IAEA
International Atomic Energy Agency

Transport of NORM

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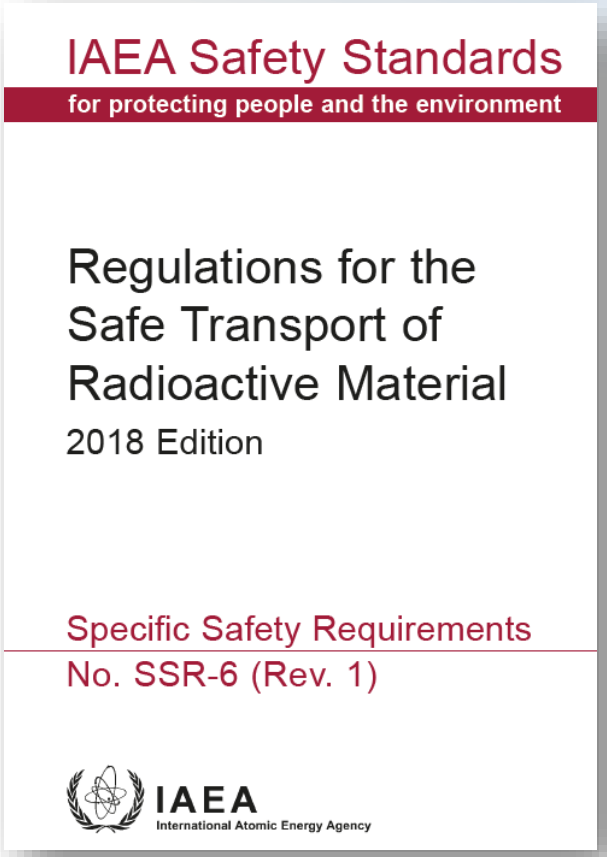
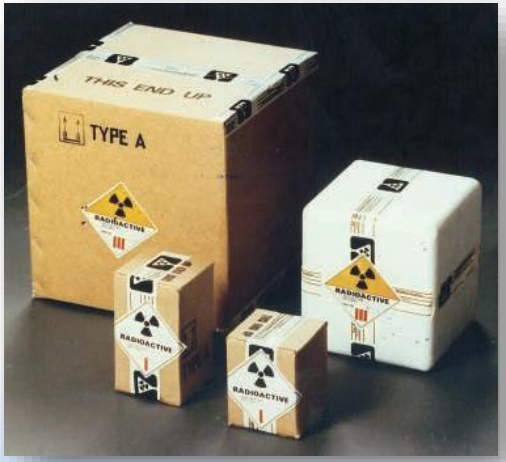
IAEA Transport Regulations

- The IAEA Regulations for the Safe Transport of Radioactive Material (also known as the 'Transport Regulations') are IAEA "requirements".
- The transport requirements for all types of radioactive materials are set down in SSR-6 (Rev. 1), 2018.
- This means that they should be complied with.
- NORM falls within the definition of radioactive material, however, not all NORM is subject to the requirements of the Transport Regulations
- The scope of application of the Transport Regulations to NORM depends on:
  - Activity concentrations
  - Whether or not the radionuclide content is incidental to the use of the material



Purpose of the Transport Regulations

- Protect people, property and the environment during transport of radioactive materials by;
  - Containment of radioactivity
  - Control of external radiation levels
- Designed to cover all radioactive materials



Application of the Regulations

- Depending upon the materials, there are different levels of application of the regulations with different requirements.
- The levels depend upon the material and are;
  - Regulations do not apply
  - Exempt
  - Excepted
  - Full application of regulations
- NORM can fall into any level (depending upon radionuclides and concentrations)

Application of the Regulations

- The regulations do not apply to;
  - *Natural materials and ores containing naturally occurring radionuclides, in secular equilibrium, which may have been processed, provided the activity concentration does not exceed 10 times the values in Table 2 of the Regulations*. (clause 107(f))
  - This equates to material that contains less than 10Bq/g of U_{nat} and 10Bq/g of Th_{nat}

- Therefore exemption may apply to ores or processed materials

Exemption of the Regulations

1. NORM that has been processed for purposes of extraction of its radionuclides, or is intended to be processed for use of these radionuclides:
   - The Transport Regulations apply if both the following criteria are exceeded:
     - The activity concentration for exempt material in transport
     - The activity limit for an exempt consignment

