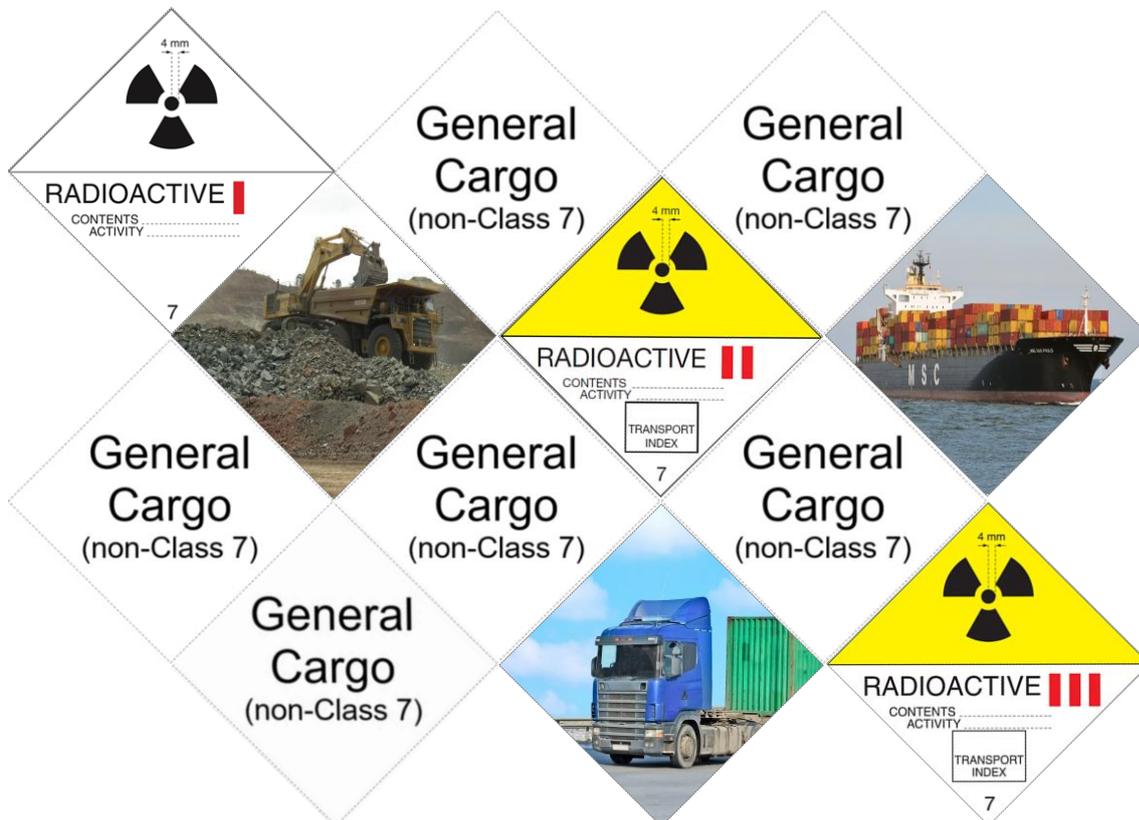


Transporting NORM

A guide to the transport of Niobium (Nb) and Tantalum (Ta) raw materials that are naturally occurring radioactive materials (NORM)



Executive Summary

Some niobium (Nb) and tantalum (Ta) raw materials contain traces of thorium (Th) and uranium (U) and are therefore naturally occurring radioactive materials (NORM).

From an assay of the material giving the concentration of Th and U it is possible to calculate the radioactivity concentration of the material measured in Becquerels per gram (Bq/g).

Material below 10 Bq/g is exempt from radioactive transport (Class 7) regulations and can be shipped as general cargo, but material above this level must be transported fully Class 7 compliant.

Shipments of NORM, especially those that qualify as Class 7, face an increased compliance burden from both international and national regulations compared to non-NORM shipments.

Although not insurmountable, the regulatory burden and the risks involved may deter a carrier or port from accepting NORM shipments, resulting in a denial of shipment (DOS).

Raising the awareness of this issue with both industry and the public, while keeping potential risks in context, is an important part of any NORM transport strategy.

This document aims to support T.I.C. members striving to comply with international, national and local regulations governing the safe and secure transport of radioactive materials, as required by the T.I.C.'s Transport Policy¹, since inappropriately shipped materials can have a negative impact on our industry.

Disclaimer

This document is for general information purposes only and does not constitute or replace any detailed advice with regard to NORM. For further information on this subject and on how to contact a NORM specialist through the T.I.C. please visit <http://www.tanb.org/>. The T.I.C. makes no claim as to the accuracy or completeness of this guide, or the suitability for the user's intended purpose and expressly disclaims any and all liability for the completeness and accuracy of, or any omissions from, this guide. This guide does not absolve the user from conducting its own research and discharging its professional duties. No liability whatsoever is accepted by the T.I.C. in connection with this guide. By its acceptance or use of this guide, the recipient of this guide acknowledges and accepts the terms of this disclaimer.

¹ <http://www.tanb.org/images/TIC%20Policy%20on%20transport.pdf>, see also Annex 4 of this report.

