

**Proceedings of the 20th International
Symposium on the Packaging and
Transportation of Radioactive Materials**

SAND2023-03770C



11-15 June 2023, Juan-les-Pins, France

**A ROAD TO NOWHERE? GAPS IN THE RADIOACTIVE MATERIAL
TRANSPORTATION SECURITY REGULATORY PROCESS**

Lorenz R. Spangler, CHMM, CDGP

Sandia National Laboratories, Office of Radiological Security
Institute of Hazardous Materials Management Representative to the International Air Transport
Associations Dangerous Goods Training Working Group, under the Dangerous Goods Board

ABSTRACT

The difference between should and shall governs the majority of the world's high hazard shipments from a security perspective, particularly in the area of radioactive materials transportation. The International Atomic Energy Agency (IAEA) Nuclear Security Series guide: Security of Radioactive Materials in Transport, NSS-9G, details the process the agency recommends a regulatory body should follow when establishing a country-specific radioactive material transport security regulatory regime. However, the language used in the guide differs from that found in the internationally accepted mode specific regulations (UN Recommendations on the Transport of Dangerous Goods - Model Regulations, the International Civil Aviation Authority (ICAO) Technical Instructions and International Maritime Dangerous Goods (IMDG) Code) which causes challenges in implementation. In addition, there are gaps in the process used to assist with the development and communication of individual country transportation security requirements for radioactive materials to the international community. This causes further issues with the flow down of documentation and training requirements. This paper explores the gaps in the radioactive materials transportation security regulatory process and offers potential solutions for closing those gaps.

INTRODUCTION

Radioactive materials are considered "dangerous goods" (DG) when in transport and are shipped in commerce throughout the world. During transport, the DG shipment is subject to a variety of regulations to ensure safety and security of the material being shipped. Regulatory requirements for safety and security are based on those within individual countries where only one set of regulations apply; across multiple country borders where various individual country regulations (e.g., US Department of Transportation, Transport Canada, etc) or agreement area regulations (e.g., European Union) apply; and in non-sovereign areas where individual country regulations are not applicable (e.g., international waters and airspace).

In addition to crossing multiple regulatory jurisdictions, the DG shipment may require multiple transport modes (e.g., ground, air, and/or water) to arrive at its destination. Therefore, transportation of DG is governed by a complex set of inter-related global instructions that harmonize the conditions (e.g., marking, labeling, packaging, paperwork, etc) under which the DG shipment is transported safely regardless of the mode (i.e., air, water, or ground) and the route (e.g., across country borders and through international airspace/waters). The safety elements for DG shipments have long been fully harmonized; however, security elements are a much more recent introduction to the regulatory arena. Therefore, some gaps remain in the process for DG shipment security that should be addressed to ensure a similar degree of harmonization and communication as the one which exists for safety elements.

11-15 June 2023, Juan-les-Pins, France

REGULATORY BACKGROUND: RADIOACTIVE MATERIALS TRANSPORT SECURITY

There is a complex set of regulations that govern the transport of DG, including radioactive material, that attempt to harmonize the safety and security of DG shipments globally. The primary global document for DG shipments has its origins in a 1956 publication by the United Nations Economic and Social Council's Committee of Experts on the Transport of Dangerous Goods. Its current form is as the United Nations (UN) Recommendations on the Transport of Dangerous Goods - Model Regulations. This document serves as the minimum baseline requirements for essentially all global DG transportation and changes to this document are typically adopted worldwide. In addition, there are two subsidiary mode-specific technical requirements documents for air (International Civil Aviation Authority [ICAO] Technical Instructions [TI]) and water (International Maritime Dangerous Goods [IMDG] Code). These documents include additional more stringent requirements that are mode-specific but otherwise adopt the minimum requirements from the UN Recommendations on the Transport of Dangerous Goods - Model Regulations. Each of these documents plays an essential role in harmonizing radioactive material transport globally. The safety elements of these documents are well harmonized; however, they are not consistent in their security requirements versus recommendations, particularly related to documentation and training.

United Nations (UN) Recommendations on the Transport of Dangerous Goods – Model Regulations

The UN Recommendations on the Transport of Dangerous Goods – Model Regulations, also known as the “Orange Book,” details the process the UN recommends should be followed when establishing a transport safety and security regulatory regime and is currently in Revision 22 released in 2021. Transport security was initially added to the Orange Book in Revision 13 released in 2003 and included the following introductory notes because it was the first time Chapter 1.4: Security Provisions was included in the document (these notes remain today):

NOTE 1: This Chapter provides requirements intended to address the security of dangerous goods in transport in all modes. Mode specific security provisions can be found in Chapter 7.2. National and modal authorities may apply additional security provisions which should be considered when offering or transporting dangerous goods.

