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Establishing the Safety Infrastructure for a Nuclear Transport Safety Programme

Michael E. Wangler
Topics to be covered

- International regime of safety and security in transport of radioactive and other hazardous materials
- Regulations for the Safe Transport of Radioactive Materials, TS-R-1 and its supporting documents
- Security and physical protection during transport
- Transport safety infrastructure considerations
- Final thoughts
INTERNATIONAL REGIME OF SAFETY AND SECURITY IN TRANSPORT OF RADIOACTIVE AND OTHER HAZARDOUS MATERIALS
International instruments

- The ECOSOC Committee of Experts and the United Nations recommendations
  - Maintains the Recommendations on the Transport of Dangerous Goods, Model Regulations (called the Orange Book)

- Convention on International Civil Aviation (the Chicago Convention)
  - Administered by International Civil Aviation Organization (ICAO)
  - Contains 18 annexes including Annex 18 on the Technical Instructions for Safe Transport of Dangerous Goods by Air (TI)
Basic international instruments

• Safety of Life at Sea (SOLAS)
  – Administered by the International Maritime Organization
  – Maintains the International Maritime Dangerous Goods Code (IMDG), which, since January 2004, has been mandatory for SOLAS signatory states.

• Europe – RID/ADR/AND – highway, rail and inland waterway
  – Administered by United Nations Economic Commission for Europe (UN/ECE) to ensure the effective implementation of these mechanisms for the transport of dangerous goods by road, rail and inland waterways.
Basic international instruments

• Postal – The Universal Postal Union (UPU) is the primary forum for cooperation between postal sector players.
  – The Treaty of Bern, signed in 1874, established the General Postal Union, which is today known as the Universal Postal Union.

• South America – MERCOSUR/ MERCOSUL – highway and rail
  – Establishes a common market based on the Treaty of Asuncion signed by the four countries of Argentina, Brazil, Paraguay, and Uruguay on March 26, 1991.
  – Establishes common dangerous good transport requirements to facilitate transboundary movement.
  – For Class 7 dangerous goods, the IAEA, ICAO and IMO requirements apply through Article 5.
Basic international instruments

•Convention on Physical Protection of Nuclear Materials
  – Convention was adopted on 26 October 1979 in Vienna, Austria and was deposited with the International Atomic Energy Agency.
  – Convention establishes a general framework for cooperation among states in the protection, recovery, and return of stolen nuclear material.
  – Convention provides for certain levels of physical protection during international transport of nuclear material.
  – Nuclear material means plutonium, uranium-233, uranium enriched in the isotope 235 or 233, uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore-residue, and so on.
The flow of IAEA regulations to the modal requirements

2009
IAEA Safety Standards Series TS-R-1

UN Dangerous Goods “Model Regulations”
All modes, All 9 Classes

2009
UN/ECE Modal Regulations
Road, Rail and Inland Waterway

2010
ICAO Technical Instruction
Air

2010
IMO IMDG Code
Sea

2011
IATA Regulations

2011
IAEA

Environmental Management

Atoms for Peace
The international regulation of the transport of all dangerous goods
REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIAL
The nine classes of dangerous goods

<table>
<thead>
<tr>
<th>Class 1</th>
<th>Explosives</th>
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<td>Class 8</td>
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<tr>
<td>Class 9</td>
<td>Miscellaneous dangerous goods</td>
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</table>
Perspective of the transport of dangerous goods by mode

- **Road**: 15% of all goods, <2% of dangerous goods, <2% of radioactive goods.
- **Rail**: 20% of all goods, <2% of dangerous goods, <2% of radioactive goods.
- **Air**: 3% - 4% of all goods, <10% of dangerous goods, <10% of radioactive goods.
- **Sea or Canal**: 50% of all goods, <1% of dangerous goods, <1% of radioactive goods.
**Basic and supporting documents**

- TS-G-1.1, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (Rev.1), 2008
- TS-G-1.3 Radiation Protection Programmes for the Transport of Radioactive Material, 2007
Basic and supporting documents

- TS-G-1.5 Compliance Assurance for the Safe Transport of Radioactive of Radioactive Materials, 2009
Objective

• To establish requirements that must be satisfied to ensure safety and to protect persons, property and the environment from the effects of radiation in the transport of radioactive material.
  – These requirements are satisfied by applying a graded approach to contents limits for packages and conveyances, to performance standards and package and implementing administrative

• To assure the safety of persons and the protection of property and the environment when these Regulations are complied with.
  – Confidence in this regard is achieved through quality assurance and compliance assurance programmes.
Scope

• Apply to the transport of radioactive material by all modes on land (rail and road), water, or in the air.
  – Routine conditions of transport (incident free);
  – Normal conditions of transport (minor mishaps);
  – Accident conditions of transport.