Contents

Executive Summary	2
Disclaimer	2
Acronyms and abbreviations	4
Introduction	5
Transport Regulations.....	6
Overview.....	6
The latest IAEA transport regulations: SSR-6	7
Transport difficulties.....	8
Definitions	9
Naturally Occurring Radioactive Material (NORM)	9
Radiation.....	9
Radioactivity	9
Annex 1: Worked examples	11
Annex 2: A checklist for regulatory compliance for NORM transport	12
Labels for Class 7 transport	14
UN 2910 versus UN 2912	15
Annex 3: Guidance materials and further reading	16
SSR-6 guidance material	16
Other transport regulations, including modal regulations.....	16
Further reading	17
Helpful websites.....	18
Annex 4: T.I.C. Transport Policy	19
Background.....	19
Policy	19
Scope	19

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Acronyms and abbreviations

ADR	European Agreement on International Carriage of Dangerous Goods by Road
Becquerel	A measure of radioactivity. One “Becquerel” is one radioactive decay per second.
Bq/g (or Bq g ⁻¹)	Becquerels per gram, the radioactivity concentration
Class 7	United Nations Model Regulations category Class 7 Dangerous Goods
DOS	Denial of shipment
IAEA	International Atomic Energy Agency
ICAO	International Civil Aviation Organisation
IMDG code	IMO International Maritime Dangerous Goods Code.
IMO	International Maritime Organisation
K	Potassium
Nb	Niobium
NORM	Naturally occurring radioactive materials
RID	European Regulations on the International Carriage of Dangerous Goods by Rail
SSG-26	IAEA advisory material on SSR-6 regulations (previously called TS-G-1.1)
SSG-33	IAEA safety standards on SSR-6 regulations (previously called TS-G-1.6).
SSR-6	IAEA Regulations for the Safe Transport of Radioactive Material (previously called TS-R-1)
Sv	Sievert
µSv/h	micro-Sievert per hour
Ta	Tantalum
Ta ₂ O ₅	Tantalum pentoxide
TFWG	Transport Facilitation Working Group
Th	Thorium
ThO ₂	Thorium dioxide
T.I.C.	Tantalum-Niobium International Study Center
TS-G-1.6	IAEA safety standards replaced by SSG-33 in 2012
TS-R-1	IAEA regulations replaced by SSR-6 in 2012
U	Uranium
U ₃ O ₈	Triuranium octaoxide, the most stable oxide of uranium
UN 2910	Class 7 rules for an “Excepted Package” with a surface radiation level <5 µSv/h
UN 2912	Class 7 rules for a package with a surface radiation level >5 µSv/h
UNECE	United Nations Economic Commission for Europe
WNA	World Nuclear Association
WNTI	World Nuclear Transport Institute

Introduction

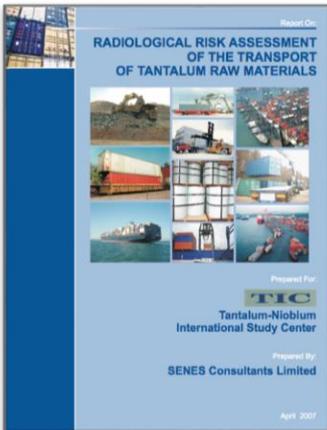
Naturally occurring radioactive materials (NORM) are ubiquitous in the natural environment and are commonly found in sands, clays, ores and minerals, by-products, recycled residues, and other materials used by humans. For many niobium (Nb) and tantalum (Ta) raw materials, such as columbite, tantalite, 'coltan', tin slag and suchlike, thorium (Th) and uranium (U) atoms are locked within the mineral matrix and therefore these raw materials are NORM.

Since the Th and U atoms are believed to interchangeably occupy the same crystal sites as the Nb and Ta atoms, it is almost impossible to separate the Th and U from these raw materials solely by physical mineral concentration. Instead, columbite, tantalite and tin slag usually require specialised chemical processing, typically digestion in hot hydrofluoric acid (HF) and sulphuric acid (H₂SO₄), following which the Th and U can be removed safely⁴. It is common that such processing facilities are far from the mine sites and that transport is required, most often by sea.

Transporting radioactive materials is challenging but feasible. International transport regulations and agreements based on regulations and guidance from the International Atomic Energy Agency (IAEA) determine the maximum concentrations of Th and U in a substance, below which limit shipments may be treated as general cargo.

Materials containing Th and U above the internationally agreed exemption level must be transported as Class 7 Dangerous Goods and in compliance with the relevant regulations to ensure their safe transport. Companies have a legal duty of care to their workers and the public and need to comply with these requirements. In addition to the IAEA's regulations and guidance country-specific requirements frequently add a layer of complexity to transporting NORM. Individual countries have the sovereign right to amend or add to the regulations applicable in their country, and frequently do.

This guide introduces the subject of NORM transport, giving a summary of the information available and offering a guide to the key steps companies could take to ensure they fulfil their regulatory obligations, but it cannot claim to be exhaustive given the complexity and variations in national regulations in existence.



T.I.C. NORM Risk Assessment

In a survey carried out by the T.I.C. as part of a risk assessment on tantalum and niobium raw materials, 95% were found to be between 5 and 50 Bq/g.

The report was prepared by the independent consultant SENES to determine the radiological characteristics of these materials and to evaluate the potential radiological exposures associated with normal transport and in the event of an accidental spillage. It is available from T.I.C. at <http://www.tanb.org/view/transport-of-norm>

⁴ Pyrochlore is typically treated near the mine site, with an aluminothermic reduction process removing the Th/U to a waste slag. Some columbites (e.g. in Brazil) are also successfully being treated near the mine sites.