NOTE 2: For the purposes of this Chapter security means measures or precautions to be taken to minimize theft or mis-use of dangerous goods that may endanger persons or property.

Chapter 1.4 of Revision 13 introduced the term “high consequence dangerous goods” that were specified in Table 1.4.1 and included “Class 7 radioactive material in quantities greater than 3000 A1 (special form) or 3000 A2, as applicable, in Type B or Type C packages.” Section 1.4.3.1 made a general recommendation as follows:

In implementing national security provisions competent authorities shall consider establishing a programme for identifying consignors or carriers engaged in the transport of high consequence dangerous goods for the purpose of communicating security related information.

The mode specific security provisions in Chapter 7.2 were also added in Revision 13 as Section 7.2.4: Security provisions for transport by road, rail and inland waterway. This new section included four provisions: 1) Crew members must carry identification that includes a photograph during

11-15 June 2023, Juan-les-Pins, France

transport; 2) The movement of high consequence shipments shall be monitored with transport telemetry or other methods *“when appropriate and already fitted”*; 3) Vehicles and inland waterway craft shall have *“devices, equipment or arrangements”* to prevent its theft of the theft of its cargo that shall be *“operational and effective at all times”*; and 4) *“Safety inspections on transport units shall cover appropriate security measures.”* These provisions are operationally focused and do not include any training or documentation requirements. These Section 7.2.4 provisions remain the same in the current Orange Book (Revision 22 released in 2021).

Revision 13 of the Orange Book also introduced the concepts of security awareness training (1.4.2.1) for all *“persons engaged in the transport of dangerous goods”* based on their responsibilities and creating a security plan (1.4.3.2) for high consequence dangerous goods shipments. The concepts were included using the term “shall” as a requirement rather than using the term “should,” which would have made them optional recommendations.

Two years later (2005), Revision 14 added one new element directly related to the security of high consequence shipment of radioactive material as Section 1.4.3.2.3:

For radioactive material, the provisions of this Chapter and of section 7.2.4 are deemed to be complied with when the provisions of the Convention on Physical Protection of Nuclear Material and of IAEA INFCIRC/225 (Rev.4) are applied.

The Convention on Physical Protection of Nuclear Material (CPPNM) is applicable to nuclear material, which it defines as: *Nuclear material means plutonium, uranium 233, uranium enriched in the isotopes 233 or 235, and any material containing one or more of the foregoing. Nuclear material does not include source material.* Similarly, IAEA INFCIRC/225 (Rev.4) is only applicable to certain fissile material, which is listed in Section 5.2 and follows the definition from the CPPNM. Therefore, the addition of 1.4.3.2.3 is only applicable to a small fraction of the high consequence shipments of radioactive material.

In another 4 years (2009), Revision 16 of the Orange Book added a footnote to 1.4.3.2.3 that added a reference to IAEA-TECDOC-967/Rev.1: Guidance and Considerations for the Implementation of INFCIRC/225/Rev.4, the Physical Protection of Nuclear Material and Nuclear Facilities, which adds some additional detail on implementation but, like INFCIRC/225 (Rev.4), is only applicable to nuclear material.

Two years later (2011), Revision 17 of the Orange Book removed the previously inserted reference to the IAEA-TECDOC-967/Rev.1 in the footnote and completely revised Section 1.4.3.1 to include 5 subsections rather than the one subsection it contained in prior revisions. This revision added a specific definition for high consequence dangerous goods as the new Section 1.4.3.1.1:

High consequence dangerous goods are those which have the potential for misuse in a terrorist event and which may, as a result, produce serious consequences such as mass casualties, mass destruction or, particularly for Class 7, mass socio-economic disruption.

Table 1.4.1 was retained (1.4.3.1.2) with a modification that removed Class 7 (radioactive materials). Two new sections (1.4.3.1.3 and 4) were added that retained the original Class 7 limits based on the A1 and A2 values and added a new table (1.4.2) of 25 specific radionuclides with separate limits based on the IAEA dangerous source (“D”) value rather than those that would be calculated using the A1 and A2 values. The D-value was published in the 2005 IAEA Safety Standards Series No.

