RADIATION DOSES FROM THE TRANSPORT OF RADIOACTIVE MATERIAL IN THE UNITED KINGDOM

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ABSTRACT

The assessment of the doses arising from the incident-free transport of radioactive material in the United Kingdom is performed periodically by means of a programme of work looking at the land, sea and air modes in turn, separately. A database containing details of UK accidents and incidents involving radioactive material over a period of more than twenty five years has been established.
The doses from routine operations are generally low, apart from those of a small number of drivers regularly delivering technetium generators for medical use. The highest accidental exposures have been from the transport of inadequately shielded industrial radiography sources.

INTRODUCTION

The transport of radioactive material in the United Kingdom is controlled by regulations based upon the International Atomic Energy Agency's model regulations[1]. These regulations require that the exposures from the handling, storage and transport of radioactive material shall be kept as low as reasonably achievable, economic and social factors being taken into account. However, the dose rates around packages containing radioactive material can be as high as 10mSv/h. The justification for the continued use of these levels is that radiation exposures arising from transport are in fact low and that the regulations provide for their periodic assessment by the Competent Authority. In the United Kingdom the Department of Transport, as Competent Authority, has instigated a programme of assessment of the exposures arising from the transport of radioactive materials. This is done on a cyclical basis looking at each transport mode in turn under incident free conditions[2,3]. A database of reported transport accidents and incidents in the UK and their radiological consequences is also maintained[4]. This work is performed under contract to the Department by the National Radiological Protection Board a statutory body one of whose functions is to provide advice on radiological protection matters to government departments.

SEGREGATION

It is a basic requirement of the IAEA Regulations that radioactive material is properly segregated both from people and photographic film. For the former, the Regulations prescribe limiting values of annual dose of 5mSv for workers and 1mSv for members of the public and from these values segregation distances can be calculated using hypothetical but realistic models. If these criteria are met in practice neither special work patterns nor detailed monitoring of radiation doses are required.

NORMAL TRANSPORT

(i) Transport Characteristics

It is convenient to consider the transport of radioactive material under three broad headings: unirradiated nuclear fuel cycle materials; irradiated nuclear fuel cycle materials including wastes; and radionuclides for medical and industrial use.

The greatest weight of radioactive material transported is in unirradiated nuclear fuel cycle materials such as uranium ore concentrate, or uranium hexafluoride. These are bulky materials of low specific activity. Uranium ore concentrate travels by road or sea in 17 tonne loads of industrial grade steel drums overpacked into 6 or 12 metre long freight containers; uranium hexafluoride whether natural, depleted or enriched travels in purpose-built cylinders holding between 2 and 12 tonnes, usually by road or sea.

Irradiated nuclear fuel cycle materials such as imported spent nuclear fuel from European and Japanese power and research reactors travel by sea with associated secondary rail journeys; domestic irradiated nuclear fuel travels mainly by rail. The highest activity of radioactive material transported is found in this category; a typical flask of seven PWR elements contains of the order of several hundred petabequerels.

Low level waste arises from both the nuclear fuel cycle and from isotope production and is transported by road and rail to an authorised repository. Its transport is, as yet, not radiologically significant.

The transport of radionuclides for medical use, both within the UK and abroad is extensive by road, sea and air: this category of material accounts for the greatest number of movements and the largest number of packages moved with around half a million packages transported each year[5]. Roughly 90% of these contain insignificant quantities of radionuclides which are exempt from many of the design and use requirements of the transport regulations. The remainder are radiologically significant and are the major source of worker exposure in routine transport.

ii) Exposures

Individual and collective doses for workers and members of the public have been estimated and are summarised in Tables 1 and 2.

Table 1: Worker Exposure

Mode	Max. Individ. (mSv)	Collective (manSv)
Road/Rail	16.0	0.4
Air	0.4	0.1
Sea	0.4	-

Table 2: Exposure of Members of the public

Mode	Max. Individ. (mSv)	Collective. (manSv)
Road/Rail	0.006	0.04
Air	0.1	0.5
Sea	0.05	-

The highest occupational doses arise in road transport from the movement of technetium generators for hospital use. Doses to members of the public are low: the highest doses are from the air transport of medical radionuclides[6].

ACCIDENTS/INCIDENTS

Accidents and incidents occur in all modes of transport to all types of goods, radioactive materials are no exception. Although the lower types of packaging for radioactive materials are not required to retain their contents in the event of a severe accident, experience over 25 years in the UK has shown that such packages do retain their contents and shielding in most accident conditions. The higher grade of packaging, Type B, is required to meet severe accident conditions without significant loss of contents or shielding and no such package has lost its contents in the UK.

The UK has a transport event database on accidents and incidents involving radioactive material; since 1964 some 400 events most of which have had trivial radiological consequences have been recorded.

Analyses of the UK events shows that in 43% of the cases the package was damaged but that there was no increase in radiation level or loss of containment; in 39% of the cases no damage occurred to the package. Radiological consequences were possible in the remaining 18% of the cases but significant exposures occurred in only a few, all involving site radiography sources. The highest radiation doses resulted from faulty packages where the radiography sources were not properly shielded.

LOOKING AHEAD

The new ICRP recommendations will have an impact on transport. There will be greater pressures to constrain doses and this could involve substantial increases in some transport costs. The application of ALARA will need to be carefully examined. The permitted surface dose rates on packages will need to be reviewed and certain handling procedures may need to be revised.

CONCLUSIONS

Although the exposures from incident free transport are currently generally low they are dependent upon particular work and traffic patterns and the need for continuous review is, therefore, justified. The analysis of accidents and incidents confirms the adequacy of the IAEA packaging standards but emphasises the need for the application of quality assurance in transport.

The highest individual occupational doses arise from the transport of technetium generators. For a few workers these can be as high as 16mSv. Other transport occupational exposures are almost an order of magnitude lower.

The collective dose to members of the public due to the transport of radioactive materials by road and rail has been estimated at 0.04 manSv. For the transport of radioactive materials from the UK by air, the collective dose has been estimated as 0.5 manSv. No estimate of collective dose has been made for sea transport.

The new ICRP recommendations will have an effect on transport: in particular the application of dose constraints needs to be carefully considered. Transport is an international matter and requires international consensus.

References

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