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The Interface of Safety and Security in Transport: A Regional Perspective*

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Abstract

Security of nuclear and other radioactive material in transport continues to be a challenge for States that are working to strengthen their nuclear security regime. One reason for this is that State regulatory agencies and other organizations lack the resources and trained personnel to dedicate to this field. For over 50 years, safety has been a major focus in the use, storage and transport of radioactive material. Only recently, since the late 1990s, has dedicated focus been given to the field of security. One way to assist States to advance nuclear security is to reach out to safety workers (regulators, inspectors, and safety compliance personnel) and showcase the need to better integrate safety and security practices.

A recent International Atomic Energy Agency (IAEA) regional workshop in Bangkok, Thailand (June 2015) yielded profound results when subject matter experts lectured on both the safety and the security of radioactive material in transport. These experts presented and discussed experiences and best practices for: (1) developing and implementing safety requirements and security recommendations for radioactive material in transport; (2) national and international cooperation;

and (3) preventing shipment delays/denials of radioactive material. The workshop participants, who were predominantly from safety organizations, shared that they received the following from this event:

1. A clear understanding of the objectives of the IAEA safety requirements and security recommendations for radioactive material in transport.
2. A general understanding of and appreciation for the similarities and differences between safety requirements and security recommendations for radioactive material in transport.
3. A greater appreciation of the interface between transport safety and security and potential impacts of this interface on the efforts to strengthen the compliance assurance regime for the safe transport of radioactive material.
4. A general understanding of assessing the transport security scenarios and developing transport security plans.

Many participants also reported their appreciation of the workshop exercises that specifically focused on practical aspects of safety and security of transport of radioactive material.

These workshop outcomes highlight the important role professionals can offer when they receive additional safety training and education for radioactive material in transport. Moreover, these professionals can help to increase capacity in countries with developing nuclear security regimes. This paper explores workshop outcomes and transportation regulations and guidelines for radioactive material.

Introduction

Even though IAEA regulations for the safe transport of radioactive material were first published more than half a century ago, the development and implementation of transport safety regulations continues to challenge many individual States. Meanwhile, the increasing incidence of radioactive material thefts, including radioactive cargo theft, and a much greater understanding of the potential radiological consequences from the malicious use of this material has renewed attention on security in recent years. Within individual States, safety regulations and operator safety practices may have been developed independently from security regulations and operator security practices. Similarly, for a variety of reasons—some historical, cultural, geographical, economic, political, and technological—States, even in the same region, may have followed different paths in their approaches to assuring safe and secure transport of radioactive material. These complexities raise two important questions: How can safety and security practices complement each other? What can States individually learn from each other about these practices and as an integrated whole?

This paper is intended to offer answers to these questions by highlighting some of the similarities and differences as well as the commonalities and conflicts of safety regulations and security guidelines in the context of the interface between them. We also explore the potential impact of this interface on safety and security. Specifically, we discuss the outcomes of the Bangkok workshop; its theme was

safety and security during the transport of radioactive material. Finally, we discuss the participants' experiences and best practices for safety requirements and security recommendations as well as national and international cooperation. As such, this paper also provides an overview of radioactive material (RAM) transport safety regulations, RAM transport security guidelines, and the interface of safety and security. Following the overview, we discuss the regional workshop in greater detail, including key outcomes and conclusions.

RAM Transport Safety Regulations

The effort to develop a standard set of recommended requirements for the packaging and transport of radioactive material that could be adopted internationally began even before the official formation of the IAEA in the late 1950s. Today's IAEA Regulations for the Safe Transport of Radioactive Material (the Regulations)[1] are a direct result of those efforts. The current edition of the Regulations (2012), and in some cases, preceding editions, provides the bases, in many countries, for harmonized transport regulations. The regulations also provide these bases at the international modal level. As an example, the latest edition of the United Nations Recommendations on the Transport of Dangerous Goods—Model Regulations (UN Orange Book)[2] all regulatory requirements related to radioactive material transport have directly incorporated the IAEA Transport Regulations. The Orange Book serves as the model for international modal regulations issued by organizations such as the International Civil Aviation Organization for air transport, the Universal Postal Union for transport by post, the International Maritime Organization for maritime (sea) transport, and the United Nations Economic Commission for Europe as well as other international organizations for the various land transport modes (road, rail, and inland waterway) within Europe and throughout the world. In general, IAEA regulatory requirements for transport have been harmonized throughout the international regulatory system, albeit not perfectly. Harmonization of international regulations is still an ongoing area of work for the Agency and its partner organizations.