2. NORM in its natural state, or which has been processed for purposes other than for extraction of its radionuclides, and which is not intended to be processed for use of these radionuclides:
   - The Transport Regulations apply if both the following criteria are exceeded:
     - **10 times** the activity concentration for exempt material in transport
     - The activity limit for an exempt consignment

Exemption of the Regulations

- **Examples of activity concentrations for exempt material in transport:**
  - U_{NAT}, Th_{NAT}: 1 Bq/g
  - ^{234}U (lung class M): 100 Bq/g
  - ^{234}Th: 1000 Bq
  - All other U, Th series : 1 or 10 Bq/g
  - ^{40}K : 100 Bq/g

- **Examples of activity limit for an exempt consignments:**
  - U_{NAT}, Th_{NAT} : 1000 Bq
  - Individual U, Th series: 10 000 or 100 000 Bq
  - ^{40}K: 1 000 000 Bq

NORM Considerations

- For U, Th series radionuclides, the values for activity concentration and total activity automatically take into account the presence of certain specified decay products in equilibrium
  - For U_{nat} and Th_{nat}, all decay products are included
  - This is why the exemption levels are at the low end of the range

- For most NORM, the activity concentration rather than the total activity is likely to be the deciding factor
  - The amounts of material involved are such that the limits on total activity will usually be exceeded

NORM Considerations

- When radionuclides are out of equilibrium, there is a formula
- The concentration of each radionuclide is divided by its respective exemption level and the fractions are added together, as follows:

$$\sum_i \frac{x(i)}{X(i)} > 1 \quad \text{or} \quad \sum_i \frac{x(i)}{X(i)} > 10$$

where

- *x(i)* = activity concentration of radionuclide *i*
- *X(i)* = activity concentration for exempt material for radionuclide *I*

- (Note that there are two formulae because of clause 107(f))

Low specific activity (LSA) material

- LSA material — radioactive material which by its nature has a limited specific activity, or radioactive material for which limits of estimated average specific activity apply
- External shielding materials surrounding the LSA material are not considered in determining the estimated average activity concentration
- NORM that is subject to the Transport Regulations could be classified as LSA-I, LSA-II or LSA-III, depending on the activity concentration and other characteristics
- The LSA classification determines the specific requirements for transport, such as packaging and labelling
- LSA-I material may be transported unpackaged subject to certain conditions

Low specific activity (LSA) material

- NORM LSA material may also be transported in industrial packages such as drums, bags and ISO containers

Surface contaminated objects (SCO)

- SCO — a solid object which is not itself radioactive but which has radioactive material distributed on its surfaces
- A surface contaminated object that is subject to the Transport Regulations could be classified as SCO-I or SCO-II, depending on the surface activity concentration, the radionuclides involved and whether the contamination is fixed or non-fixed

- SCO-I objects may be transported unpackaged under certain conditions

Surface contaminated objects (SCO)

- Contamination is defined as the presence of a radioactive substance on a surface in amounts exceeding the following:
  - Beta, gamma, low toxicity alpha emitters: 0.4 Bq/cm^2
  - All other alpha emitters: 0.04 Bq/cm^2
- Low toxicity alpha emitters include:
  - U_{nat}, U_{dep}, Th_{nat}, ^{235}U or ^{238}U, ^{232}Th, ^{228}Th and ^{230}Th when contained in ores or physical and chemical concentrates
  - Alpha emitters with a half-life of less than 10 days
- Only objects whose surfaces are ‘contaminated’ according to this definition are subject to the Transport Regulations

Packaging

- Must be suitable to contain the radioactive material and prevent the spread of radioactivity during any incident which might occur during the transportation

- Type of package depends on;
  - Activity of material
  - Radionuclides present
  - Form of material (liquid, gas, solid)

- Radioactive material must be packed and stowed so that contents are retained under ‘routine conditions of transport’

- Does not need to be a rigid box
  - Eg pallet of drillcore trays, securely wrapped with plastic

Excepted Packages

- Doserate on surface less than 5 µSv/h (clause 516)
- Quantity of U_{nat} is unlimited (clause 408)
- UN Number 2910
- Transport documents describe package as:
  - Radioactive Material – Excepted Package limited Quantity of Material
  - Name and address of consignor and consignee
- No labels on outside of package expect for UN number
- Dangerous good certificate completed

