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World Nuclear Transport Institute

The Implementation of Radiation Protection Programme Requirements in the Transport of Nuclear Fuel Cycle Materials

conference paper

Dr William L Wilkinson
WNTI Consultant

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Abstract

The International Atomic Energy Agency (IAEA) requires organisations involved in transport of radioactive material to implement a Radiation Protection Programme (RPP) to control radiation dose exposure to both workers and the public from transport operations. For nuclear fuel cycle materials, radiation protection is dealt with prior to shipment by using a package design to control exposures to workers and the public. Dose assessment and evaluation is a key issue for RPPs. The extent of control measures in the RPP should relate to the magnitude and likelihood of radiation exposure. The World Nuclear Transport Institute (WNTI), therefore, made an assessment of the likely doses to workers in the transport chain, for the various modes of transport and for the main nuclear materials. Analysis of the data on dose up-take during the various modes of transport of nuclear fuel cycle materials indicates that it is very unlikely that any group of workers, or any member of the public, will receive annual doses in excess of 1mSv and the transport of nuclear fuel cycle materials should therefore fall into the lowest category, for which no workplace or individual dose monitoring is required.

1. Introduction

Nuclear power generates electricity in 32 countries and supplies over 16% of the world's electricity demand. It will continue to play a major role in meeting the world's increasing need for electricity and reducing carbon dioxide emissions without putting undue stress on the environment. The nuclear power industry is becoming increasingly global in terms both of products and services. The national and international transport of nuclear fuel cycle materials by all modes of transport is essential to support this activity.

The IAEA requires the organisations involved in the transport of radioactive material to implement an RPP in order to control radiation dose exposure to both workers and the public from transport operations. The major nuclear fuel cycle companies and their customers normally operate on nuclear licensed sites and have extensive experience in the preparation and implementation of comprehensive radiation protection provisions. In some cases, nuclear fuel cycle materials are transported by dedicated carriers and these companies also have well established radiation protection provisions.

However, there are many transport organisations for which the transport of nuclear fuel cycle materials is only a small part of their business; typical of these are trucking companies, sea carriers, port handling organisations and airline services. Previously, such companies may not normally have had fully developed RPPs in operation which would meet the requirements of the IAEA Transport Safety Regulations (TS-R-1). Accordingly, without a good understanding of what is required in an RPP, there is the possibility that they would perceive the development and implementation of a formal RPP as difficult to justify in terms of the value to them of the nuclear fuel cycle business. This need not be the case.

It clearly is necessary to ensure that RPPs are implemented properly to protect workers and the public. However, it is important to allay the concerns of operators in the transport chain that such programmes would be too onerous to justify in business terms as well as to allay perceived risks among the public.

2. Implementation of Radiation Protection Programmes

RPPs are intended to provide for and document the framework of controls applied by a transport organisation to limit the normal and potential exposure of workers and the public. They have to include details on the procedures to be adopted to optimise protection and safety, including such issues as dose assessment, segregation of packages, emergency response, training and quality assurance.

Dose assessment and evaluation is a key issue for RPPs, and this includes both a dose assessment at the pre-operational stage to ensure that account has been taken of all reasonably practicable radiation protection measures, and radiation monitoring and dose assessment where appropriate during transport to demonstrate compliance and to establish good practice.

The nature and extent of control measures in the RPP should relate to the magnitude and likelihood of radiation exposure. Therefore, it is possible to apply a graded approach to the RPP requirements as provided for in the IAEA Transport Safety Regulations (TS-R-1).

TS-R-1 applies the following actions:

- where it is most unlikely that the dose will exceed 1mSv/year, very little action needs to be taken for evaluating and controlling worker doses;
- where it is likely that the dose will be 1-6mSv/year, a dose assessment programme is necessary, and can involve workplace or individual dose monitoring;
- where it is likely that the dose will exceed 6mSv/year, individual monitoring of transport personnel is mandatory.

The 1mSv/year effective dose limit is the dose limit for members of the public and for operations below this level no workplace or individual dose monitoring is required.

TS-R-1 accepts that the categories will be based generally on a prior radiological assessment using existing dose data for similar transport activities. This is why it is important to collect reliable dose data relating to nuclear fuel transport operations to assess the implications of the new requirements for nuclear fuel cycle transports.

2.1 Dose assessment

A study carried out by WNTI with the co-operation of its members made an assessment of the likely doses to various types of worker in the transport chain, and also to members of the public for the transport of various fuel cycle materials, for various modes of transport, mainly based on experience of actual operations, as follows:

- workers – loading and unloading workers, crew/drivers, inspectors, supervisors;
- mode – rail, road, sea;
- materials – uranium ore concentrate, uranium hexafluoride, oxide powder, new fuel, spent fuel, plutonium, mixed oxide fuels (MOX), and wastes.

There are several published studies covering the major nuclear fuel cycle materials but the studies are fragmented, and in some cases specific to particular situations; they require careful analysis to establish confidence in their accuracy and validity. Data from direct measurements, or estimates based on assumed transport scenarios and dose rates from packages are the most reliable. Computer codes can also give a useful guide.

