



# Radiation Protection Program Design for the Transport of Nuclear Substances

GD-314

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## **Radiation Protection Program Design for the Transport of Nuclear Substances GD-314**

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## Preface

This document provides guidance for the implementation of a radiation protection program to transport nuclear substances in accordance with the *Nuclear Safety and Control Act* (NSCA) and the regulations made under the NSCA.

Requirements associated with this document are found in the *Packaging and Transport of Nuclear Substances Regulations*.

The CNSC reviewed international studies on doses to workers who handle packages containing nuclear substances. In addition, the organization initiated its own research project to gather information on doses received by Canadian transport workers. The research revealed that some employees of trucking and courier companies who are not normally licensed by the CNSC were receiving radiation doses in excess of the current limits set for the public. As a result, the CNSC is providing information on radiation protection programs to assist in reducing these doses.

Some carriers, and most consignors and consignees, are licensed by the Canadian Nuclear Safety Commission (CNSC) and are covered by radiation protection programs implemented through the CNSC's licensing process. While most carriers do not require a licence from the CNSC, they remain subject, however, to the requirement for a radiation protection program pursuant to the *Packaging and Transport of Nuclear Substances Regulations*. This document is intended to assist carriers that are regulated but not licensed by the CNSC.

This document does not address criticality safety that may be necessary for packages containing fissile material. Packages containing fissile material need additional considerations that are beyond the scope of this document. For guidance in this area, please contact the CNSC at [transport@cnsccsn.gc.ca](mailto:transport@cnsccsn.gc.ca).

Key principles and elements used in developing this document are consistent with national and international standards; for example, the *International Maritime Dangerous Goods Code* published by the International Maritime Organization (IMO). In particular, this guidance document aligns with the IAEA Safety Standards Series No. TS-G-1.3, *Radiation Protection Programmes for the Transport of Radioactive Material*, published in 2007.

Nothing contained in this guidance document is to be construed as relieving any person from pertinent requirements. It is the person's responsibility to identify and comply with all applicable regulations.

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# GD-314, Radiation Protection Program Design for the Transport of Nuclear Substances

## 1. Introduction

### 1.1 Purpose

This document provides guidance in designing a radiation protection program for the transport of nuclear substances in accordance with the *Nuclear Safety and Control Act* (NSCA) [1] and the regulations made under the NSCA.

### 1.2 Scope

This document describes a typical radiation protection program that carriers of nuclear substances can implement, to comply with the requirements of the *Packaging and Transport of Nuclear Substances Regulations* [2].

This document is intended to assist carriers who are regulated under the NSCA but not licensed by the Canadian Nuclear Safety Commission (CNSC). Consignors, carriers, and consignees who are licensed are already covered by the requirements for a radiation protection program through the CNSC's licensing process.

This guidance document aligns with the IAEA Safety Standards Series No. TS-G-1.3, *Radiation Protection Programmes for the Transport of Radioactive Material*, published in 2007 [3]. It does not address nuclear criticality safety that may be necessary for packages containing fissile material. This material requires additional considerations that are beyond the scope of this document. For guidance in this area, please contact CNSC staff at [transport@cnsccsn.gc.ca](mailto:transport@cnsccsn.gc.ca).

### 1.3 Relevant regulations

The *Packaging and Transport of Nuclear Substances Regulations* (PTNSR), made under the NSCA, include a number of obligations that are relevant to this guide:

1. Subsection 15(7) states that “Every carrier of radioactive material shall implement and maintain work procedures to ensure compliance with these Regulations and shall keep a record of those procedures.”
2. Subsection 18(1) states that “Every consignor, carrier and consignee of radioactive material shall implement a radiation protection program and shall, as part of that program:
  - a. keep the amount of exposure to radon progeny and the effective dose and equivalent dose received by and committed to persons as low as reasonably achievable, social and economic factors being taken into account, through the implementation of
    - i. management control over work practices
    - ii. personnel qualification and training
    - iii. control of occupational and public exposure to radiation
    - iv. planning for unusual situations
  - b. prevent persons from receiving doses of radiation higher than the radiation dose limits prescribed by the *Radiation Protection Regulations* [4]

- c. train persons referred to in the program on the application of the program.”
3. Subsection 18(2) states that “Every consignor, carrier and consignee shall:
  - a. keep a record of its radiation protection program and of any information collected under the program
  - b. retain the record of information collected under the program for the period ending two years after the date on which it is collected”

## 2. Background

Most consignors and consignees and some carriers are licensed under the NSCA and its associated regulations. As part of the CNSC’s licensing requirements, these licensees must have established radiation protection programs that cover all activities associated with nuclear substances.