• Take into account radiological and non-radiological hazards when implementing controls such as routeing or physical protection.

• Ensure that radioactive material is kept secure in transport so as to prevent theft or damage and to ensure that control of the material is not relinquished inappropriately.
Out of scope

These Regulations do not apply to:

- Radioactive material that is an integral part of the means of transport;
- Radioactive material moved within an establishment where the movement does not involve public roads or railways;
- Radioactive material implanted or incorporated into a person or live animal for diagnosis or treatment;
- Radioactive material in consumer products;
- Natural material and ores containing naturally occurring radionuclides; and
- Certain non-radioactive solid objects with radioactive substances present on any surfaces.
Definitions

- The Regulations define terms that are used specially for TS-R-1. These terms might be defined differently from normal usage.
- Not all materials that emit ionizing radiation are defined as radioactive material for the purposes of TS-R-1.
- Radioactive material shall mean any material containing radionuclides where both the activity concentration and the total activity in the consignment exceed the values specified in Section 4.
- Some of these materials might be regulated as radioactive material for other purposes.
General provisions

• Radiation protection – A radiation protection programme shall be established for the transport of radioactive material.
• Emergency response – Emergency provisions shall be observed to protect persons, property and the environment.
• Quality assurance – A quality programme acceptable to the competent authority (CA) shall be established.
• Compliance assurance – The competent authority is responsible for assuring compliance with these Regulations.
• Non-compliance – Non-compliance with the Regulations will be reported to the CA as soon as possible.
• Special arrangements – Consignments which do not conform with the Regulations shall be transported only under special arrangement.
• Training – Each person engaged in transport shall be trained.
Activity limits and classification

- UN ID numbers
- $A_1$ and $A_2$ values
- Low specific activity materials (LSA)
- Surface contaminated objects (SCO)
- Special form radioactive material
- Low dispersible radioactive material
- Fissile material
- Uranium hexafluoride
- Excepted, Industrial, Type A, Type B and Type C packages
- Empty packagings
Requirements and controls for transport

- Requirements before first and each shipment
- Requirements and controls for transport of LSA material and SCO in industrial packages or unpackaged
- Determination and limits on transport index, criticality safety index and radiation levels for packages and overpacks of consignments, freight containers and overpacks
- Marking, labelling and placarding
- Consignors’ responsibilities
  - Shipping documents
  - Information to carriers
  - Notification of competent authorities
- Stowage and segregation
Labels and placards
Requirements for radioactive materials and for packagings and packages

• Requirements for radioactive material
  – LSA-III radioactive material
  – Special form radioactive material
  – Low dispersible radioactive material

• General requirements for all packages and additional requirements for air transport

• Requirements for packagings
  – IP-1, IP-2 and IP-3
  – Type A, Type B and Type C
  – Uranium hexafluoride
  – Fissile material
Example spent fuel cask – FSV Cask
Test procedures

- Leaching test for LSA-III material and low dispersible radioactive material
- Tests for special form radioactive material
- Tests for packages
  - Normal conditions of transport -- water spray, free drop, stacking and penetration tests
  - Accident conditions of transport – mechanical, thermal and water immersion tests
  - Water leakage for fissile material packages
Tests for normal (Type A) and accident (Type B) conditions of transport

Test A Tests:

- **DROP**: Free-drop test onto a flat, hard surface. This test is conducted only on packages weighing 11,000 pounds or less.

- **WATER**: Water spray for 1 hour to simulate rainfall of 2 inches per hour.

- **PENETRATION**: Penetration test by dropping a 13-pound, 1.25-inch diameter bar vertically onto the package from a height of 3.3 feet.

- **COMPRESSION**: Compression test of at least 5 times the weight of the package. This test is conducted for at least 24 hours.

Test B Tests:

- **FREE DROP**: A 30-foot free drop onto a flat, essentially unyielding surface so that the package's weakest point is struck.