For accurate assessments, the dose rates should be those in occupied areas combined with appropriate exposure times. The aim of the WNTI study was to collect the best data, which represent current practice from both existing published sources and records of WNTI member companies.

Road, rail and sea transport are all commonly used for nuclear fuel cycle materials. Air transport is carried out, but only to a limited extent.

For road transport, non-irradiated nuclear fuel cycle materials - uranium ore concentrates, uranium oxide powder, uranium hexafluoride, and new fuel - are normally carried in containers on trailers. Loading is by crane or lift-truck with limited access by workers. Similar conditions apply to rail transport. The quantities of uranium ore concentrates and uranium hexafluoride are quite large, typically thousands of tonnes per year in countries involved in the nuclear fuel cycle industry. Low and intermediate level wastes are transported by road under conditions similar to those for uranium ore concentrates; that is, packed in drums and loaded into standard ISO containers. Rail transport is similar.

Spent nuclear fuel is transported within Europe mainly by rail, with road transport confined to the short journeys from the reactor site to the railhead. Spent fuel is transported by sea from Japan to Europe for reprocessing in dedicated vessels to sea terminals close to the reprocessing plants, followed by short road/rail journeys. For spent fuel, crane handling of flasks is used at the sea terminals with limited access by workers. Some spent fuel is likewise transported by sea from continental Europe to the UK. The limited transports of high-level waste, for example from la Hague in France to storage facilities in Europe and Japan, are closely similar to spent fuel transport.

The individual dose up-takes to workers and the public resulting from the transport of the various nuclear fuel cycle materials by different modes of transport are summarised in the following table:

Maximum annual dose up-takes for various materials and modes of transport

Material	Persons	Road	Rail	Sea
		(All measurements in microSieverts)		
Non-irradiated material	Handlers	300	300	<300
	Crew	100-700	<4	<300
	Public	<4	<1	<20
Spent fuel	Handlers	<1000	200	<1000
	Crew	200-500	2	<700
	Public	<4	<6	<1
Waste (LLW/ILW)	Handlers			
	Crew	20-400	<600	
	Public	<4	<4	
High-level waste	Handlers		1700	<1000
	Crew		200	<600
	Public		20	<1
MOX/plutonium	Handlers			<1000
	Crew			<200
	Public			<1

Analysis of the data on dose up-take during the various modes of transport of nuclear fuel cycle materials indicates that it is very unlikely that any group of workers, or any member of the public, will receive annual doses in excess of 1mSv. The transport of nuclear fuel cycle materials should therefore fall into the lowest category, for which no workplace or individual dose monitoring is required.

The International Basic Safety Standards also require operators all along the transport chain to adopt the safety principle that in operations that give rise to exposure, radiation protection should be optimised to reduce doses to As Low As Reasonably Achievable (ALARA), which is normal practice in the nuclear industry. For nuclear fuel cycle transport, the ALARA principle can be met by demonstrating that attention has been paid to minimising dose up-take and that best practice has been adopted; for example, in the segregation and storage of containers, the shielding of drivers, the supervision of working practices, operator training, and so on. The optimisation principle can be achieved with the application of common sense and good practice.

2.2 Actions to facilitate implementation

The requirement for radiation programmes is included in the IAEA Transport Safety Regulations as part of the General Provisions, and as such, sets down the basic principles. Detailed guidance is essential to achieve successful implementation of these principles by the industrial organisations concerned. WNTI and its members have co-operated closely with the IAEA and national competent authorities by providing an input of industrial experience to ensure that the guidance document, the IAEA Provisional Safety Guide (TS-G-1.5) clearly interprets the intentions of the regulations and gives detailed guidance and information sources to the various organisations in the transport chains which have to implement them. It is important to set down clearly the various responsibilities of the transport organisation, its management and workers.

In addition, WNTI within its working groups has prepared advice for onward transmission to the supply chains involved in nuclear fuel cycle transport. On that basis, seminars have been organised by leading nuclear fuel cycle companies for their transport service providers which covered all aspects of RPPs and discussed typical examples which could be used as pro-formas for consignors, carriers, port handling organisations, and similar organisations. WNTI also gives lectures at the International Maritime Organization World Maritime University to students involved in various aspects of sea transport from many countries on the transport of radioactive materials and the requirement to establish RPPs.

3. Conclusions

Preparation of RPPs ensure that an adequate framework of controls will be applied by the various organisations in the transport chain to meet the radiation protection principles, protecting workers and the public.

This is a new requirement for many organisations which have traditionally played an important role in the transport of nuclear fuel cycle materials. The detailed guidance provided by the IAEA coupled with the help and advice provided by WNTI and the nuclear fuel cycle industry will help them to develop RPPs, and this is important to facilitate the provision of international transport services.

For further information, please contact:

WNTI
7 Old Park Lane
London W1K 1QR
Tel: + 44 (0) 207 408 1944
Fax: + 44 (0) 207 295 1964
Email: wnti@wnti.co.uk

www.wnti.co.uk