Transport Regulations

Overview

International NORM transport regulations are overseen by the IAEA⁵, a United Nations agency based in Vienna, Austria. This agency has a mandate “to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world,”⁶ and since 1961 this has included a mandate regarding transport regulations of radioactive materials. Over the following decades these regulations have undergone a continuous and comprehensive process of review and revision.



The IAEA regulations are applied along two parallel paths:

- International and transnational regulations:

IAEA regulations are incorporated into the United Nations Model Regulations for Dangerous Goods, which are then used as the basis for the ‘modal regulations’ for international transport by air, land or sea, including:

 - UNECE: United Nations Economic Commission for Europe.
 - ADR: European Agreement on International Carriage of Dangerous Goods by Road.
 - RID: Regulations concerning the International Carriage of Dangerous Goods by Rail.
 - IMO (IMDG code) : International Maritime Organisation (International Maritime Dangerous Goods Code).
 - ICAO-TI: International Civil Aviation Organisation – Technical Instructions.
- National regulations:

Each country implements the IAEA regulations to a varying degree. Some are nearly identical texts, other countries modify, add or remove sections of the text, leading to differences between jurisdictions.

A government organisation designated to work in connection with the IAEA’s transport regulations is known as a “competent authority”⁷. Such organisations have the responsibility for ensuring that national legislation assures compliance with the requirements in the IAEA’s transport regulations. If you are involved in NORM materials you should be prepared to cooperate with relevant competent authorities to demonstrate compliance with transport regulations.

The key thing to remember with this regulatory structure, is that a company must comply with *national* regulations in each country where its material is transported, as well as any *local* regulations in ports, cities or regions, and *additionally* with *international* regulations for those stretches of transport that fall within the scope of those international regulations.

⁵ <https://www.iaea.org/>

⁶ Statute of the IAEA, 23 October 1956, as amended 28 December 1998, Article III, para. 6.

⁷ A list of competent authorities as at 22 March 2016 is available from the IAEA website: <https://www-ns.iaea.org/downloads/rw/transport-safety/competent-authorities-list.pdf>

For example:

For a transport from country A via a sea route to country B and subsequently land transport to country C, the consignor company must comply with the following:

- *National* regulations in origin country A for the land transport from the consignor facility to the port, and any regulations particular to that port;
- *IMDG Code* for the sea transport from the port in country A to the port in country B;
- *National* regulations of the flag country of the ship used for sea transport;
- *National* regulations and any *port* regulations in every port of call (whether transit or transshipment), along the route from country A to country B;
- *Port* regulations on arrival in country B, and *national* regulations in country B for the land transport from the port to the border with country C;
- *National* regulations in destination country C for the land transport to the final destination (from the border with country B to the consignee facility);

In addition,

- Where it exists, a regional agreement such as *ADR*⁸ or *RID*⁹ for the land transport from the port in country B to the consignee facility in country C.

Note that the IAEA regulations do not appear anywhere in the above example, however the IAEA regulations form the basis for all the other regulations, therefore familiarity with the IAEA regulations provides a good grounding for complying with the other regulations.

The latest IAEA transport regulations: SSR-6

The latest edition at the time of writing (December 2016) are the “Regulations for the Safe Transport of Radioactive Material, 2012 Edition”, also known simply as SSR-6¹⁰. This edition replaced TS-R-1 last published in 2009. SSR-6 defines radionuclide specific exemption levels in units of radioactivity concentration Bq/g, below which materials are outside the scope of regulatory control. The exemption levels are raised by a factor of 10 for natural materials and ores, including materials processed by physical and/or chemical means.

For the transport of niobium and tantalum raw materials, the radionuclides of concern are essentially only those listed as Th(nat) and U(nat), provided that these two elements are in natural equilibrium with their decay products. The exemption levels listed in SSR-6 are 1 Bq/g for both Th(nat) and U(nat), therefore for NORM the exemption level becomes 10 Bq/g.

Further reading, guidance, research papers and so forth are listed in Annex 3.

⁸ European Agreement Concerning the International Carriage of Dangerous Goods by Road.

⁹ Regulations concerning the International Carriage of Dangerous Goods by Rail.

¹⁰ SSR-6 can be downloaded at http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1570_web.pdf

Transport difficulties

Among some sectors of the public and transport authorities there is a negative perception of any NORM materials and particularly those materials subject to Class 7 regulation, regardless of the actual nature of NORMs, their characteristics and the many important benefits they can bring to society.¹¹

Transport in compliance with all applicable regulations therefore faces several difficulties:

- Conflicting requirements between international and national regulations, and/or between different national regulations. These may arise in classification criteria, requirements during transport, or any other area open to contradiction.
- The negative perception of radioactive materials by some authorities and the public. This has led to bans from transport through certain areas, or additional requirements at the national or local level, sometimes politically motivated.

Furthermore, one must appreciate that a ship's captain, a plane's pilot and a port's harbourmaster each has the legitimate right to decline carriage or passage to any package they personally deem unsafe (whether or not that package is actually unsafe).