Transport activities are generally exempt from CNSC licensing, provided they comply with all regulatory requirements. The majority of carriers do not have a CNSC licence, but they remain subject to requirements in the PTNSR, including the requirement to have a radiation protection program in place if they transport nuclear substances.

To ensure that nuclear substances are transported safely, a consignor should request a carrier to demonstrate that it has a radiation protection program in place.

## 3. Radiation Protection Program

A radiation protection program is a system or plan that provides adequate consideration of radiation protection measures with respect to certain activities of a business or operation. The program’s aim is to control activities involving nuclear substances so that radiation doses to workers and the public are kept “as low as reasonably achievable” (ALARA), taking into account social and economic factors.

The level of risk, including the probability and amount of radiation exposure to workers and the public, determines the nature and extent of a radiation protection program. For example, if the risk of exposure is low, the program is normally simple. On the other hand, if the risk is high, the program should be detailed and comprehensive.

As part of a radiation protection program carriers should keep radiation doses ALARA by:

- implementing management controls over work practices
- qualifying and training personnel
- controlling occupational and public exposures to radiation
- planning for unusual situations

For more information on ALARA, refer to the CNSC’s Regulatory Guide G-129, *Keeping Radiation Exposures and Doses “As Low As Reasonably Achievable (ALARA)”*, as amended from time to time.

In addition, persons should not receive radiation doses higher than the radiation dose limits prescribed in the *Radiation Protection Regulations* and those persons referred to in the radiation protection program should be trained on the application of the program.

In a radiation protection program, all aspects of transport for normal and accident conditions should be included, with emphasis on transport operations where radiation exposure is likely to occur. This can include handling, loading, storage in transit, and the movement of packages.

In accordance with subsection 18(2) of the *Packaging and Transport of Nuclear Substances Regulations*, the radiation protection program and any information collected under the program must be recorded. These records must be retained for the period ending two years after the date it was collected. CNSC inspectors and designated officers may request to review records associated with the radiation protection program.

Radiation protection in the transport of nuclear substances is only one aspect relevant to the protection and safety of workers, the general public, and the environment. Radiation protection programs are generally established and managed with other health and safety programs such as industrial health and safety, and fire safety. A radiation protection program can refer to these other programs where appropriate.

#### **4. Risk-Informed Approach to a Radiation Protection Program**

Based on international trends, working experience and historical worker dose information, three categories of risk have been established in respect of radiation protection in the transport of nuclear substances: low, medium and high. These three risk categories take into consideration potential radiation exposure to workers, which determines the nature and extent of the radiation protection program needed, as follows:

##### **1. Low risk**

Workers in the low-risk category are unlikely to receive a dose greater than 1 millisievert (mSv) per year, the maximum allowable for a member of the public. A comprehensive radiation protection program is not necessary. Each worker involved in the handling and transport of the packages should have an understanding of basic radiation protection principles.

##### **2. Medium risk**

Workers in the medium-risk category can potentially receive doses greater than 1 mSv per year, but less than 5 mSv per year. A more detailed radiation protection program is needed for this category and each worker involved in the handling and transport of the packages should be trained on the program.

##### **3. High risk**

Workers in the high-risk category have the potential to receive 5 mSv or more per year, but may not exceed limits specified in the *Radiation Protection Regulations*. A detailed radiation protection program is recommended for this category. Each worker involved in the handling and transport of the packages should be trained on the program.

## 5. Elements of a Radiation Protection Program

A radiation protection program normally includes the following elements:

1. scope (including a risk assessment)
2. roles and responsibilities
3. dose assessment
4. monitoring radiation doses (not required for carriers in the low-risk category)
5. surface contamination
6. segregation (for Category II-Yellow, Category III-Yellow, and exclusive use)
7. emergency response
8. training
9. written work procedures

If a carrier transports nuclear substances, the checklist provided in Appendix A may be useful in assisting the individual responsible for the radiation protection program to organize and present the information.

Most consignors and consignees should already have radiation protection programs in place, pursuant to the *Radiation Protection Regulations*. Consignors, carriers, and consignees are encouraged to cooperate and take advantage of any common elements of the existing radiation protection programs, to ensure radiation protection without duplication of effort.

