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Important Parameters for Safety Assessment of the Transport of Radioactive Materials

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1. Introduction

As the site of repository was materialized, a number of licensing activities for the construction and operation are being pursued including safety assessment of transportation of radioactive material.
Particular safety assessment model for the transportation have been developed in foreign countries and international organization such as IAEA, which is reflected in computer simulation codes: RADTRAN5 or INTERTRAN 2. In order to assess radiological consequences of the transportation of radioactive materials using those codes, there are a number of input parameters which should be quantified for the assessment
This paper describes the important input parameters necessarily quantified for the safety assessment of transportation of LILW especially for the Gyung-Ju repository. This parameter study is mainly aiming for the implementation of RADTRAN 5 to Gyung-Ju repository and to help safety analysts process and validate data for the purpose of RADTRAN 5 modeling.

2. Parameters Related to Risk in association with the Transportation

Transport risk assessment involves consideration of the variability of certain parameters over the transport routes as well as the statistical nature of transport incidents and accidents, with two components to be quantified: (1) the expected frequency of occurrence of some initiating event leading to an adverse consequence and (2) the magnitude (or severity) of the potentially adverse consequence resulting from transport accidents. Followings are the items that might be considered as basic data for the safety assessment foe the normal transportation(incident –free)

- Incident-free transport data needs,
- Transport accident frequency and severity analysis data, and postulated accident conditions
- Uncertainty of the transport risk estimates and the sensitivity of the various parameters within the framework of the risk assessment model,
- Implications of human error that increase the probability of an accident, and
- Quality assurance requirements.

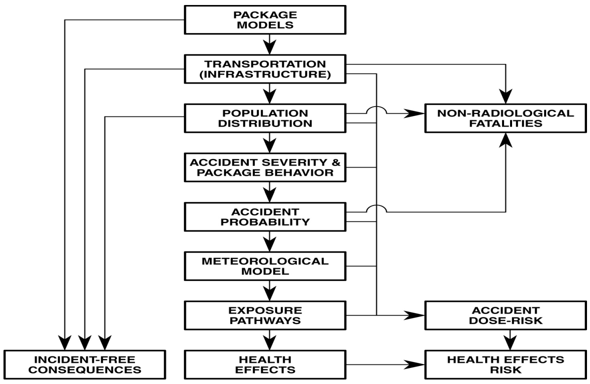

Fig.1 Systematic Diagram of Safety Assessment of the Transportation

2.1 Incident Free Cases

The consequence of incident-free transport is an exposure to a low level of radiation from the package; the probability of such exposure is 1. In other words incident-free transport is defined as the transport activity in which no accident or other incident occurs. The radiological risk associated with incident-free (or routine) transport results from the potential exposure of people to low levels of external radiation (mostly gamma) emerging from loaded shipments. The radiation exposures to persons from loaded shipments, however, are not limited to those persons who are engaged in transport operations but also include those who may incidentally be present in the shipment path.
The RADTRAN5 computer code system considers, in particular, radiation exposures of the following population groups:

- Persons residing along the route of transport (off-link population)
- Persons sharing the route of transport (on-link population), i.e. persons in vehicles traveling on the transport route
- Persons at stops
- Crew members and handlers, including aircraft flight attendants.

The parameters involved in land transport include, for example, duration of exposure, vehicular speed, stopping time, traffic density, route characteristics and population density. If a homogeneous population zone characterized the shipment path and if the speed of the vehicle were uniform, the calculation would be fairly straightforward. However, the code package takes into account different populations densities and vehicle velocities in up to three different population density zones, e.g. urban, suburban and rural.
The expected dose to workers and to members of the

public along the transport route is for normal conditions of transport (incident-free case) calculated as collective dose, also taking into account handling operations. In addition to the collective dose of different population groups, the code calculates hypothetical maximum individual doses to a person living close to the highway or railroad track if it happens. Figure 2 illustrates one of the incident-free pathways modeled in the RADTRAN5 computer code. The incident-free dose for persons along the transport route is directly proportional to the external dose rate of the package and inversely proportional to the speed of the vehicle transporting the material and to the distance (r) between the vehicle and the receptor. The population dose, referred to as off-link dose, is integrated over all receptor distances (r) out to a predefined maximum r (bandwidth) for a uniformly distributed population to give the total off-link population dose.

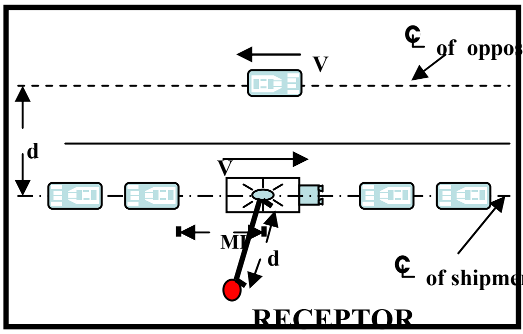

Fig.2 Pathways for Exposure Dose to a Receptor

The most relevant input parameters to be provided by the user in the input file of the RADTRAN5 computer code system for calculating the radiological impact attributable to incident-free transport include the following:

- Dose rate at 1 m, i.e. the TI value
- The fraction of gamma
- Number of packages and number of shipments.
- Characteristic package dimension
- Travel Distances
- Vehicle speed.
- Population densities including numbers of people at stops and at any intermediate storage locations.
- Mode of transport (e.g., road, rail…).
- Route characteristics
- Traffic densities.
- Number of handlings if intermodal transfers are involved.

2.2 Postulated Accident Cases

There are two overriding considerations governing the development and application of transport accident assessment approaches: (1) the principal objectives of the transport accident (or risk) assessment to be undertaken and (2) the type and quality of event data describing the severity and frequency of transport and handling accidents available to the risk analyst.

There are two basic approaches available for the development thorough understanding of how transport accidents occur and the estimation of the frequency and severity of transport accidents. These are:

- Use of historical accident event data representative for the field of transport operations being considered or event data adapted from similar transport conditions, and
- Synthesis of the accident frequency from an analysis of the combination or sequences of events which could cause the accident, together with data for their likelihood of occurrence.

Of particular importance to transport risk assessment, however, are abnormal occurrences identified by a condition which may occur during handling and transport of radioactive material package consignments with the potential of causing degradation or failure of a packaging's safety functions, i.e. loss of shielding, confinement and heat dissipation integrity. In practice, identification of these conditions relies on a thorough analysis of conceivable events or event sequences by the assessor for a given mode of transport or operation and may include movement and non-movement related accident conditions, impact due to conditions as bridge collapse, explosion due to flammable gas buildup inside package, sabotage, etc. Accident severity categorization schemes define the type and severity of accidental loads (accident environments), to allow quantitative assessment of the broad range of outcomes of possible accident environments for a given mode of transport.

In typical accident scenario, followings are two main categories which have to be defined by qualifying inputs for the accident analysis.

- Aerosol generation and airborne release fractions during the accidents
- Fire release fractions

3. Conclusion

Major parameters for the safety assessment of transportation of radioactive material are summarized and described. These data should be justified before those are used as inputs for the safety assessment. Some of data can be easily derived from previous experience foe example operational experience of nuclear power plants while others are very difficult due to lack of pre-practice. Therefore, much effort to justify the input parameters for the safety assessment should be made.

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