The complex compliance burden on transporting NORM, combined with the risks of unintentional non-compliance due to conflicting requirements of national regulations can lead to a carrier making the commercial decision that the transporting of Class 7 goods is not a profitable business, resulting in denial of shipment (DOS) for such Class 7 goods. For a company wishing to arrange a shipment of radioactive material, this difficulty will then manifest itself in a lack of carriers willing to quote for the transport required, or in rate quotes that are a multiple of the general freight rate.

While working on the one hand to meet its regulatory obligations, a company facing these difficulties may wish to consider the following parallel approach:

- Research the potential routes from consignor to consignee. In the case of maritime transport, this should include every port of call, noting whether this would involve transit or transshipment.
- Identify the regulations applicable in each country, region and port along the transport route. Contact the authorities in each of these areas to verify transport information.
- Contact the competent authority¹² in your country, introduce your company, and build a trusting relationship. Maintaining good communication and mutual trust with your regulator may be useful both in the short and the long term.
- Armed with the above researched information and contacts, approach freight forwarders and carriers from a position of strength to explain the transport required.

¹¹ Some authorities are surprised to discover that not all Class 7 material is nuclear waste: in fact the vast majority of Class 7 shipments are medical radiopharmaceuticals such as molybdenum-99 which is usually shipped in small quantities by air freight.

¹² A list of competent authorities as at 22 March 2016 is available from the IAEA website: <https://www-ns.iaea.org/downloads/rw/transport-safety/competent-authorities-list.pdf>

Definitions

Naturally Occurring Radioactive Material (NORM)

NORM is essentially defined¹³ as containing only the naturally occurring radionuclides K-40, U-235, U-238 and Th-232 and their radioactive decay products. For niobium and tantalum raw materials, there should not be any other radionuclides *i.e.* of artificial/human origin, while the K-40 content is unlikely to be of significance.

The definition for NORM further states that “Material in which the activity concentrations of the naturally occurring radionuclides have been changed by a process is included in naturally occurring radioactive material.”, therefore untreated ores, mineral concentrates, tin slags, and the waste produced after chemical processing of these raw materials, all fall under the classification of NORM.

Note that in the USA and some other countries NORM is sometimes subdivided to include the term “technologically enhanced NORM” (“TENORM”). This distinction is used by those who state that NORM should not include materials with radionuclides disturbed or altered from their natural equilibrium. However, IAEA does not use this term and nor does the T.I.C.

Radiation

“Radiation” is a measure of the energy given off by radioactivity, *i.e.* something radioactive.¹⁴ There are different types of radiation, and the one of chief concern for niobium and tantalum NORM is in the form of gamma rays. The gamma radiation can be measured by instruments e.g. a Geiger-Müller tube, it is often described as the “dose rate”, and is most often measured in units of Sievert (Sv) over a time period. The Sievert is a large unit, and the most common measures encountered are $\mu\text{Sv/h}$ (micro-Sievert per hour) or mSv/y (milli-Sievert per year). Note that $1 \text{ mSv} = 1'000 \mu\text{Sv}$.

Radioactivity

“Radioactivity” is the decay of radioactive atoms in a substance. Radioactive atoms are naturally unstable atoms, and these will undergo a spontaneous change in order to achieve a more stable composition. The frequency with which these atoms decay is the radioactivity, and this is measured in units of Becquerel (Bq), where one Becquerel equals one atomic decay per second. The amount of radioactivity in a mass of material is known as the “radioactivity concentration”, measured in Becquerel per unit mass. The Becquerel is a very small unit, and the most common measures encountered are:

- MBq (mega Becquerel)
- GBq (giga Becquerel)

¹³ IAEA Safety Glossary 2007, p. 126, “naturally occurring radioactive material (NORM)”: “Radioactive material containing no significant amounts of radionuclides other than naturally occurring radionuclides.”.

¹⁴ A common analogy is to consider a burning candle; “radioactivity” is the combustion of the wax in the candle flame, while “radiation” is the heat given off by the candle flame.

- Bq/g (Becquerel per gram)
- kBq/kg (kilo Becquerel per kilogram)

Note that 1 GBq = 1'000 MBq = 1'000'000'000 Bq, while 1 Bq/g = 1 kBq/kg (they amount to the same).

Note also that there is no straightforward way of calculating the radiation level in Sieverts from a radioactivity level in Becquerels or vice versa.

Calculating Becquerels per gram (Bq/g) from an assay

In all documentation issued by the T.I.C., unless noted otherwise, figures quoted in Bq/g (the “radioactivity concentration”) refer to the relevant (parent) nuclide only, in accordance with the values for Th(nat) and U(nat) listed in the IAEA regulations SSR-6¹⁵ of 2012, which have remained unchanged since first introduced in 1996 and are still the authority at time of writing.

The Bq/g values can be measured directly by gamma spectroscopy¹⁶, or by a simple conversion from elemental analysis for thorium and uranium. Since assays can measure either elemental Th/U or the oxide form the method of calculation is given here for both.

The conversion factors applied are as follows:

For Th/U oxide:

- 1% ThO₂ = 35.6 Bq/g
- 1% U₃O₈ = 104 Bq/g

For elemental Th/U:

- 1% Th = 40.6 Bq/g
- 1% U = 123 Bq/g

See Annex 1 for worked examples of how to calculate the Bq/g from assay results.