Additional guidance is available from the CNSC upon request; contact the CNSC at [transport@cnsccsn.gc.ca](mailto:transport@cnsccsn.gc.ca).

### 5.1 Scope and risk assessment

The scope of the radiation protection program should be determined by the category of risk of radiation exposure, as described in Section 4. The scope should document the program's policy and objectives, and normally include a commitment from management to keep radiation doses ALARA and to meet other regulatory requirements.

### 5.2 Roles and responsibilities

The radiation protection program should identify who is responsible for such areas as training, dose assessment and radiation dose monitoring, emergency response, reporting to relevant authorities and periodic program review. A contact person for the organization or, if applicable, a list of contact persons for each facility should be included in the program's documentation.

### 5.3 Dose assessment

A dose assessment is an evaluation of the radiation dose that a person might receive while performing certain activities (e.g., handling or storage of packages containing nuclear substances). Dose assessment is a key element of a radiation protection program and should consider two fundamental radiation protection principles:

1. identify the sources of radiation doses in normal working conditions (i.e., consider both the actual and potential sources of radiation when handling and transporting packages)
2. measure or estimate the radiation doses to workers and the public, and the frequency of exposures (both actual and potential)

### 5.3.1 General assumptions for dose assessments

Doses to transport workers who handle packages of nuclear substances will normally depend on the surface dose rate from the package, time of exposure to the package, distance from the package, and shielding from the radiation. The category of package (Category I-White, Category II-Yellow, and Category-III Yellow), the package handling methods, and the number of packages in each category are also important considerations to take into account when assessing transport related doses.

External radiation levels of excepted and Category I-White packages are low and are generally considered safe to handle without special restrictions. An explicit dose assessment is not normally required for operations involving only these categories of packages.

Several studies have shown a correlation between the Transport Index (TI) and the doses received by the workers. A Canadian study [5] confirms that handling less than a total of 300 TI of medical isotopes annually (regardless of individual package TI) is not likely to result in a total effective dose greater than 1 mSv per year. Such carriers may not require detailed monitoring, dose assessment, or individual records.

Where a worker is involved in the regular shipment of similar consignments from year to year, it is usually possible to estimate radiation exposures from normal transport by examining previously collected exposure data. The same types of transport operations under similar conditions are likely to result in similar exposures.

If an individual worker is monitored using a dosimeter, the measured doses can be used to estimate doses of workers performing similar tasks. This is commonly referred to as the “grouping of workers.”

For Category II-Yellow and Category III-Yellow packages, correlations based on similar operations can be used if the information is available and properly justified by the carrier.

It is necessary to periodically reassess or review the assumptions used in estimating worker doses in order to verify their accuracy, especially if there is an increase in the number of packages containing nuclear substances handled and transported.

Records of the dose assessment, including estimations, calculations, measurements and justifications, should be maintained as part of the record of procedures for the radiation protection program.

### 5.3.2 Dose assessment methods

Dose assessments can be done using different methods; for example:

1. using existing dose records and dose assessment information from similar operations
2. using accepted dose assessment models (such as the one described in Appendix A)
3. monitoring an area or an individual using radiation detection equipment or individual dose monitoring devices, such as thermoluminescent dosimeters (TLDs), for a specific period of time to measure the actual radiation dose

## 5.4 Monitoring radiation doses

The *Radiation Protection Regulations* set out the limits for radiation doses. The effective dose limit for members of the public is 1 mSv per year. Any person for whom there is a reasonable probability that they will receive a dose greater than the limit for the public in the course of their business or occupation is classified as a Nuclear Energy Worker (NEW), as defined in section 2 of the NSCA. The dose limits for NEWs are specified in section 13 of the *Radiation Protection Regulations*. These limits are meant to ensure that no individual is exposed to unacceptable risk due to radiation exposure.

While the *Radiation Protection Regulations* specify dose limits, carriers are required to keep doses ALARA, with social and economic factors taken into account. For further information on keeping doses ALARA, carriers should refer to the CNSC's guidance document G-129, *Keeping Radiation Exposure and Doses as Low as Reasonably Achievable (ALARA)*, as amended from time to time.