11-15 June 2023, Juan-les-Pins, France

RS-G-1.9, Categorization of Radioactive Sources and then incorporated into the 2009 IAEA Nuclear Security Series (NSS)-11: Security of Radioactive Sources (please note, there is a newer revision that was released in 2019 [NSS-11G]). Section 1.4.3.1.4 added the sum of fractions method (also found in those two IAEA references) for aggregating multiple sources. So, the Orange Book did not incorporate the D-value approach until 6 years after it was originally published by the IAEA in 2005. This D-value approach and the reorganization from Revision 17 remains in place though the current Revision 22 of the Orange Book released in 2021. Revision 21 of the Orange Book that was released in 2019 updated the section 1.4.3.2.3 reference from INFCIRC/225/Rev.4 (1999) to the “new” revision, INFCIRC/225/Rev.5 (2011). So, the Orange Book was not updated to this reference until 8 years after it was originally published by the IAEA in 2011.

International Civil Aviation Organization (ICAO) Technical Instructions for the Safe Transport of Dangerous Goods by Air

The ICAO Annex 18 to the Convention on International Civil Aviation: The Safe Transport of Dangerous Goods By Air is the document that contains “*an internationally agreed set of provisions governing the safe transport of dangerous goods by air.*” This document provides high level requirements and the detailed specifications for how the broad provisions of Annex 18 are implemented are published in the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air, also known as the TIs. It is the ICAO TIs that mimic the detailed technical information from the Orange Book and are updated regularly with the most recent revision being the 2023-2024 edition.

The ICAO Annex 18 includes the following instruction to countries that are party to ICAO:

VARIATIONS FROM THE TECHNICAL INSTRUCTIONS

In accordance with the provisions of Annex 18, 2.5, Contracting States are required to notify ICAO of those cases where they have adopted provisions different from those contained in these Instructions. The variations which have been notified by States are listed in Attachment 3, together with notified variations from airline operators.

This establishes the practice by which both countries and airlines notify ICAO of any special requirements that are implemented through their national regulations (countries) or operating procedures (airlines) that differ from the standard requirements. These variations are known as state and operator variations respectively. For example, some airlines will not carry Class 7 dangerous goods cargo and specify that through this variation process.

As the topic of security requirements for dangerous goods was evolving through the Orange Book, the ICAO had to address the impact of these security requirements on air transport. In 2003, the ICAO Dangerous Goods Panel (DGP) met and considered the impact of these evolving dangerous goods security requirements being promulgated through the Orange Book on the ICAO documents. A central theme of those discussions was whether the Aviation Security element that is represented in ICAO Annex 17 was the appropriate location to address the new dangerous goods security requirements or if Annex 18 was more appropriate. Based on the meeting notes, the final recommendations were to incorporate things in Annex 18 and the accompanying ICAO TI:

- Annex 18: The amendment consists of a definition of dangerous goods security and a new Chapter 13 requiring States to establish dangerous goods security measures.

11-15 June 2023, Juan-les-Pins, France

- ICAO TI: Because of the difficulties that some members envisaged in enforcing such provisions in their States through their dangerous goods legislation, it was agreed to give the provisions only the status of recommendation. A new Chapter 5 to Part 1 of the Technical Instructions was developed, covering general security provisions, training and security plans, but only as recommendations.

So, even though the security provisions were added to the Orange Book as requirements using “shall” in relation to security plans and training, the term “should” is used for the air requirements. Security training is also not even considered in the minimum requirements specified in the training table 1.5.A, regardless of the job position associated with dangerous goods shipping as shown in Figure 1.

Aspects of transport of dangerous goods by air with which they should be familiar, as a minimum	Shippers and packers		Freight forwarders			Operators and ground handling agents						Security screeners
	Category											
	1	2	3	4	5	6	7	8	9	10	11	12
General philosophy	X	X	X	X	X	X	X	X	X	X	X	X
Limitations	X		X	X	X	X	X	X	X	X	X	X
General requirements for shippers	X		X			X						
Classification	X	X	X			X						X
List of dangerous goods	X	X	X			X				X		
General packing requirements	X	X	X			X						
Packing instructions	X	X	X			X						
Labelling and marking	X	X	X	X	X	X	X	X	X	X	X	X
Shipper's Declaration and other relevant documentation	X		X	X		X	X					
Acceptance procedures						X						
Recognition of undeclared dangerous goods	X	X	X	X	X	X	X	X	X	X	X	X
Storage and loading procedures					X	X		X		X		
Pilots' notification						X		X		X		
Provisions for passengers and crew	X	X	X	X	X	X	X	X	X	X	X	X
Emergency procedures	X	X	X	X	X	X	X	X	X	X	X	X