¹⁵ <http://www-pub.iaea.org/books/IAEABooks/8851/Regulations-for-the-Safe-Transport-of-Radioactive-Material>

¹⁶ Gamma-ray spectroscopy measures the frequency and energy intensity of gamma rays emitted by a material. It is a specialist analytical method providing a high degree of sensitivity and accuracy, particularly useful if a chemical analysis method or instrument is not sufficiently sensitive to low levels of thorium and uranium.

Annex 1: Worked examples

1)

If a material contained 0.04% ThO₂ and 0.06% U₃O₈, the radioactivity concentration would be:

$$(0.04\% * 35.6) + (0.06\% * 104) = 1.42 + 6.24 = 7.66 \text{ Bq/g}$$

In this case the material would be **below** the 10 Bq/g exemption level for transport and therefore could be transported as general cargo. Note however that low activity materials that qualify as general cargo may still trigger alarms e.g. gate monitors at industrial facilities or handheld monitors used by authorities in ports and at border crossings, therefore documentation to demonstrate the low activity should always accompany such materials during transport.

2)

If a 200 kg drum contained 0.08% ThO₂ and 0.09% U₃O₈, the radioactivity concentration would be:

$$(0.08\% * 35.6) + (0.09\% * 104) = 2.85 + 9.36 = 12.2 \text{ Bq/g}$$

In this case the material would be **above** the 10 Bq/g exemption level.

Materials above the 10 Bq/g exemption level and therefore subject to transport regulations, will also need to have the total radioactivity calculated for the package. The total radioactivity for the 200 kg dry content of the package:

$$200'000 * 12.2 = 2'440'000 \text{ Bq} = 2.44 \text{ MBq}$$

Note that total radioactivity figures are always likely to be large, therefore for convenience these are expressed as MBq, GBq etc.

3)

If a 20 tonne container held 0.80% Th and 0.18% U (note the difference from ThO₂ and U₃O₈), the radioactivity concentration would be:

$$(0.80\% * 40.6) + (0.18\% * 123) = 32.5 + 22.1 = 54.6 \text{ Bq/g}$$

In this case the material would be **above** the 10 Bq/g exemption level.

As in example 2, materials above the 10 Bq/g exemption level also need to have the total radioactivity calculated for the package. The total radioactivity for the 20 tonne dry content of the package:

$$20'000'000 * 54.6 = 1'092'000'000 \text{ Bq} = 1.09 \text{ GBq}$$

Annex 2: A checklist for regulatory compliance for NORM transport

Here follows a step-by-step approach to help establish regulatory compliance when planning to perform a shipment of NORM that may be subject to Class 7 transport regulations, and where to find further details. Some of these requirements will appear onerous e.g. steps 2) to 5), however this will only be the case when first setting up these systems and is to be expected when undertaking any new complex work.

- 1) Determine the radioactivity concentration of the material in units of Bq/g (see worked examples in Annex 1):
 - a) If it is below 10 Bq/g, the material is exempt from Class 7 transport regulations. You may ship the material accompanied by an analysis certificate to demonstrate this.
 - b) If it is above 10 Bq/g, the material is subject to Class 7 transport regulations; proceed to Step 2.
- 2) Establish a company **management system** based on recognised standards, for all activities relevant to the transport of NORM. You should be prepared to give the competent authority access to your facilities for inspection to demonstrate compliance with the transport regulations. See IAEA document **TS-G-1.4**¹⁷ for further guidance.
- 3) Establish a basic **radiation protection programme** for the transport of the NORM. The nature and extent of the measures to be employed will be relatively straightforward provided the magnitude and likelihood of radiation exposures are kept low. Companies that do not keep NORM on their own premises should ensure their sub-contractors discharge this duty. See IAEA document **TS-G-1.3**¹⁸ for further guidance.
- 4) Ensure workers receive appropriate **training** concerning radiation protection, and relevant regulations including the IAEA transport regulations. Training should be tailored to each role and may include any/all of the following topics:
 - a) General awareness: categories of radioactive material; labelling, marking, placarding, packaging and segregation; transport documents; emergency response documents.
 - b) Function specific: specific requirements applicable to person's function.
 - c) Safety: (i) accident avoidance, including handling equipment and stowage methods; (ii) emergency response information; (iii) general dangers of the various categories of radioactive material and how to prevent exposure; (iv) procedures to be followed in the event of a leak/spillage, and any emergency response procedures.
- 5) Prepare an **emergency response** plan in the event of accidents or incidents during the transport of radioactive material. The emergency provisions in the plan shall be designed

17 http://www-pub.iaea.org/MTCD/publications/PDF/Pub1352_web.pdf

18 http://www-pub.iaea.org/MTCD/publications/PDF/pub1269_web.pdf

so as to protect persons, property and the environment. This type of planning is relatively straightforward for low level NORM. See IAEA document **TS-G-1.2**¹⁹ for further guidance.