If using personal monitoring devices, such as TLDs, it is advisable to use a dosimetry service licensed by the CNSC. Contact the CNSC at [transport@cnsccsn.gc.ca](mailto:transport@cnsccsn.gc.ca) for the current list of licensees offering this service.

Periodic re-assessment or review of how the doses were determined is suggested, especially when there is a change in the number or types of packages handled and transported.

### 5.4.1 Risk categories

The three categories of risk require monitoring as follows:

#### 1. Low risk:

Workers in the low-risk category are unlikely to receive a dose greater than 1 mSv per year. Routine monitoring is not normally needed. Area monitoring can be done in the vicinity of the worker to demonstrate that the working conditions remain satisfactory and do not exceed the dose limit for this risk category.

#### 2. Medium risk:

Workers in the medium-risk category are likely to receive a dose greater than 1 mSv but less than 5 mSv in a year. These workers should be classified as NEWs. Individual monitoring is recommended to help ensure that the working conditions are satisfactory and do not exceed the dose limits for this risk category. If an individual worker is monitored using a dosimeter, the measured doses can be used to estimate doses of workers carrying out similar tasks.

#### 3. High risk:

In the high-risk category, the expected annual dose to a worker is likely to equal or exceed 5 mSv. These workers should be classified as NEWs. Individual monitoring should be part of the radiation protection program in an effort to ensure that dose limits prescribed by the *Radiation Protection Regulations* are not exceeded.

#### 5.4.2 Nuclear Energy Workers (NEWs)

Any worker who is likely to receive more than 1 mSv per year in the course of their normal duties is considered a NEW in accordance with section 13 of the *Radiation Protection Regulations*. Carriers who are licensed by the CNSC have specific obligations with respect to NEWs.

For those not licensed by the CNSC, it is suggested that NEWs be informed in writing:

1. that they are considered to be Nuclear Energy Workers
2. of the risks associated with the radiation to which the workers may be exposed in the course of their duties
3. of the risks associated with exposure of embryos and fetuses to radiation
4. of the applicable effective dose limits
5. of the equivalent dose limits
6. of the worker's dose, if being monitored

It is further suggested that female NEWs:

1. are informed of the specific dose limits for pregnant NEWs, as specified in section 13 of the *Radiation Protection Regulations*
2. are advised to inform their employers when aware that they are pregnant, so that appropriate work adjustments can be considered to limit exposure to 4 mSv for the remainder of pregnancy

Where the above information is provided to NEWs, they should acknowledge in writing that they have been informed of the matters mentioned above.

#### 5.5 Surface contamination

Periodic monitoring for contamination on the surfaces of packages, components, equipment, and conveyances is recommended. This monitoring may be conducted by the consignor or by the carrier. If done by the carrier, the method should be described as part of the radiation protection program.

Pursuant to the PTNSR, the limits for non-fixed radioactive contamination as specified in paragraphs 508–514 of the IAEA TS-R-1 *Regulations for the Safe Transport of Radioactive Material* [6] must not be exceeded.

TS-R-1 states that non-fixed contamination on the external surfaces of any package or conveyance shall be kept as low as practicable and, under routine conditions of transport, shall not exceed the following limits:

1. 4 Bq/cm<sup>2</sup> for beta and gamma emitters and low toxicity alpha emitters
2. 0.4 Bq/cm<sup>2</sup> for all other alpha emitters

These limits are applicable when averaged over any area of 300 cm<sup>2</sup> of any part of the surface.

Every effort should be made to minimize surface contamination as it may affect radiation doses to individuals. The conventional approach to routine monitoring for surface contamination is to monitor a representative fraction of surfaces in an area or on packages.

The frequency of monitoring will depend on factors such as the number of packages handled or transported, how the packages are handled, and previous contamination monitoring results.

The program should include the applicable criteria for controlling surface contamination and provide an outline of the type and extent of the monitoring program.

### **5.6 Segregation of packages containing nuclear substances**

Simple segregation techniques, such as placing packages away from drivers, or storing packages in secluded, unoccupied areas of a warehouse, can help to reduce exposures to all workers, including those who do not handle packages containing nuclear substances. Segregation should be included in a radiation protection program for workers who handle Category II-Yellow and Category III-Yellow packages and exclusive use shipments.

Segregation tables can be used to determine the minimum distance for an occupied position based on the transport index of the packages being transported. These tables can be found in the IAEA Safety Guide No. TS-G-1.1 (ST 2) [7], the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* [8], and the *International Maritime Dangerous Goods Code* [9]. The use of segregation tables as a guide to determine and monitor dose limits does not remove the requirement for keeping doses ALARA.

