# PATRAM 2010

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

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# CONTENTS

- Background Information
- Rationale for the CRP
- CRP Output
- IAEA Transport Regulations, TS-R-1
  - Exemption Values and their Origin
- CRP Approach and Materials Studied
- Objectives and Results for each Participant
- Conclusions

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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

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# RATIONALE FOR THE CRP

- 2005: TRANSSC 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

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# 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

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# 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

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# 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

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# 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 μSv/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

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# 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

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# 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.

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# 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 ×10 factor for NORM unless intended for radionuclide extraction

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# 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)

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# 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**

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# 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 ×10 factor
- TS-R-1 para. 408(a)(iv): ×30 limiting factor is superfluous: impossible to reach limiting condition of 10 mSv/h at distance of 3 metres
- Excepted packages: ×20 factor could be adopted to limit NORM activity concentration

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# 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

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# 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 µSv/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

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# 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

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# 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 µSv/y
  - annual dose to the forklift driver for 1 Bq/g normalised $^{226}Ra$ concentration is 500 µSv/y
  - U ore transport at 10 Bq/g induced 100 µSv/y
  - Handling of big bags with 7 Bq/g $^{226}Ra$+$^{228}Ra$ could exceed 1 mSv after <1000 hours exposure

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# 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

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# 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

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# 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

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# 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 μSv per shipment

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# 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

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# 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 μSv/y
- Consider applying the TS-R-1 exemption values with ×10 factor to loading of phosphate and potash

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# 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

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# 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

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# 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

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# 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 μSv/y

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# 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 μSv/y with a ×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

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# 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

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# 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

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# CONCLUSIONS 2

- 1 Bq/g for U(nat) and Th(nat) was appropriate for the basic exemption value and that the ×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

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# CONCLUSIONS 3

- With the exception of France, it was found that the restriction relative to the end use of NORM in paragraphs 107(e) and 409 could be removed.

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# CONCLUSIONS 4

- The provision for the activity concentrations of NORM not to exceed 10 times the values specified in Table 2 of TS-R-1 (2009) as specified in paragraph 107(e) of TS-R-1 (2009) should be made clearer to ensure its effective application.
- Options suggested by the CRP include the addition of a footnote to the entries for K-40, Th(nat) and U(nat) referring to paragraph 107(e).

# CONCLUSIONS 5

- 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

- Draft CRP report will be provided to TRANSSC 21 in November 2010

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