

NORM VI INTERNATIONAL SYMPOSIUM

COORDINATED RESEARCH PROJECT ON THE “APPROPRIATE LEVEL OF REGULATORY CONTROL FOR THE SAFE TRANSPORT OF NATURALLY OCCURRING RADIOACTIVE MATERIAL (NORM)”

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IAEA

International Atomic Energy Agency

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BACKGROUND INFORMATION

- **International Conference on the Safety of Transport of Radioactive Material, 2003**
 - **Issue for further work: reconsideration of applicability of transport regulation to NORM**
 - **Additional research to relieve unnecessary burden on transport of low activity NORM**
 - **Board of Governors approved Action Plan, including Secretariat action to initiate CRP**

RATIONALE FOR THE CRP

- **2005: TRANSSEC recommended the examination of the adequacy of safety standards for transport of NORM**
- **2006: CRP on the “Appropriate Level of Regulatory Control for the Safe Transport of Naturally Occurring Radioactive Material (NORM)”**
 - **Evaluate radiation hazards**
 - **Decide the degree of control to ensure safety**

CRP OUTPUT

- **CRP investigates an area of concern**
- **CRP output is independent; it does not feed into a regulatory review cycle directly**
 - **It is incumbent on Member States to pursue recommendations of the CRP**
 - **Only Member States can submit proposals for change to the regulations**
 - **CRP results may thus influence TS-R-1, TS-G-1.1 and/or other regulations**

IAEA TRANSPORT REGULATIONS

- **UN Agency with mandate to “enlarge the contribution of atomic energy to peace, health and prosperity throughout the world.”**
- **“standards of safety for protection of health and minimization of danger”**
- **Regulations for the Safe Transport of Radioactive Material TS-R-1**

TS-R-1 EXEMPTION VALUES

- **TS-R-1 basis for modal/national regulations**
 - **International Maritime Dangerous Goods Code**
 - **National supplementary requirements**
- **Radionuclide specific exemption limits, Bq/g**
- **Distinction by “intended use”**
 - **TS-R-1 para. 107(e) provides 10× factor for materials not intended for radionuclide extraction**
 - **TS-G-1.1 para. 107.4 explains this includes physically/chemically processed materials**

EXEMPTION VALUE ORIGIN

- Derived for BSS by a set of representative exposure scenarios, that would give rise to doses corresponding to the exemption of practices, *i.e.* $< 10 \mu\text{Sv/y}$
- TS-G-1.1 para. 401.4: these scenarios were not specifically related to transport
- Subsequent calculations showed the limits in BSS were generally similar

CRP APPROACH 1

- **Studies were submitted by nine countries**
 - **Brazil** **Canada** **France**
 - **Germany** **Iran** **Israel**
 - **Romania** **United Kingdom** **USA**
- **Australia submitted a report but did not participate**
- **Studies included national surveys and dose assessments of NORM transport**

CRP APPROACH 2

- **Standardised scenario calculation for 1 Bq/g**
 - Canada, France, Germany, Israel
- **Doses calculated for combinations of:**
 - Facility and transport workers and members of the public;
 - Land (lorry, train) and sea (break bulk and container ship);
 - Packaged and unpackaged material;
 - Internal and external doses;
 - Normal transport and accident conditions;
 - Various operations including loading/unloading.

CRP APPROACH 3

- **Some participants carried out an assessment of regulatory provisions for NORM transport**
 - **Consideration of exemption value validity**
 - **Proposed new values for exempt material**
 - **Considered type-specific exemptions**
 - **Proposed modification of regulations e.g.:**
 - **TS-R-1 para. 107(e) allows a $\times 10$ factor for NORM unless intended for radionuclide extraction**

CRP MATERIALS STUDIED

- **coal ash (France)**
- **ores containing thorium and uranium (Brazil)**
- **pipe scale (France, Germany, United Kingdom)**
- **phosphates (Iran, Israel)**
- **potash and phosphatic fertilisers (Israel)**
- **tantalum raw materials (Canada)**
- **uranium ores (Brazil, Iran)**
- **uranium ore tailings (Romania)**
- **zircon (Iran, United Kingdom)**