### **5.7 Emergency response**

The radiation protection program should provide emergency response procedures to deal with any emergency or other unusual situations such as lost or incorrectly delivered packages, and unclaimed or found packages. The program should include the following information:

1. the name of the person responsible for the carrier's emergency response
2. a telephone number at which that person can be reached 24 hours a day, 7 days a week
3. any other relevant information about the carrier's emergency response plan for nuclear substances.

### **5.8 Training**

In accordance with paragraph 18(1)(c) of the *Packaging and Transport of Nuclear Substances Regulations*, persons referred to in a radiation protection program must be trained on the implementation and application of the program.

Training should be related to specific jobs or tasks and include detailed actions and protective measures to take during normal job functions as well as in the event of an accident. It also explains the basic principles of radiation protection: time, distance and shielding and provides useful examples, such as placing the packages away from the driver or in unoccupied areas of the warehouse.

In some cases, the training may need to include the use of specific equipment, such as dosimeters, radiation survey meters, contamination meters, and information on ionizing radiation and their effects on people. The amount of training needed relates to the nature and extent of the risk, as assessed using the methods previously discussed.

Adequate training requires a continuous commitment from both the employer and employee, and involves initial training and refresher courses at appropriate intervals. Periodic evaluation of the

effectiveness of the training is suggested, especially where there is a change in tasks being performed by the employee.

Relevant records pertaining to the training should be maintained as part of the record of the radiation protection program.

In addition to training on the radiation protection program, all workers involved in the transport of nuclear substances should be trained in the application of the *Packaging and Transport of Nuclear Substances Regulations*.

### **5.9 Written work procedures**

In accordance with subsections 15(7) of the *Packaging and Transport of Nuclear Substances Regulations*, carriers of nuclear substances are required to implement and maintain work procedures and keep a record of those procedures.

Radiation protection is based on the basic principles of time, distance and shielding, and these factors should be considered when developing written work procedures. As a result, work procedures should take into account the following:

- to reduce the dose received, it is important to minimize the time spent handling packages and to use the maximum distance between the worker and the packages. It is good practice to carry Category III-Yellow packages using a cart whenever possible, even for light packages
- doses received are related to the distance from which the packages are handled or stored. Packages containing nuclear substances should always be located away from workers and members of the public. Unless necessary, workers should not work or stay close to packages
- the amount of dose received is also based on the amount and type of shielding. To minimize the dose while the nuclear substance is being transported, packages should always be located as far away from the workers as possible. To provide additional shielding, other goods being transported should be placed between the worker and the packages containing the nuclear substances

For additional protection when transporting Category II-Yellow and Category III-Yellow packages, portable shielding can be used to lower the dose received if the distance between the packages and the worker is limited or if the packages will be transported for several hours.

The longer a package is handled or transported, the greater the potential exists for a higher dose to be received by the worker. To minimize any possible radiation dose to workers or the public, carriers should factor in time, distance and shielding into their written work procedures.

## Glossary

### **ALARA**

The concept of As Low As Reasonably Achievable, taking social and economic factors into account.

### **carrier**

A person who — regardless of whether for hire or reward — has possession of dangerous goods while they are in transport (*Transport of Dangerous Goods Regulations* [10]).

### **consignee**

A person to whom a consignment is being or is intended to be transported (*Packaging and Transport of Nuclear Substance Regulations* [2]).

### **consignor**

A person in Canada who:

- (1) is named in a shipping document as the consignor;
- (2) imports or who will import dangerous goods into Canada; or
- (3) if paragraphs (1) and (2) do not apply, has possession of dangerous goods immediately before they are in transport.

A person may be both a consignor and a carrier of the same consignment; for example, a manufacturer who also transports the dangerous goods he or she produces (*Transport of Dangerous Goods Regulations* [10]).

### **conveyance**

- (1) for transport by road or rail: any vehicle
- (2) for transport by water: any vessel, or any hold, compartment, or defined deck area of a vessel
- (3) for transport by air: any aircraft

### **effective dose**

The sum of the products, in sieverts, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue set out in column 1 of an item of Schedule 1 (*Radiation Protection Regulations* [10]) by the tissue weighting factor set out in column 2 (*Radiation Protection Regulations*) of that item.