Overview of IAEA Safety Standards

Currently, packaging and transport of radioactive material is governed by the IAEA Safety Standard, "Regulations for the Safe Transport of Radioactive Material," (SSR-6). SSR-6 specifies the types of packaging required, limitations on the contents of each type of packaging, labeling, and rules for transport. For example, paragraph 101 of SSR-6 states that the Regulations "…establish standards of safety which provide an acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment that are associated with the transport of radioactive material." This paragraph goes on to indicate that because the Regulations utilize the principles set forth in basic IAEA radiation protection documents, "compliance with these Regulations is deemed to satisfy the principles of the Basic Safety Standards in respect of transport."

These Regulations are based on the philosophy that radioactive material being transported should be adequately packaged to provide protection against the hazards of the material under all conditions of

transport, including foreseeable accidents. By making safety a priority in the package design requirements, the Regulations hold the consignor of the material responsible for adequate packaging. This fundamental philosophy minimizes dependence on careful and proper actions by the carrier, yet the carrier also bears responsibility.

In addition, paragraph 105 of SSR-6 indicates that "the safety of persons, who are either members of the public or workers, is assured when these Regulations are complied with," and that "confidence in this regard is achieved through *management system* and *compliance assurance* programmes." Thus, management system and compliance assurance become key links in the safety chain established by the requirements in the Regulations.

A description of the Regulations' philosophy follows:

1. Packages of radioactive material should be dealt with in the same way as other hazardous goods.
2. Safety depends first upon the adequate package design and second upon total compliance of the prepared package to all applicable documentation and requirements.
3. The consignor should be responsible for ensuring safety during transport through proper characterization of the contents, proper packaging of those contents, and proper operational actions including adequate communications. Communications in this context include shipping papers, marking, placarding and labelling, transport indexes, criticality safety indexes, approval certificates, proper shipping names, and UN numbers.

This philosophy places the burden of safety on the proper preparation of consignments rather than on carriers. The intent of the Regulations is that consignments of radioactive material can be transported with minimal special handling. However, in accord with the robust nature of the packaging requirements in the Regulations, transport industry workers are expected to treat radioactive material consignments with care but with no more care than that accorded to other dangerous goods.

Similarly, the Regulations state "what" has to be achieved rather than "how" to achieve the desired degree of protection in terms of the detailed design specifications; they are *performance based* rather than prescriptive. The Regulations also do not generally explain "why" a given requirement is imposed or how it should be achieved. Additional insight into the "why" and "how" of the Regulations may be obtained thru the IAEA Specific Safety Guide, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (No. SSG-26).[3] The scope of the Regulations is clearly specified in paragraphs 106–109 of SSR-6; these paragraphs define the range of applicability of the Regulations.

The Regulations apply to:

1. The transport of radioactive material by all modes on land, water, or in the air.

2. Any transport which is incidental to the use of the radioactive material (paragraph 106 of SSR-6).

In this context, transport comprises all operations and conditions associated with, and involved in, the movement of the radioactive material including the package design; manufacture, maintenance and repair of the packaging; and preparation, consigning, loading, carriage (including in-transit storage), unloading, and receipt at the final destination of loads of radioactive material and packages.

Recall that the Regulations utilize a graded approach for performance standards. This graded approach is characterized by three general performance levels that relate to the design of the package (paragraph 106 of SSR-6): (1) routine conditions of transport (incident free); (2) normal conditions of transport (minor mishaps); and (3) accident conditions of transport.

In contrast, paragraph 107 of SSR-6 specifies that the Regulations do *not* apply to seven different types of material:

1. Radioactive material that is an *integral part of the means of transport* (such as depleted uranium counterweights in aircraft).
2. Radioactive material moved *within an establishment* that is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads or railways.
3. Radioactive material implanted *or incorporated into a person* or live animal for diagnosis or treatment (such as a cardiac pacemaker or radionuclides injected into a person for medical purposes).
4. Radioactive material in or on a person who is to be transported for medical treatment because the person has been subject to accidental or deliberate intake of radioactive material or contamination.
5. Radioactive material in con*sumer products* that have received regulatory approval, following their sale to the end user (such as smoke detectors).
6. *Natural material and ores* containing naturally occurring radionuclides which may have been processed provided the activity concentration of the material does not exceed ten times the values specified (paragraphs 401–406 of SSR-6). For natural materials and ores with radionuclides not in secular equilibrium, the activity concentration shall be calculated using the mixture formula of paragraph 405.
7. Non-radioactive solid objects the surfaces of which do not carry radioactive contamination (paragraph 214).

In addition, there are two other areas related to the scope of the Regulations; one deals with *controls on shipments*, and the other deals with *subsidiary risks* of the contents of consignments.