BRAZIL OBJECTIVES

- **Provide a theoretical basis for the establishment of:**
 - **(i) A_1 and A_2 values for LSA-I uranium or thorium ores and concentrates as well as NORM and compare these with TS-R-1 limits**
 - **(ii) quantities of LSA-I materials and NORM based on A_1 and A_2 values to be transported in excepted packages**
 - **(iii) limiting upper values for the classification of NORM as LSA-I radioactive material**

BRAZIL RESULTS

- **Most conservative scenario was external dose to truck driver under normal transport conditions**
 - **No shielding between the radioactive load and the driver was considered**
 - **A factor of 15 could be used for the exclusion of NORM from transport regulations**
 - **Same order of magnitude as the $\times 10$ factor**
- **TS-R-1 para. 408(a)(iv): $\times 30$ limiting factor is superfluous: impossible to reach limiting condition of 10 mSv/h at distance of 3 metres**
- **Excepted packages: $\times 20$ factor could be adopted to limit NORM activity concentration**

CANADA OBJECTIVES

- **Study composed of the Tantalum-Niobium International Study Center's "Radiological Assessment of the Transport of Tantalum Raw Materials"**
- **Examine the transport of tantalite and tin slag under normal and accident conditions**
- **Assess members of the public, transport workers and facility workers**
- **Conduct sampling and dose measurements**
- **Compare measurements with modelling**

CANADA RESULTS

- **Analysed 67 shipments of material**
- **>70% of tantalite was >10 Bq/g**
- **Modelled dose rates were more conservative than real measured dose rates**
 - **Containers not entirely full in reality**
- **Doses from potential accident <10 μ Sv/y**
- **All transport worker doses <1 mSv/y**
- **Based on 0.3 mSv/y reference dose, propose exemption value of at least 30 Bq/g**

FRANCE OBJECTIVES

- Calculate A_2 values for the 'unlimited' materials, and exemption values for larger quantities of material (~20 tonnes)
- Examine the validity of the 10 mg limiting intake
- Derive A_2 values for accident conditions
- Take account of different transport conditions e.g. whether the material is in drums or bags
- Survey broad range of materials

FRANCE RESULTS

- Dose assessments from realistic scenarios
- Analysed 475 samples of various materials
- Calculation results agree with measurements
- Results include:
 - annual dose to the driver for 1 Bq/g normalised ^{226}Ra concentration is 330 $\mu\text{Sv/y}$
 - annual dose to the forklift driver for 1 Bq/g normalised ^{226}Ra concentration is 500 $\mu\text{Sv/y}$
 - U ore transport at 10 Bq/g induced 100 $\mu\text{Sv/y}$
 - Handling of big bags with 7 Bq/g $^{226}\text{Ra}+^{228}\text{Ra}$ could exceed 1 mSv after <1000 hours exposure

GERMANY OBJECTIVES

- Review and categorise the most important materials containing natural radionuclides
- Review, analyse and evaluate the radiation exposure imposed by the shipment of NORM and expected exposure of the shipment staff and the population
- Develop evaluation criteria and safety requirements for NORM transport
- Develop procedures to determine the limits for exempt materials and consignments for transport of all NORM

GERMANY RESULTS

- **Based on a 0.3 mSv/y dose limit:**
 - **For bulk transport of NORM in equilibrium a ×5 factor could apply to exempt material regardless of the intended end use**
 - **TS-R-1 para. 107(e) could change as follows:**
 - **Delete the intended use restriction**
 - **Add a distinction between materials:**
 - **secular equilibrium: 5 Bq/g for Th and U**
 - **non-equilibrium: use formula in para. 405 with limits on certain radionuclides**

IRAN OBJECTIVES

- **Examine all aspects of NORM: characterisation, loading and types of packages, transport operations**
- **Collect information and measurements on the normal transport of NORM:**
 - **Mining and mineral processing**
 - **Oil and gas production**
 - **Phosphate industry**
 - **Scrap metal recycling**
 - **Uranium ore materials**
- **Evaluate radiological impact**

IRAN RESULTS

- **Assessed doses for occupational scenarios of unpackaged phosphate rock:**
 - **Truck driver: 0.062 mSv/y**
 - **Mechanical loader operator: 2.07 mSv/y**
- **Marine transport and loading of ships was not considered, only offloading of ships and storage**
 - **Doses from offloading in all unpackaged scenarios was less than 20 μ Sv per shipment**