### **equivalent dose**

The product, in sieverts, obtained by multiplying the absorbed dose of radiation of the type set out in column 1 of an item of Schedule 2 (*Radiation Protection Regulations* [10]) by the radiation weighting factor set out in column 2 (*Radiation Protection Regulations*) of that item.

### **nuclear energy worker (NEW)**

A person who is required, in the course of the person's business or occupation in connection with a nuclear substance or nuclear facility, to perform duties in such circumstances that there is a reasonable probability that the person may receive a dose of radiation that is greater than the prescribed limit for the general public (*Nuclear Safety and Control Act* [1]).

### **thermoluminescent dosimeter (TLD)**

A device used to monitor exposure to radiation.

**transport index (TI)**

The maximum radiation level in microsieverts per hour at 1 metre from the external surface of the package divided by 10.

Example: For a dose of 1 mSv/h (0.1 mrem/h) at 1 m,  $TI = 0.1$

## **Appendix A: Information on the Design of a Radiation Protection Program for the Transport of Nuclear Substances**

The following is the type of information that the CNSC expects to see in a radiation protection program and is included here to assist carriers to develop a program. Additional guidance is available from the CNSC upon request; contact the CNSC at [transport@cnsccsn.gc.ca](mailto:transport@cnsccsn.gc.ca).

### **A.1 Carrier information**

Include the name of the company that is transporting the nuclear substances. Use an individual's name only if that person is a sole proprietor.

Include the legal, physical address of the company's head office, including the complete street name and number, and rural route number if appropriate, city, province or territory, and postal code. A post office box number may be included in addition to the street address. Provide a telephone number including the area code.

### **A.2 Roles and responsibilities**

Include the name, title and telephone number (including area code) of the person who is responsible for the company's radiation protection program.

Include the name, title and telephone number (including area code) of the manager who is responsible for supervising the company's radiation protection program.

Include a list of all the operational centres and locations that the company uses when transporting or storing nuclear substances. With each site (operational centre or location), include the name, title and telephone number (including area code) of a contact person for each site.

### **A.3 Scope and risk assessment**

The number of packages handled or transported each year affects the dose received by workers. The type of package also affects the dose. Include an actual count or "best estimate" of the total number of packages containing nuclear substances that the company transports per year.

Describe the types of nuclear substance packages transported. Packages containing nuclear substances are classified as follows:

1. Category I-White, Category II-Yellow and Category III-Yellow, based on the dose emitted at the surface and at 1 metre from the package.
2. "Excepted" packages do not have labels and can be used to transport only a limited quantity of nuclear substances. The dose rate at the surface is similar to the Category I-White. No special precautions are required for excepted packages and packages with Category I-White labels as the dose rate is low.

### **Identify the risks**

If the company transports fewer than 40 packages per year and no Category III-Yellow packages are involved, the risk is low. Otherwise, estimate the maximum radiation dose to identify the appropriate risk category. Part D provides a method for estimating the dose.

**A.4 Dose assessments**

The following provides one example of an accepted dose assessment model. This model is based on the number of packages in each category that an employee would handle in a year. If another dose assessment method is used, attach all information relevant to the dose measurement or calculation.

**Dose assessment model**

This table provides background information when calculating the estimated dose.

This information may be used for the formula calculation to estimate the maximum radiation dose to employees.

This table provides two estimates of the maximum number of packages over a one-year period:

1. for individuals who do not handle packages, but are in proximity to them
2. for individuals who handle packages

Category of Packages	Number of packages handled that could result in an annual dose of 1 mSv or greater	
	For each package, worker is at 1 metre for 30 minutes	For each package, worker is in contact for 5 minutes and at 1 metre for 30 minutes
Category I-White	4,000 packages	1,600 packages
Category II-Yellow	200 packages	40 packages *
Category III-Yellow	20 packages	7 packages **
Category III-Yellow + exclusive use	0 packages	0 packages
* Packages with an average dose rate of 0.25 mSv/h at contact and Transport Index = 1		
** Packages with an average dose rate of 1.25 mSv/h at contact and Transport Index = 10		

**Formula calculation to estimate the maximum radiation dose to employees**

Calculate the estimated dose and determine the risk category, as follows:

**Step 1:** Provide an actual count or “best estimate” of the maximum number of packages of each type that an employee would handle in a one-year period.