Marking and Labelling

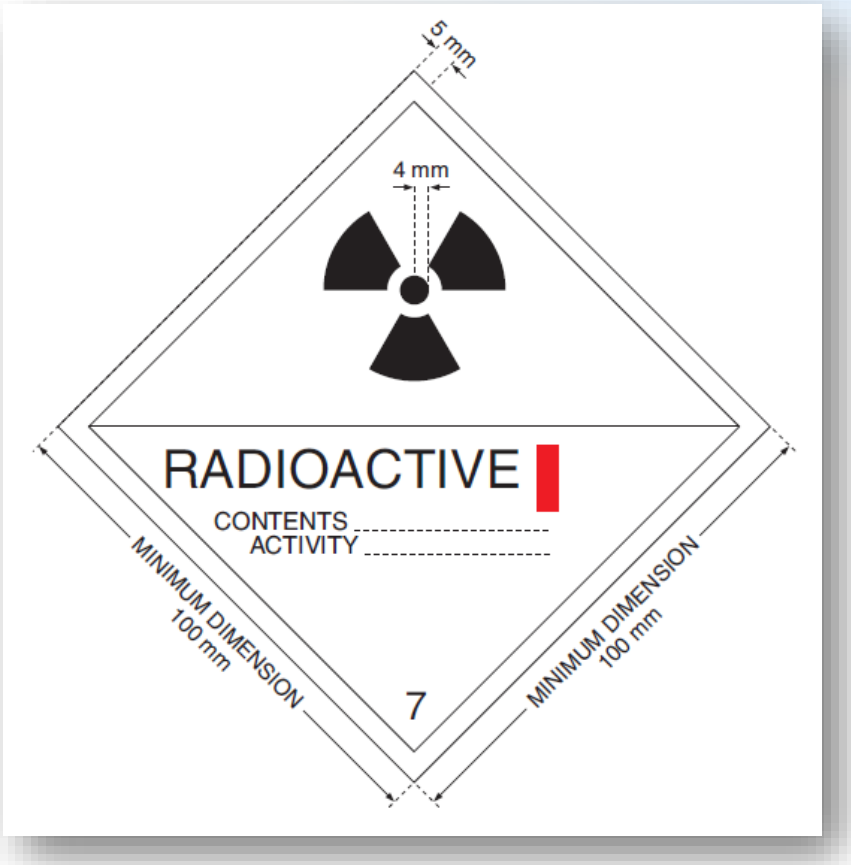
- UN number
- Labelling
  - 2 per package
- Placards
  - 4 per container
- Transport Index
  - Related to the radiation level 1 m from the package exterior
- Hazard labels
  - Includes secondary hazards

Marking and Labelling

- Examples of UN numbers relevant to NORM:
  - 2910 Radioactive Material, Excepted Package — Limited quantity of material
  - 2912 Radioactive Material, Low specific Activity (LSA-I)
  - 3321 Radioactive Material, Low specific Activity (LSA-II)
  - 3322 Radioactive Material, Low specific Activity (LSA-III)
  - 2913 Radioactive Material, Surface Contaminated Objects (SCO-I or SCO-II)