ISRAEL OBJECTIVES

- **Study production of potash from the Dead Sea and phosphate from an open mine**
 - **A few million tonnes produced annually and shipped unpackaged**
- **Estimate doses to workers carrying out the production, storage and transport**
 - **Concentrations of natural radionuclides in these materials are low**
 - **There has been some concern over health effects**

ISRAEL RESULTS

- **Concentrations in phosphate and potash are below values in RS-G-1.7:**
 - ^{40}K in potash is about 15 Bq/g
 - U in phosphate is about 1-2 Bq/g
- **Dose to loading workers at phosphate and potash facilities estimated at <0.3 mSv/y**
- **Dose to the public assumed at <10 $\mu\text{Sv/y}$**
- **Consider applying the TS-R-1 exemption values with $\times 10$ factor to loading of phosphate and potash**

ROMANIA OBJECTIVES

- **Look at the safe disposal and transport of tailings from the Crucea uranium mine**
- **Identify and evaluate the potential risks and radiological consequences due to transport and disposal of the very low level radioactive materials (NORM)**
- **Determine the radon population doses from tailing sites representative of present day and likely future conditions**

ROMANIA RESULTS

- Results showed the effective dose for workers was <20 mSv/y
- The collective dose using a mathematical model was 0.2 mSv/y
- Total effective radon doses: 5.88 mSv in the witness zone; 15.50 mSv in the impact zone
 - Estimated effective dose <0.2 mSv/y
- Effective dose for all radionuclides transferred to the environment estimated at $<1.4 \times 10^{-6}$ Sv/y

UNITED KINGDOM OBJECTIVES

- **Review all NORM transport in the UK**
- **Where appropriate, assess the radiological impact of the transport**
- **Coal, coal ash, iron and steel production, building materials, potash, phosphate rock and fertilisers, ores and mineral sands, wastes from the oil, gas and China Clay industries were all surveyed**

UNITED KINGDOM RESULTS

- Concentration of radionuclides in building materials, potash, coal, coal combustion products and iron and steel production waste, were below exemption values
- No large scale transport of high activity materials. For phosphate, ilmenite and zircon a generic assessment of dose gave <0.2 mSv/y
- Truck transport of pipes from oil industry with Ra scale would give <0.1 mSv/y
- Truck transport of pipes from China Clay industry with Ra scale would give ~ 0.1 mSv/y
- Doses to the public were all <10 μ Sv/y

USA OBJECTIVES

- **1996 move to dose-based limits**
 - **Previously 70 Bq/g limit applied; materials had been transported safely for decades**
 - **TS-R-1 limits based on 10 μ Sv/y with a $\times 10$ factor according to end use; found to be consistent with RS-G-1.7**
 - **U <1 Bq/g unamenable to control with a graded approach leading to 10 Bq/g**
- **TS-R-1 para. 107(e) references to extraction leads to four situations for a material**

USA RESULTS

- **Collected data from mineral and uranium fuel cycle industries:**
 - One material was <1 Bq/g
 - Most were 1-10 Bq/g
 - Some were >10 Bq/g, up to several hundred
- **1-10 Bq/g materials were for extraction of metals, for radionuclides, or both**
- **For two materials with the same radiation energies and doses, exemption values may differ by two orders of magnitude**
 - **Exemption values should be risk-based**
- **Propose to remove the restrictions**

CONCLUSIONS 1

- **Calculated doses for personnel involved in transport (drivers and loaders) were within the range described in the Regulatory Context**
- **The doses to the general public were at least an order of magnitude lower**

CONCLUSIONS 2

- **1 Bq/g for U(nat) and Th(nat) was appropriate for the basic exemption value and that the $\times 10$ provision for NORM as defined in TS-R-1 (2009) para. 107(e) was both appropriate and necessary**
- **10 Bq/g value for ^{40}K may be too restrictive given the natural ratio to stable potassium**

CONCLUSIONS 3

- **107(e) ×10 provision for NORM should be made clearer to ensure its application**
- **Options include the addition of a footnote to the entries for ^{40}K , Th(nat) and U(nat) which would refer to 107(e)**

CONCLUSIONS 4

- **Application of para. 405 to materials not in equilibrium should be made clearer**
 - *E.g.* for radium which has been separated from its parent chain, the 10 Bq/g exemption value for ^{226}Ra and ^{228}Ra may be too high when not applying the rule for mixtures
- **Final CRP report will be provided to TRANSSEC 20 in June 2010**