**Step 2:** Use the numbers from Step 1 to calculate the estimated dose (D).

**Step 3:** Use the estimated dose (D) to determine the risk category.

This calculation assumes that the worker receives the maximum exposure to each package. The maximum exposure to a package is defined as the worker being in contact with the package for five minutes and at a distance of 1 metre from the package for 30 minutes.

**Step 1:** Calculate the estimated dose:

List the maximum number of packages in Categories I, II, and III that an employee would handle in a one-year period.

1. Category I-White            A = \_\_\_\_\_ packages per year
2. Category II-Yellow        B = \_\_\_\_\_ packages per year
3. Category III-Yellow       C = \_\_\_\_\_ packages per year

**Step 2:** Calculate the estimated dose (D)

1. D (mSv) =  $(A/1600) + (B/40) + (C/7)$
2. D (mSv) =  $(\text{_____}/1600) + (\text{_____}/40) + (\text{_____}/7)$
3. D (mSv) = \_\_\_\_\_

**Step 3:** Determine the risk category for the radiation protection program

1.  Low                    If D is less than or equal to 1 mSv.
2.  Medium            If D is greater than 1 mSv and less than 5 mSv.
3.  High                If D is equal to or greater than 5 mSv.

### A.5 Monitoring radiation doses

Dose limits are meant to ensure that no individual is exposed to an unacceptable risk due to radiation exposure, and monitoring ensures that dose limits are not exceeded.

It is suggested to periodically reassess or review how doses were determined, especially when there is a change in the number or types of packages handled and transported.

When the area is classified as low risk, area monitoring can be done in the vicinity of the worker to demonstrate that working conditions remain satisfactory and meet regulatory requirements.

If using personal monitoring devices (such as TLDS), it is advisable to use a CNSC-licensed dosimetry service. Contact the CNSC at [transport@cnsccsn.gc.ca](mailto:transport@cnsccsn.gc.ca) for a list of licensed dosimetry services.

Any worker who is likely to receive more than 1 mSv per year in the normal course of their duties is considered a Nuclear Energy Worker (NEW). Most workers in the medium- and high-risk categories should be classified as NEWs.

### A.6 Surface contamination

Periodic monitoring for contamination on surfaces of packages, components, equipment, and conveyances is recommended, and may be conducted by the consignor or by the carrier.

If surface contamination is checked internally (by the carrier), include the relevant information such as the following:

1. the frequency of monitoring
2. the criteria for controlling surface contamination
3. an outline of the type and extent of the monitoring program

**A.7 Segregation**

Segregation involves keeping the packages away from people while in transport, in transit, or in storage. Simple techniques, such as placing packages away from drivers, or storing packages in secluded, unoccupied areas of a warehouse, can help to reduce exposures.

Include a description of segregation techniques that are practiced by workers handling packages containing nuclear substances, in storage and in transit.

**A.8 Emergency response**

Include the name, title, and telephone number (including area code) of the person, title or position responsible for the company's emergency response plan. Note that this individual should be available at this telephone number 24 hours a day, 7 days a week.

Include any other relevant information about the company's emergency response plan for nuclear substances.

**A.9 Training**

All workers involved in the transport of nuclear substances should be trained on the company's radiation protection program as well as the *Packaging and Transport of Nuclear Substances Regulations* and the *Transportation of Dangerous Goods Regulations*. Other training may be offered to workers, as required.

**A.10 Written work procedures**

A company's written work procedures should explain the handling, segregation, loading, storage, and identification and documentation of packages containing radioactive substances.

**A.11 Signatures**

At least two individuals should sign the radiation protection program confirming that they understand their responsibilities with respect to the company's safe transport of nuclear substances. These individuals include the person responsible for the radiation protection program, as well as the manager responsible for supervising the program.

**A.12 Checklist**

The following checklist may be used when designing a radiation protection program for the transport of nuclear substances. It will help identify information that should be included in a program.