Controls on shipments relating to routing or physical protection that may be imposed by various governmental agencies for purposes other than radiological safety are not specified in the Regulations (see paragraph 108 of SSR-6). However, the Regulations note that such controls must not detract from the standards of safety for which the Regulations have been developed relative to the radiological hazards posed by the contents of the package. Also, it should be ensured that radioactive material is kept secure in transport so as to prevent theft and damage and to ensure that control of the material is not relinquished inappropriately (see paragraph 109 of SSR-6).

Relative to *subsidiary risks*, the Regulations simply state (see paragraphs 110 and 507 of SSR-6) that all "relevant transport regulations for dangerous goods of each of the countries" involved in the transport "shall apply in addition to" the Regulations.

Key Elements of Safety Regulations

In sum, with respect to the interface of safety and security in transport, the following elements of the transport safety regulations are particularly relevant:

- Requirements for packaging and packages
- Radioactive contents
- Shipment, consignment, consignor, carrier, and consignee
- Conveyance
- Regulatory controls
- Approvals
- Hazard communication

RAM Transport Security Guidelines

The transport safety regulations discussed in the previous section are designed to protect people, property, and the environment from the dangers of the radioactive material. Security measures protect people, property, and the environment, too. But transport security guidelines are also designed to protect the radioactive material from threats posed by people with malicious intent.

Threats to radioactive material could include criminals acquiring and using radioactive material for malicious purposes such as dispersal of the radioactive material by sabotage of the radioactive material transport packages. The consequences of such malicious use of radioactive material could be high. The IAEA Nuclear Security Series (NSS) provides guidance for States desiring to build or improve their nuclear security regimes, helping reduce the likelihood of such events.

Overview of IAEA Security Guidelines

In part, this paper focuses on the security guidelines from "Security in the Transport of Radioactive Material" (NSS-9). NSS-9 provides guidance to States on setting up national transport security regulations for radioactive material transport; implementing or enhancing a nuclear security regime;

defining security levels for packages; and minimizing the likelihood of theft or sabotage through a combination of security measures to deter, detect, delay, and respond.

NSS-9 defines three security levels as:

1. **Prudent management practices** for excepted packages, low specific-activity packages (LSA-I), and surface contaminated objects (SCO-I).
2. **Basic security level** for packages below the **security radioactivity threshold** (see below).
3. **Enhanced security level** for packages above the **security radioactivity threshold.**

The transportation **security radioactivity thresholds** are based on the potential radiological consequences of malicious acts involving radioactive material. The thresholds are derived from dangerous quantity values (D-values) or from A_1 and A_2 values.

In certain circumstances, a State may consider **additional security measures** beyond the baseline levels, e.g., measures based on assessment of the prevailing threat or considerations related to the nature of the material.

Key Elements of Security Guidelines

Table 1 lists the security measures recommended by transport security level. The security measures are cumulative—prudent management practices should also be used for basic and enhanced security level shipments, and basic security level measures should also be used for enhanced security level shipments. Table 2 lists examples of transport security elements.

Table 1 Comparison of security measures by security level

Prudent management practices	Basic security level	Enhanced security level
• Basic control measures included in Basic Safety Standards • Normal commercial practice	• General security provisions • Basic security awareness training • Personnel identity verification • Security verification of conveyance • Written instructions • Exchange of security-related information • Trustworthiness determination	• Identification of carriers and consignors • Security plans • Advance notification • Tracking devices • Communications from the conveyance • Additional security provisions for transport by road, rail, and inland waterway

Security for radioactive material transport includes multiple elements designed to minimize the likelihood of a malicious act involving the material or loss of control of the material. Security elements may include information and cyber security, access control, physical security, personnel security, guards and escorts, and security response forces. See Table 2.

Table 2 Some typical security elements and examples of their use

Security element	Security element involves…	Example
Information and Cyber Security	Identifying, classifying, and controlling sensitive information	Protecting information on specific routing and timing of shipments
Access Control	Limiting access to vehicles and in-transit storage areas to authorized personnel	Checking crew identification documents against verified list
Physical Security	Physical security measures to deter, detect, assess, and delay unauthorized access to material	Locks on cargo containers, cargo areas, and cabs. Alarms, locking tie-downs
Personnel Security	Personnel have necessary security clearance Personnel identity verification	Crew members carry positive identification
Guards and Escorts	Monitor and accompany shipments, control access	Escorts accompany shipment in separate vehicle
Security Response Force	Respond to transport security incident to counter any attempted malicious acts	Local police closest to planned route may be contacted in advance