- **PUNCTURE**: A 40-inch free drop onto a 6-inch diameter steel rod at least 8 inches long, striking the package at its most vulnerable spot.

- **THERMAL**: Exposure of the entire package to 1475°F for 30 minutes.

- **IMMERSION**: Immersion of the package under 50 feet of water for at least 6 hours.
Approval and administrative requirements

• Design approval
• Shipment approval
• Special arrangement approval
• Competent authority approval certificates
• Validation of certificates
SECURITY AND PHYSICAL PROTECTION DURING TRANSPORT
Security

• Prudent management practices
  – No further security measures to be applied other than those basic control measures included in the Basic Safety Standards and normal commercial practices.

• Basic security level
  – Additional consideration for security awareness training, personnel identity verification, security verification of conveyances, written instructions, exchange of security-related information and trustworthiness determination.

• Enhanced security level
  – Further considerations for identification of carriers and consignors, security plans, advanced notification, tracking devices, communications from the conveyance and additional security provisions for transport by road, rail and inland waterway

Reference: IAEA Nuclear Security Series No. 9, Security in the Transport of Radioactive Material
Physical protection during transport of spent fuel

- Preplanning and coordination for spent nuclear fuel shipments
- Advance notifications
- Provision for movement control center
- Provision for escorts, including armed escorts
- Contingency and response procedures
- Mode-specific requirements
- Requirements for personnel access authorisations
General considerations

- Implementation of a nuclear power programme necessitates transporting radioactive material with specific characteristics, including spent fuel, which is highly radioactive.
- Safety of radioactive material transport is principally assured through a graded approach including elements of design, testing and review of the transport package.
- Transport of certain radioactive material requires a prior approval of the package design and approval of the shipment by a competent authority.
General considerations – continued

• Planning, shipment and emergency response must account for the continually changing environment during transport of radioactive material.


• An adequate legal framework must be established to implement international regulations for the transport of radioactive materials and other dangerous goods.

• A competent authority must be establish for package design and shipment approval.
Phase 1 – actions

• Action 189. The government should consider the implications for the legal and regulatory framework of the transport of nuclear fuel and radioactive waste, over and above the existing transport of other radioactive material.
Phase 1 – considerations

- Regulations in respect of the transport of radioactive material will already be being carried out in most States.
- A nuclear power programme will increase by several orders of magnitude the total quantity of radioactive material transported.
- New regulators for transport safety must be cognizant of the existing regulatory regimes.
Phase 2 – actions

• Action 190. All relevant organizations should make a plan on how to meet the relevant international safety requirements and should start to fill the gaps identified in Phase 1.

• Action 191. The regulatory body and the organizations in charge of the transport of radioactive material should participate in international activities and networks to provide mutual support.
Phase 2 – considerations

• Arrangements for the transport of fresh fuel and spent fuel should be assessed.

• An evaluation should also be made for the expected needs for the transport of low level and intermediate level radioactive waste generated during plant operation.

• Assistance from another State should be obtained when needed.
Phase 3 – actions and considerations

• Action 192
  – The regulatory body and the organizations in charge of the transport of radioactive material should fully implement the changes to the national requirements and arrangements for the transport of radioactive material in accordance with the plan in Phase 2.

• Considerations
  – Requirements for such transport should be in place and implemented before planning the transport.
  – Operating organizations for nuclear power plants should have plans and contingency plans in place for the transport of radioactive material from nuclear power plants prior to their operation.
Final thoughts

• We have reviewed the international instruments that drive the regulatory regime for radioactive and other hazardous materials.

• We have looked at TS-R-1 to determine the main requirements for designing and transporting packages containing radioactive material.

• We have summarized the security and physical protection actions that must be considered for transporting spent fuel and other radioactive material.

• We have considered all of the above within the context of a nuclear power programme for transporting spent fuel.
Final thoughts

• Transport activities are conducted in public space and cannot be subject to the safe type of controls as for a fixed facility.
• Most countries already have a transport safety and security regulatory programme in place.
• The existing transport programme could be revised to include spent fuel and other radioactive material.
• Countries should be encouraged to have a single regulatory body dealing with all transport safety and security, with assistance from other regulatory bodies.
• Countries should be encouraged to participate in international transport safety and security activities and to seek assistance from other countries when appropriate.