also responsible for ensuring that adequate emergency plans exist.

6. Conclusions

About 20 million consignments of radioactive material take place around the world each year. Radioactive material is not unique to the nuclear fuel cycle and only about 5% of the consignments of such material are fuel cycle related. Radioactive materials are used extensively in medicine, agriculture, research, manufacturing, non-destructive testing and minerals exploration.

Any incident that involves damage to a package containing radioactive material is to be reported as soon as practicable to the competent authority in whose jurisdiction the incident occurred. Relevant State or Territory emergency services should be contacted in accordance with the emergency response arrangements of the given jurisdiction.

International regulations for the transport of radioactive material have been adopted into national regulations, as well as into modal regulations, such as the International Maritime Organisation's (IMO) Dangerous.

Nuclear materials have been transported since before the advent of nuclear power over forty years ago. The procedures employed are designed to ensure the protection of the public and the environment. For the generation of a given quantity of electricity, the amount of nuclear fuel required is much smaller relative to all other fuel.

As of 30 June 2010, 99 States have made a political commitment to implement the Code of Conduct on the Safety and Security of Radioactive Sources, of which 58 have also notified the Director General of their intention to act in a harmonized manner in accordance with the Code's supplementary Guidance on the Import and Export of Radioactive Sources.

A total of 105 States have nominated points of contact for the purpose of facilitating the export and import of radioactive sources and have provided the details to the Agency. The Code and the Guidance are not only widely accepted on a national level, but are also supported by several groups of countries such as the Asia-Pacific Economic Cooperation, the European Union, the Group of Eight (G8) and the Organization for Security and Co-operation in Europe.

This very strong political support shows that the provisions in the Code and the Guidance are widely accepted at the international level.

It is recommended that special services in the ports are engaged in order to control ships and crew professionally and provide timely assistance in preventing smuggling, finding a suspected item, and organising protection.

The IMO would be in charge of laying down procedures of the conduct of the ship and crew in the event of radiation on board the ship. In order to increase the level of protection against radiation hazards on board, officers and crew require additional education on radiation threats, symptoms and treatment.

The IMO and the *International Labour Organization* – *ILO* should prescribe the safety at work methods with respect to activities in the vicinity of irradiated areas.

The IAEA has regularly issued revisions to the transport regulations in order to keep them up to date. The latest set of regulations is published as TS-R-1, Regulations for the Safe Transport of Radioactive Material, 2009 Edition.

Requirements based on the IAEA regulations have been adopted in about 60 countries, as well as by the International Civil Aviation Organisation (ICAO), the International Maritime Organisation (IMO), and regional transport organisations.

The objective of the regulations is to protect people and the environment from the effects of radiation during the transport of radioactive material.

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