Figure 1. Minimum Requirements for Training Curricula

International Maritime Organization (IMO) International Maritime Dangerous Goods (IMDG) Code

The International Maritime Dangerous Goods Code (IMDG) details the process the International Maritime Organization (IMO) recommends should be followed when establishing a transport safety and security regulatory regime for water transport. The applicability of the IMDG Code is defined in Chapter 1.1 General Provisions as: “The provisions contained in this Code are applicable to all ships to which the International Convention for the Safety of Life at Sea, 1974 (SOLAS), as amended, applies and which are carrying dangerous goods as defined in regulation 1 of part A of chapter VII of that Convention.” However, Chapter 1.1 goes on to state: “Although this Code is legally treated as a mandatory instrument under chapter VII of SOLAS, as amended, the following provisions of the Code remain recommendatory: “Chapter 1.4 (Security provisions) except 1.4.1.1, which is mandatory.” Section 1.4.1.1 states:

The relevant provisions of chapter XI-2 of SOLAS, as amended, and of part A of the International Ship and Port Facility Security (ISPS) Code apply to companies, ships and port

11-15 June 2023, Juan-les-Pins, France

facilities engaged in the transport of dangerous goods and to which regulation XI-2 of SOLAS, as amended, apply taking into account the guidance given in part B of the ISPS Code.

These elements are like the aviation security requirements for accessing sensitive areas and are not applicable to personnel who do not access these areas. So, like the air mode requirements, the water mode security-related provisions for training and documentation are recommendations that use the term “should” rather than requirements that use the term “shall.” The IMDG Code does not contain provisions for state variations like those used in the modal requirements for air transport.

PROBLEM STATEMENT

As mentioned previously, the Orange Book serves as the basis for dangerous goods transport regulations globally. These regulations are primarily focused on ground shipments (e.g., via vehicle on roads) and then supplemented for more stringent mode-specific requirements when the shipment will travel by air or water. Essentially all dangerous goods shipments originate as a ground shipment because they need to travel to the airport/port from their place of origin. The common approach to such a multi-modal shipment is to focus on the applicable air and/or water regulations because these regulations have historically been so well harmonized with the ground shipment safety requirements and are more stringent. Unfortunately, as was demonstrated in the regulatory background section, that is not the case for security.

The air and water regulations related to security are actually less stringent than the ground regulations because the training and documentation (e.g., security plans for high consequence shipments) are recommended rather than required. Air and water carriers typically train their personnel to their mode specific regulations as specified in the applicable documents (e.g., ICAO TIs and IMDG Code). This training does not typically address dangerous goods security elements because they are recommended and there is a belief that any security that might be necessary for dangerous goods is covered through the already required aviation or port security training.

The scope of who requires training for general security awareness and detailed high consequence shipment security plans is also a variably implemented. The US Department of Transportation has provided multiple interpretive memos outlining who would require training which includes:

- Shippers
- Carriers
- Anyone who performs a pre-transportation function per the 49 CFR 171.8 definition.

A summary (though not all inclusive) would be anyone who handles/stores/maintains/controls the shipment, prepares paperwork for the shipment, or operates a vehicle transporting the shipment would require not only general security awareness training, but also training to the specific security plan(s) applicable to the high consequence dangerous goods shipment. This means that a security plan that includes elements applicable to the specific shipment needs to be developed by the company that is offering the shipment for transport as well as the carrier(s) moving the shipment. In some cases a dedicated security plan is developed for a specific shipment and in others an umbrella security plan that addresses all of the high consequence dangerous goods shipments is developed.

For dangerous goods transportation via the air mode, the US Department of Transportation has included a state variation, known as USG-17, that changes the “should” to “shall” in the high consequence dangerous goods shipment security provisions and therefore requires general security

11-15 June 2023, Juan-les-Pins, France

awareness training, a specific security plan, and training to the security plan for shipments to the US based on the security requirements prescribed in 49 Code of Federal Regulations Part 172, subpart I. The US is the only state that includes a variation related to replacing the “should” with a “shall” for the security of high consequence dangerous goods shipments despite multiple other countries having high consequence dangerous goods shipment security requirements in their main dangerous goods transport regulations.