- 6) Ensure the packaging to be used meets the general requirements listed on pages 23 and/or 33 of **SSG-33**²⁰. The packaging will usually need to be to “Industrial Package type 1” (IP-1) standard.²¹
- 7) Prepare the package for shipment (*i.e.* fill the packaging with the NORM material to be transported). Determine the surface dose rate of the packaged material. *I.e.* once the material is packed ready for shipment, measure the dose rate at the surface of the package:
 - a) If it is below 5 µSv/h, it is considered an “Excepted Package” with the code **UN 2910**. It is still Class 7 however the regulatory requirements are simplified to reflect the low risk of this material. See pages 23-27 of **SSG-33** for a full list of the **SSR-6** regulatory paragraphs to be complied with.
 - b) If it is above 5 µSv/h, it is given the code **UN 2912** for “RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I), non-fissile or fissile-excepted”. See pages 33-43 of **SSG-33** for a full list of the **SSR-6** regulatory paragraphs to be complied with. See also Step 8 regarding Transport Index (TI) and labelling.
- 8) **UN 2912** packages should have their TI determined by measuring the highest radiation dose rate in mSv/h (milli Sievert per hour) around the package at a distance of one metre, and multiplying this value by 100 to obtain the TI. The TI value determines the type of label to be applied and is noted on this label (except for White-I):

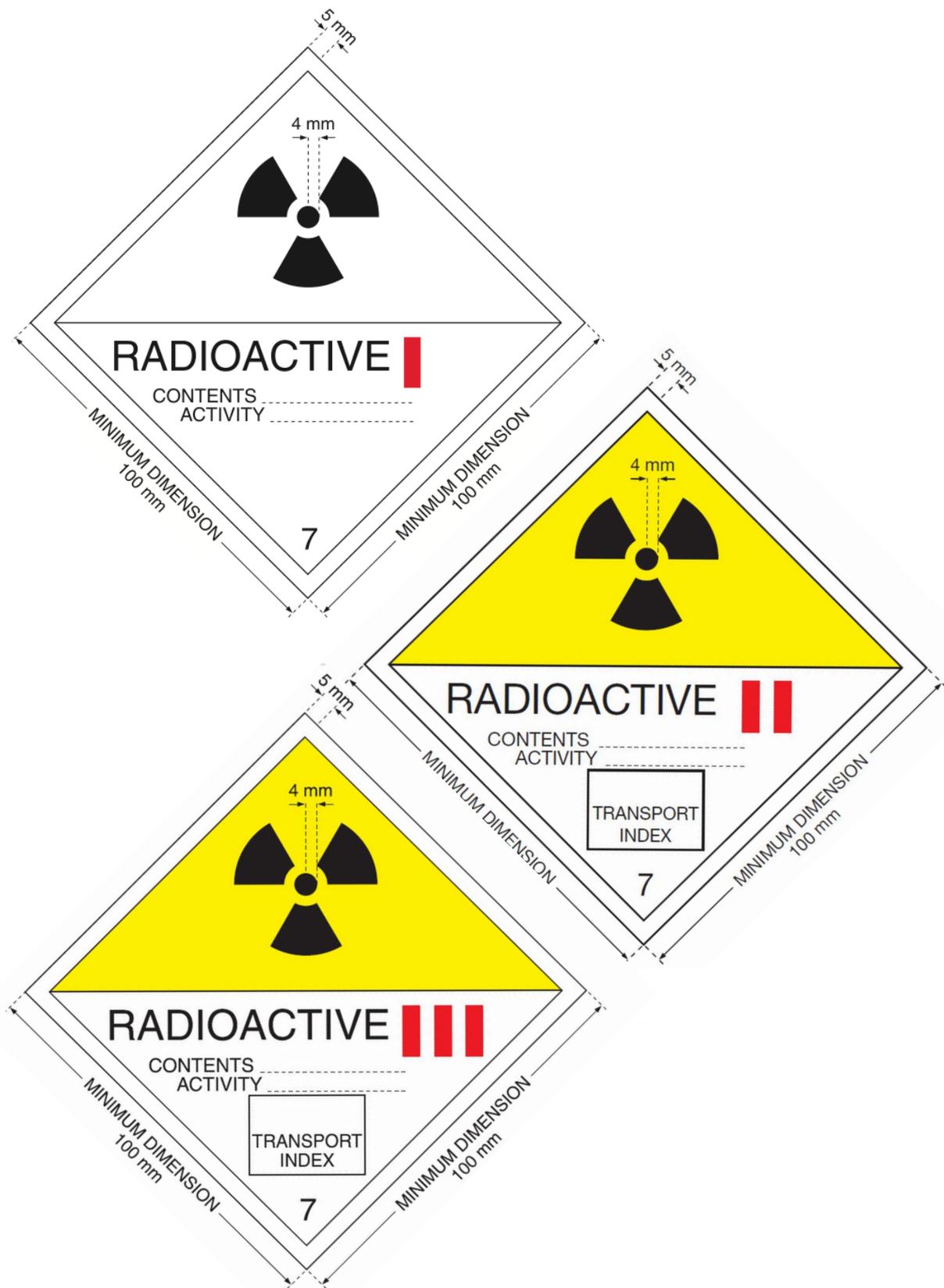
Transport Index (TI)	Label type
Less than or equal to 0.05: may be quoted as “0”	White-I
0 to 1	Yellow-II
1 to 10	Yellow-III
More than 10	Yellow-III under <i>Exclusive Use</i>

¹⁹ http://www-pub.iaea.org/MTCD/publications/PDF/Pub1119_scr.pdf

²⁰ **SSG-33** basically provides a full summary of the requirements, listing the regulatory paragraphs that apply to each UN number. To ship UN 2910 or UN 2912, look up the relevant UN number and you find a list of the applicable paragraphs to be complied with. The 2005 version of this document was known as **TS-G-1.6**. <http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1666web-37958620.pdf>

²¹ The requirements will depend on whether the NORM is likely to be UN 2910 or UN 2912 (it is generally UN 2912). In some borderline instances the 2910/2912 status cannot be known until the material is packaged ready for shipment. The requirements for the two are however broadly similar and should not present a problem.