Components of a Radiation Protection Program	Information Included	Not Applicable
<b>A. Carrier information</b>		
Carrier's name and address		
<b>B. Roles and responsibilities</b>		
Individual responsible for the radiation protection program		
Manager responsible for radiation protection program		
List of site offices, and contact person for each site		
<b>C. Scope and risk assessment</b>		
Number of packages transported annually		
Types of packages transported		
<b>D. Radiation dose estimate</b>		
Estimate of maximum radiation dose to employees		
Use formula to estimate maximum radiation dose to employees and determine risk category		
<b>E. Monitoring of radiation doses</b>		
Include procedures for periodic dose re-assessments, if conducted		
Is radiation detection equipment used? If so, what type and by whom?		
Are workers classified as Nuclear Energy Workers (NEWs)?		
<b>F. Surface contamination</b>		
Are radioactive surface contamination checks on surfaces of packages, components, equipment, and conveyances carried out? If so, are they done by the carrier or consignor?		
Frequency of surface contamination checks		
Criteria for controlling surface contamination		

Components of a Radiation Protection Program	Information Included	Not Applicable
Outline of the type and extent of the monitoring program		
<b>G. Segregation</b>		
Description of segregation techniques used in storage and in transit by workers handling packages containing nuclear substances		
<b>H. Emergency response information</b>		
Emergency response contact name, title or position, and a 24/7 telephone number including area code.		
Provide relevant details of the company's emergency response plan for nuclear substances.		
<b>I. Training</b>		
<i>Packaging and Transport of Nuclear Substance Regulations</i>		
<i>Transportation of Dangerous Goods Regulations</i>		
Application of this radiation protection program		
Other training		
<b>J. Written work procedures</b>		
To explain the company's emergency response plan		
To explain the handling of packages containing radioactive substances		
To explain the segregation of packages containing radioactive substances		
To explain the loading of packages containing radioactive substances		
To explain the storage of packages containing radioactive substances		
To verify the identification and documentation of packages containing radioactive substances		
<b>K. Signatures</b>		
Individual responsible for the radiation protection program		
Manager responsible for supervising the radiation protection program		

## References

1. *Nuclear Safety and Control Act*, S.C., 1997, c.9.
2. *Packaging and Transport of Nuclear Substances Regulations*, SOR/2000-208.
3. International Atomic Energy Agency, *Radiation Protection Programmes for the Transport of Radioactive Material*, Safety Standards Series No. TS-G-1.3, IAEA Vienna (2007), or as amended from time to time.
4. *Radiation Protection Regulations*, SOR/2000-203.
5. “*Doses to Transport Workers: Phase 2*”, ECOMatters Inc. RSP 0158, a report prepared for the Canadian Nuclear Safety Commission, Ottawa, Canada (2002).
6. International Atomic Energy Agency, *Regulations for the Safe Transport of Radioactive Material*, Safety Standards Series No. TS-R-1, 1996 Edition (ST 1, Revised), IAEA Vienna (2000).
7. International Atomic Energy Agency, Advisory Material for the IAEA, *Regulations for the Safe Transport of Radioactive Material*, Safety Standards Series No. TS-G-1.1, IAEA, Vienna (2002).
8. *Technical Instructions for the Safe Transport of Dangerous Goods by Air*, published by the International Civil Aviation Organization (ICAO) Doc. 9284 AN/905 (2011-2012), or as amended from time to time.
9. *International Maritime Dangerous Goods Code*, including Amendment No. 35-10, published by the International Maritime Organization (IMO) (2010), or as amended from time to time.
10. *Transport of Dangerous Goods Regulations*, SOR/2001-286. This section may contain reference information such as links to other documents on the Internet/Intranet.

### Additional Information

The following documents contain additional information that may be of interest to persons involved in implementing a radiation protection program:

1. International Atomic Energy Agency, *Planning and Preparing for Radioactive Material Transport Emergencies*, Safety Standards Series No. TS-G-1.2, IAEA, Vienna (2002).
2. International Atomic Energy Agency, *International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources*, Safety Series No. 115, IAEA, Vienna (1996).
3. International Atomic Energy Agency, International Labour Office, *Occupational Radiation Protection*, Safety Standards Series No. RS-G-1.1, IAEA, Vienna (1999).
4. International Atomic Energy Agency, International Labour Office, *Assessment of Occupational Exposure due to External Sources of Radiation*, Safety Standards Series No. RS G 1.3, IAEA, Vienna (1999).
5. International Atomic Energy Agency, International Labour Office, *Assessment of Occupational Exposure due to Intakes of Radionuclides*, Safety Standards Series No. RS-G-1.2, IAEA, Vienna (1999).
6. International Atomic Energy Agency, *Optimisation of Radiation Protection in the Control of Occupational Exposure*, IAEA Safety Report No. 21, IAEA, Vienna (2002).