For dangerous goods transportation via the water mode, the US Department of Transportation has a specific section of the regulations, 49 CFR § 176.13(b) that addresses training and states:

A carrier may not transport a hazardous material by vessel unless each of its hazmat employees involved in that transportation is trained as required by subpart H of part 172 of this subchapter.

49 CFR Subpart H is the section of the US regulations that requires training in accordance with Subpart I which specifies high consequence dangerous goods and the associated security plans and training required for such shipments. However, given the IMDG Code specifies that security plans are recommendations rather than requirements (again should versus shall), the use of security plans and associated training for high consequence dangerous goods shipments via water may not be fully implemented.

RECOMMENDATIONS

To address the identified gaps in the processes related to security of shipments of high consequence dangerous goods (including radioactive material) the following recommendations are made:

- 1) Develop a detailed crosswalk with a gap analysis between the aviation security requirements and those required for high consequence dangerous goods shipments by the Orange Book. This analysis needs to include an evaluation of whether the scope of personnel that require the aviation security training covers the scope of those who require the security plan training.
- 2) Develop a detailed crosswalk with a gap analysis between the port security requirements and those required for high consequence dangerous goods shipments by the Orange Book. This analysis needs to include an evaluation of whether the scope of personnel that require the port security training covers the scope of those who require the security plan training.
- 3) Update the mode-specific provisions to address the gaps by changing the recommendations to requirements (should to shall) where necessary.
- 4) Add/harmonize the definition of who requires security plans for high consequence dangerous goods shipments and which personnel require training across all modes.
- 5) Evaluate the role of the IAEA in addressing the specific need for state variations to be communicated to the mode-specific groups (ICAO and IMDG) when a state has a requirement that supersedes the mode-specific recommendations related to security of high consequence dangerous goods shipment.
- 6) Ensure the training and workshops to raise awareness for the need of security during transport of radioactive material and the necessity for regulatory regimes to address transport security of radioactive material include the appropriate personnel. This would include the liaisons that represent the member states and operators to the appropriate mode-specific groups to communicate state and operator variations related to dangerous goods security.

11-15 June 2023, Juan-les-Pins, France

CONCLUSIONS

The addition of security training and documentation requirements in the international regulatory standards for all modes of dangerous goods shipments has progressed significantly since the concept of security was introduced in the early 2000s. However, there continue to be gaps in the system where security requirements are not uniformly being applied regarding training and documentation. A combination of analyses, document updates, and communication can be used to effectively address these gaps to ensure the security of high consequence dangerous goods (including radioactive material) shipments in addition to their safety.

ACKNOWLEDGMENTS

I would like to acknowledge the National Nuclear Security Administration Office of Radiological Security for their support in developing this paper and presenting it at PATRAM22. Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525. I would also like to acknowledge my colleagues at the International Air Transport Association (IATA) Dangerous Goods Training Working Group (DGTWG) for their professionalism in working to address the gaps identified in this paper for the air mode.

REFERENCES

INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA Safety Standards Series No. RS-G-1.9, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, Vienna.

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance and Considerations for the Implementation of INFCIRC/225/Rev.4, The Physical Protection of Nuclear Material and Nuclear Facilities, IAEA-TECDOC-967 (Rev. 1), IAEA, Vienna (2000).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5), IAEA Nuclear Security Series No. 13, IAEA, Vienna (2011).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Materials in Transport, Nuclear Security Series No. 9-G (Rev. 1), IAEA, Vienna (2020).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

INTERNATIONAL CIVIL AVIATION ORGANIZATION, Annex 18 to Convention on International Civil Aviation: The Safe Transport of Dangerous Goods By Air, multiple revisions.

INTERNATIONAL CIVIL AVIATION ORGANIZATION, Dangerous Goods Panel, Meeting Minutes of the Nineteenth Meeting, Montreal, CA, 27 October – 7 November 2003.



11-15 June 2023, Juan-les-Pins, France

INTERNATIONAL CIVIL AVIATION ORGANIZATION, Technical Instructions for the Safe Transport of Dangerous Goods by Air, Doc 9284, multiple revisions.

INTERNATIONAL MARITIME ORGANIZATION, International Maritime Dangerous Goods Code, multiple revisions.

UNITED NATIONS, Recommendations on the Transport of Dangerous Goods - Model Regulations, multiple revisions.