Labels for Class 7 transport ²²



²² These labels are taken from the IAEA document **SSR-6**, pp. 69-71. See also pp. 74-75 of the same document for examples of placards.

UN 2910 versus UN 2912

Some of the key differences between **UN 2910** and **UN 2912** requirements are as follows (note these are differences only, this is not a full list of requirements). Note that where a content limit is specified, for both 2910 and 2912 this is unlimited due to the “A₂” value for Th(nat) and U(nat) being unlimited.²⁴

UN 2910	UN 2912
May contain and be transported with other goods.	The package may not contain any items other than those that are necessary for the use of the radioactive material.
Must be packaged.	May be transported unpackaged under “ <i>Exclusive Use</i> ”.
The radiation level at any point on the external surface of an excepted package may not exceed 5 µSv/h.	The maximum radiation level at any point on any external surface of the package or overpack may not exceed 2 mSv/h (note alternatives and exceptions).
TI not required.	TI to be determined. Packages and overpacks are assigned to category I-WHITE, category II-YELLOW or category III-YELLOW.
Mark each package with “UN 2910”.	Mark each package with “UN 2912” and “RADIOACTIVE MATERIAL, LOW SPECIFIC ACTIVITY (LSA-I)”. Also mark each package that conforms to an IP-1 design with “TYPE IP-1”.
Marking with the word “RADIOACTIVE” on an <u>internal</u> surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.	Labels must be fixed to two opposite sides of the outside of the package or overpack, or on all four sides of a freight container. Mark the label with the contents “LSA-I” and the maximum activity of the contents (in MBq or GBq, see examples in Annex 1).
May be sent by domestic and international post (e.g. for samples).	May not be sent by post. Various restrictions and requirements to be implemented during transport.

²⁴ The “A₂” value is a limit for most radionuclides, for how much may be carried in a so-called “Type A” package. Most NORM base their radioactivity on natural thorium Th(nat) and uranium U(nat) whose A₂ values are “*Unlimited*”, and therefore any limits based on the A₂ are also unlimited for these NORM.

Annex 3: Guidance materials and further reading

The full text of IAEA's transport regulation **SSR-6** can be downloaded at http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1570_web.pdf

SSR-6 guidance material

In addition to the **SSR-6** regulations, the IAEA also maintains the following guidance documents²⁵ which are reviewed and revised on a regular basis. These are useful in helping to understand the purpose of regulatory text and how it may be complied with, and in this respect the two more useful documents in this list are **SSG-26** and **SSG-33**:

- Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition) – **SSG-26**;²⁶
<http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1586web-99435183.pdf>
- Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material – **TS-G-1.2 (ST-3)** – 2002 Edition;
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1119_scr.pdf
- Radiation Protection Programmes for the Transport of Radioactive Material – **TS-G-1.3** – 2007 Edition;
http://www-pub.iaea.org/MTCD/publications/PDF/pub1269_web.pdf
- The Management System for the Safe Transport of Radioactive Material – **TS-G-1.4** – 2008 Edition;
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1352_web.pdf
- Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition) – **SSG-33** – published in 2015;²⁷
<http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1666web-37958620.pdf>

Other transport regulations, including modal regulations

As explained in the Transport Regulations Overview, the IAEA document **SSR-6** acts only as a recommendation, despite having the word “Regulations” in its title.²⁸ **SSR-6** forms the basis for other modal regulations, for example:

- The “Recommendations on the Transport of Dangerous Goods, Model Regulations” (United Nations Model Regulations) – Rev. 19 published 2015;
http://www.unece.org/trans/danger/publi/unrec/rev19/19files_e.html

²⁵ Note the related document “Compliance Assurance for the Safe Transport of Radioactive Material” – TS-G-1.5 – 2009 Edition (http://www-pub.iaea.org/MTCD/publications/PDF/Pub1361_web.pdf) is intended for government competent authorities only.

²⁶ **SSG-26** is basically an accompanying text to be read in conjunction with the regulations **SSR-6**: almost paragraph by paragraph, **SSG-26** explains the purpose and background of the text in **SSR-6**. The 2008 and earlier versions of this document were known as **TS-G-1.1**.

²⁷ **SSG-33** basically provides a full summary of the requirements, listing the regulatory paragraphs that apply to each UN number. To ship UN 2910 or UN 2912, look up the relevant UN number and you find a list of the applicable paragraphs to be complied with. The 2005 version of this document was known as **TS-G-1.6**.

²⁸ It is only used as “regulations” for transport organised for the IAEA.