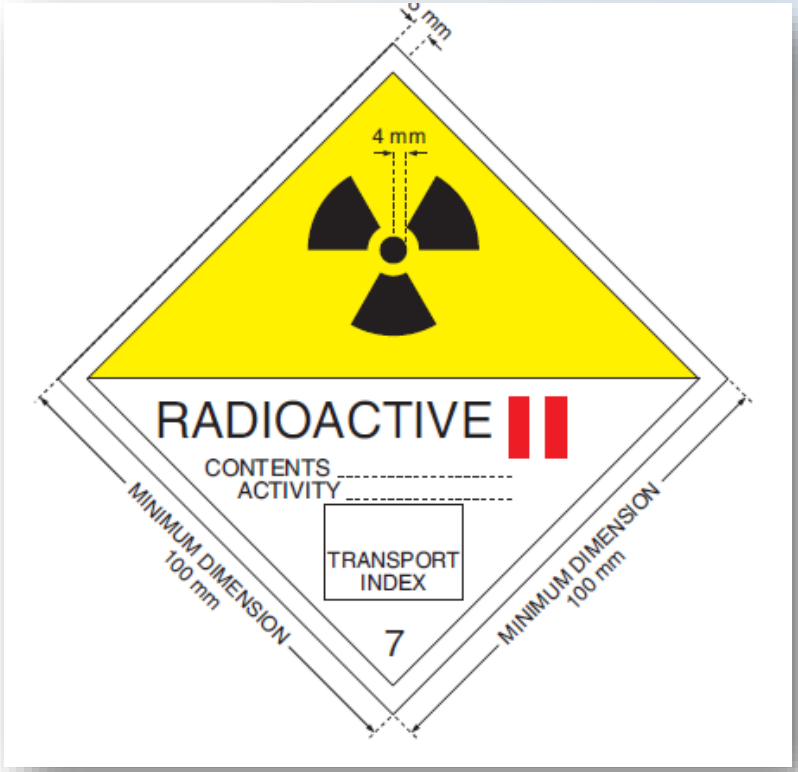
Category I-White

- Dose rate at surface
  < 5 µSv/h
- Dose rate at 1m
  < 0. 5 µSv/h
- Describe contents and estimate total activity, for NORM, use LSA
- If the surface dose rate is higher than figures above, it can be repacked



Category II-Yellow

- Used when dose rate at 1 m is > 0.5 mSv/h
- Describe contents and estimate total activity
- Need to add “Transport Index”



Transport Index

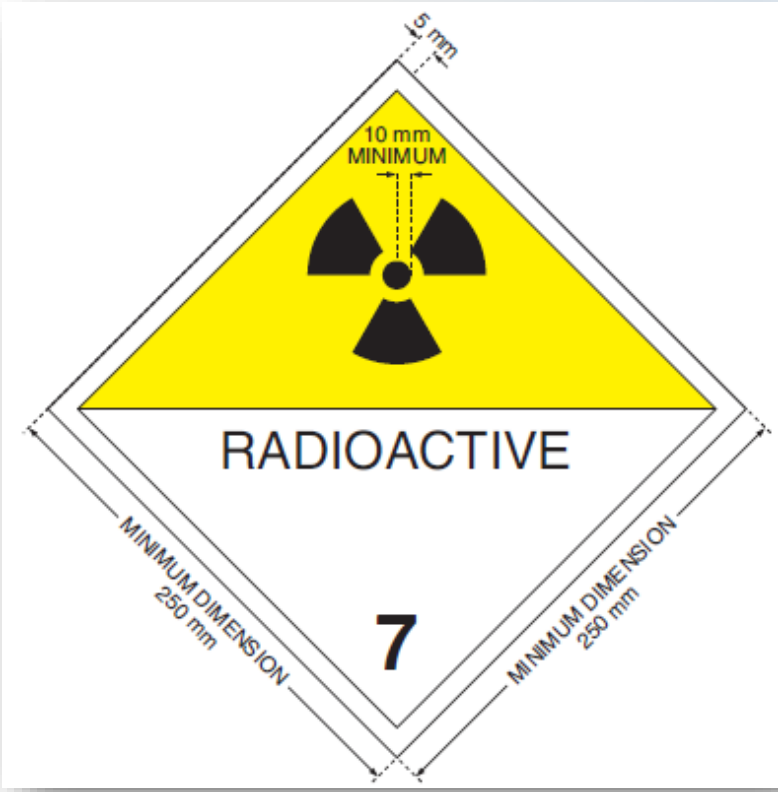
- Maximum dose rate at one metre from the package in mSv/h, multiplied by 100

Labelling Requirements

- White Label I
  - Dose rate on surface must not exceed 5µSv/h
- Yellow Label II
  - Dose rate on surface must not exceed 500µSv/h
  - Transport Index must not exceed 1
- Yellow Label III
  - Dose rate on surface must not exceed 2000µSv/h
  - Transport index must not exceed 10

Placard

- Placards go on the vehicle
  - Same style as dangerous goods placards
- 2 sides and rear of a vehicle
- 4 sides of a container



Documentation

- Dangerous goods declaration
- Consignor's note
  - Information on the consignor and consignee
  - Description of the radioactive material
  - Any additional safety information
  - Emergency instructions, telephone numbers, etc.

Declaration Form Information

- Proper shipping name
  - Radioactive Material Low Specific Activity (LSA-1)
- Radioactive material
  - Uranium ore
  - UN number 2912
- Activity, Hazard Category, Transport Index
  - As for label
- Package Classification
  - IP-1

Responsibilities

- There are three ‘players’
  - The consignor (the person sending the package)
    - Responsible for packaging, labelling and providing accurate documentation
  - The carrier
    - Responsible for carriage. Proper stowage, interim storage, undelivered packages, radiation protection, training of drivers and storekeepers etc
  - The driver
    - Safety and security of load, emergency procedures

Key Messages

- IAEA Transport Regulations are mandatory
- Regulations can appear to be detailed and complex
- Need to have good understanding of material being transported
- NORM is at low end of requirements