The Interface of Safety and Security

Both *safety* and *security* involve a combination of administrative, technical, and managerial features for two different purposes that usually coincide, but they sometimes collide. *Safety* matters are intrinsic to *activities*, transparent, and apply probabilistic *safety analysis*. *Security* matters concern *malicious* actions and are confidential, and they use threat based judgment[4]. Security includes: (a) measures to prevent unauthorized access or damage as well as loss, theft, or unauthorized transfer of radioactive sources; (b) vulnerability assessment—whether attractive to terrorists; (c) design basis threat assessment to determine the extent of measures to deter, detect, and delay accomplishment of malevolent intention; (d) prior arrangement, for example, with intelligence authorities and police

forces; and (e) a security plan or program especially for Category 1 sources. Elements of safety regulations that are relevant to security are identified below.

Key Elements of Safety Regulations Relevant to Security

To ensure security during transport of radioactive material, theft or damage should be prevented, and it should be ensured that control of the material is not inappropriately relinquished. The Regulations require that radioactive material be transported in a packaging of appropriate design determined on the basis of the radiological hazard associated with the radioactive content of the package. The security significance of the radioactive content (identity, activity, and mass) is closely related to its safety significance. Packages (packaging and radioactive contents) are subject to activity limits and material restrictions, as well as subject to the corresponding regulatory requirements. From a security perspective, an overpack enables the consignor to track a consignment made up of multiple packages that are contained in a single handling unit.

In terms of package radioactivity, safety requirements ensure levels outside a package as well as activity within its contents remain within limits. Compliance assurance inspectors could help corroborate the authenticity of a consignment that is a security concern. The consignor (that is, the person who forwards a consignment for transport) is primarily responsible for the safety of the consignment. Meanwhile, the carrier implements the safety instructions during the shipment such as handling the package, stowage, and segregation for occupied areas. The consignor should ensure security provisions are appropriate to the security level warranted for the shipment. The security concerns in respect of the conveyance would need to be addressed particularly for certain potentially high-risk shipments, viewed as such, from safety considerations.

Note that the regulatory control measures are aimed at ensuring safety during transport. Many of the safety control measures also serve as effective security measures. One example is the requirement for a fastening device for the containment system that cannot be unintentionally opened. Another example is the requirement for a package tie-down that discourages removal of the package from the conveyance. The approval requirement in addition to ensuring compliance with the safety provisions can also assure the authenticity of the shipment, which is an important security consideration.

Similarly, marking and labelling constitute an important safety requirement. They caution the public and workers about the radioactive nature of the consignment and provide necessary information. However, this safety provision can be inconsistent with the security requirement for restricting information about the radioactive consignment. But conflicts can be resolved by comparing the risks of implementing this requirement with not implementing the same, understanding that a breach of security has safety implications. As such, any deviation from safety requirements must be carefully deliberated to ensure that the overall safety of the shipment is never compromised.

Table 3 lists some safety elements and their safety and security functions.

Table 3 Safety elements and their safety and security functions

Element	Safety function	Security function
Transport package	Contain material Radiation shielding Criticality safety	Robust packaging deters and delays access.
Fastening devices	Secure package to conveyance.	Deter, delay access
Marking and labelling	Communicates information relevant to health and safety.	Categorization to determine security level
Tie-down of package on conveyance	Package stays intact on the conveyance even after a severe impact.	Removal of the package is discouraged.
Shipment approval requirement	Safety evaluation is made prior to shipment.	Documentary support for the authenticity of the shipment
Requirement for emergency preparedness	A radiological emergency has to be managed and the consequences mitigated effectively.	Breach of security can have radiological consequence. Response mechanism is important.

IAEA Regional Workshop, Bangkok, Thailand

In June 2015, a Regional Workshop on Safety and Security during Transport of Radioactive Material was organized by the IAEA in Bangkok, Thailand. It was the first time under the project that the participating States were formally introduced to security during transport of radioactive material.

Twenty-eight participants and observers from 16 countries attended the workshop which included 13 lectures and five exercises on the safety and security of transport of radioactive material. Of these, seven lectures and three exercises were on the security of radioactive material transport. The participants presented the safety and security status of radioactive material transport in their respective States. The workshop activities also included a technical visit. The next section describes the participants' and subject matter experts' presentations.

Presentations by participants

The following list outlines scenarios for the participating States:

1. Every State accords importance to security.
2. Every State implements the IAEA's Code of Conduct on Safety and Security of Radioactive Sources.