- The “International Maritime Dangerous Goods Code” (IMDG Code) for transport by sea – published 2016 (not available for free download);
<http://www.imo.org/en/Publications/IMDGCode/Pages/Default.aspx>
- The “European Agreement Concerning the International Carriage of Dangerous Goods by Road” (ADR) for transport by road in the EU and signatory countries – published 2015;
<http://www.unece.org/trans/danger/publi/adr/adr2015/15contentse.html>
- The “Regulations concerning the International Carriage of Dangerous Goods by Rail” (RID) for transport by rail in the EU and signatory countries – published 2015;
<http://www.otif.org/index.php?id=542&L=2>
- The “European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterway” (ADN) for transport by inland waterway in the EU and signatory countries – published 2015;
http://www.unece.org/trans/danger/publi/adn/adn2015/15files_e.html
- The “Technical Instructions for the Safe Transport of Dangerous Goods by Air” (ICAO Technical Instructions) for transport by air – published 2015;
<http://www.icao.int/safety/DangerousGoods/Pages/technical-instructions.aspx>

Further reading

The IAEA also publishes a variety of research papers, reviews and studies, in addition to there being various texts that lay out the basic principles on which all regulations are based (*i.e.* not just transport). While not required reading for anyone wishing to comply with transport regulations, they provide a broader and deeper background for those interested in understanding the basis for and wider context around the transport regulations.

- Fundamental Safety Principles – **SF-1** – 2006 Edition;
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1273_web.pdf
- Assessing the Need for Radiation Protection Measures in Work Involving Minerals and Raw Materials – **SRS-49** – 2006 Edition; *
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1257_web.pdf
- Application of the Concepts of Exclusion, Exemption and Clearance – **RS-G-1.7** – 2004 Edition;
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1202_web.pdf
- Input data for quantifying risks associated with the transport of radioactive material – **TECDOC-1346** (2003);
http://www-pub.iaea.org/MTCD/publications/PDF/te_1346_web.pdf
- Regulatory Control for the Safe Transport of Naturally Occurring Radioactive Material (NORM) – **TECDOC-1728** (2013); **
http://www-pub.iaea.org/MTCD/publications/PDF/te_1728_web.pdf
- Transport Saves Lives – brochure calling for action to sustain the transport of radioactive material (2012)
<http://www.tanb.org/images/Denial%20of%20Shipment%20brochure%202012.pdf>
- Transport for Life - a call for action on the transport of radioactive material (2011)
<http://www.tanb.org/images/Denial%20of%20Shipment%20brochure%202011.pdf>

*: **SRS-49** specifically mentions niobium and tantalum in section 3.1.3, however the radioactivity concentration values described as “typical” are considered by this author as upper level values that are only reached in a minority of cases. Regardless of what is or isn’t ‘typical’, “the prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.”²⁹ and these persons or organisations need to assess on a regular basis the radioactivity concentrations in their materials, and act accordingly.

** : **TECDOC-1728** is the final published report of the IAEA research project that the T.I.C. contributed to during 2006-2010. The T.I.C. research was submitted with the kind support of Canada, and readers will find the T.I.C. research in the Canadian sections in this report.

Helpful websites

Further general information is available on the following web pages:

- European ALARA Network for Naturally Occurring Radioactive Materials
<http://ean-norm.eu/>
- IAEA Transport Safety Unit
<http://www-ns.iaea.org/tech-areas/radiation-safety/transport.asp>
- Transport Facilitation Working Group (TFWG)
<https://www.eiseverywhere.com//ehome/203772>
- T.I.C. (public website page on NORM transport)
<http://www.tanb.org/view/transport-of-norm>
- World Nuclear Association (WNA)
<http://www.world-nuclear.org>
- World Nuclear Transport Institute (WNTI)
<http://www.wnti.co.uk/>

²⁹ **SSR-6** paragraph 101.

Annex 4: T.I.C. Transport Policy

Background

The Tantalum-Niobium International Study Center (T.I.C.) has a broad-based membership encompassing all levels of the niobium and tantalum industries, from mining through to component and product manufacture. Along that supply chain there is the need to transport raw materials including mineral concentrates and secondary slags, from which niobium and tantalum are extracted. Some of these raw materials also contain naturally occurring thorium and/or uranium, at levels which often are above the regulatory exemption level set by the IAEA and recognised internationally in modal regulations such as those of the ICAO, IMO and UNECE, and numerous national regulations.

This policy³⁰ was adopted by the T.I.C. membership in October 2014 at the 55th General Assembly held in New York, NY, United States of America.

Policy

As an industry association, the T.I.C. is committed to lawful and ethical trade practices.

We have consistently encouraged our members to adhere to these principles and we wish to positively influence the supply chain in this regard.

This commitment therefore requires that each and every T.I.C. member company fully complies with all applicable international, national and local regulations governing the safe and secure transport of radioactive materials.

Members should additionally take steps to confirm that their immediate suppliers also fully comply with all applicable international, national and local regulations governing the safe and secure transport of radioactive materials.

Members are expected to engage and cooperate with the relevant authorities to ensure the above compliance requirement is met.

The T.I.C. commits itself to assist with advice, facilitation and guidance to help members with compliance.

Scope

The scope of this policy covers the transport of all raw materials containing the elements niobium and/or tantalum, where the radioactivity exceeds the relevant applicable exemption level for radioactive materials. This radioactivity includes, but need not be limited to, naturally occurring thorium, uranium and their decay products. Transport of radioactive material includes the transport of Class 7 Dangerous Goods.

³⁰ <http://www.tanb.org/images/TIC%20Policy%20on%20transport.pdf>