3. Source inventories are up to date in many States.
4. Sources are controlled at the port of entry.
5. Coordination among the Competent Authority, security agencies, and emergency response agencies is established.
6. Shipments of sensitive radioactive material (e.g., Category 1 sources) have security cover.
7. Some participating countries already have in place security requirements during the transport of radioactive sources.
8. Many States require help from IAEA to establish safety and security systems.

Presentations by IAEA Experts at the Workshop

The IAEA expert presented the following topics:

- The need for security during transport of radioactive material
- International Recommendations and Guidance on Security in the Transport of Radioactive Material
- Transport Safety and Interface with Security
- Transport Security Approaches and Security Levels
- Security Measures: Applying a Graded Approach, Developing a Transport Security Plan
- Interdepartmental Co-operation and International Obligations–Safety and Security during Transport of Radioactive Material
- Preparedness and Response Plan to Security Events Involving Category 1 and 2 Sources during Transport of Radioactive Material–Need for Co-operation

Presenters emphasized how transport safety requirements aim to assure a degree of security. Paragraph 109 of IAEA Regulations for the Safe Transport of Radioactive Material[1] requires that "Measures should be taken to 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.*" However, there are no globally accepted "security standards" for the transport of radioactive material. Participants appreciated that security measures should be commensurate with potential radiological risks from breaches of security as outlined in the IAEA's guide for the security of radioactive material transportation.[4]

Discussions on both safety and security focused on the importance of inspecting packages originating from another country as well as shipments even if they do not require approval. Similarly, discussions also concluded that non-compliance should be dealt with as provided under national regulations, and the competent authority of the country of origin of the shipment should be notified. And participants observed that participating States were implementing the IAEA Code of Conduct on Safety and Security of Radioactive Sources, a code that requires compliance with IAEA's transport regulations. The IAEA Guidance on Import and Export of Radioactive Sources prescribes, *inter alia*, that the credentials of the importer and exporter should be established, the competent authorities of the

exporting/importing countries should interact, and advance notifications should be sent to competent authorities prior to the shipment. Experts also familiarized participants with the levels of security and the corresponding measures.

Overview of Exercises

Experts facilitated three related exercises during the workshop. Participants watched a film on the transport of radioactive material ranging from LSA material to spent fuel, and a discussion followed. Participants identified instances of compliance with safety requirements and security recommendations. Their responses underscored the levels of their involvement with secure transportation of radioactive material. As a result of these exercises, not only did participants correctly describe safety and security aspects of transport but they could also distinguish safety and security approaches. Participants also studied transport security plans with particular respect to the transport of Category 1 and 2 sources, and they developed their own national plans for emergency security preparedness and response arrangements.

Technical Visit

As part of the workshop, participants visited an industrial radiography institution where they observed the practices adopted by the institution for safety and security during transport of radioactive material. Following the technical visit, participants elaborated on a range of security-related issues. The site tour made it clear that such visits were very effective for addressing questions specific to the security of radioactive material transport.

Participants' Feedback

The effectiveness of a workshop can best be judged by the feedback received from the participants. Participant feedback demonstrated:

1. A clear understanding of the:
   - objectives of the IAEA safety requirements
   - security recommendations for radioactive material in transport
2. A general understanding of and appreciation for:
   - the similarities and differences between safety requirements
   - security recommendations for radioactive material in transport
3. A greater appreciation of:
   - the interface between transport safety and security
   - potential impacts of the interface on the efforts to strengthen the compliance assurance regime for the safe transport of radioactive material
4. A general understanding of:
   - assessing the transport security scenarios
   - developing transport security plans

Outcomes

Based on these observations, we can conclude that every State accords importance to security of transport of radioactive material. Although some States regulate security during transport, others ensure security through executive control. The workshop experience reemphasized how many States require help from the IAEA to establish safety and security systems, including providing training to their personnel. As far as the structure of the workshop and lessons learned, participants appreciated the unique features of safety and security approaches, and they preferred exercises to lectures.

Conclusions

Although safety requirements may also provide security, the resolution of conflicts between safety requirements and security must not compromise safety.

Communication, coordination, and cooperation are equally important aspects of both safety and security.

The Regional Workshop on Safety and Security during Transport of Radioactive Material under RAS9067 offers the participants clear understanding of the common and distinct objectives of safety and security, the distinction of the measures and procedures in the implementation of safety and security programs, and the application of a graded approach.

To be safe you need to consider security. To be secure you need to consider safety aspects; and regulatory bodies and operators, shippers, and carriers cannot look at the issue of safety or security in a vacuum without considering the impact, benefit, or interfacing of the other. Safety regulations address many of the security needs; therefore, many States are encouraged to stipulate and implement safety requirements.

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