

Building an Integrated Safety–Security Culture in the Transport of Radioactive Material through Management System Standards: Strengthening Indonesia’s Framework

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Abstract

The safe and secure transport of radioactive material poses critical challenges, particularly for Indonesia as an archipelagic nation on international trade routes. Risks of radiation exposure, theft, or sabotage demand a robust regulatory framework supported by strong safety–security culture. This paper explores Indonesia’s approach in aligning national regulations, such as Government Regulation No. 58/2015 and its derivative, with international standards to strengthen radioactive material transport safety. Integrating ISO 9001:2015, ISO 31000:2018, ISO 28000:2022, and ISO 22301:2019 improves quality management, risk assessment, supply chain security, and business continuity. The study emphasizes that management systems and culture must reinforce each other: systems without culture risk becoming formalities, while culture without systems lacks consistency. Adopting ISO’s Annex SL high-level structure makes IAEA TS-G-1.4 more compatible and efficient. Key recommendations include applying risk-based thinking, enhancing supply chain traceability, embedding continuity planning, strengthening audits, and expanding competence, ensuring Indonesia contributes to a harmonized global framework.

Key words: transportation of radioactive material, security–safety culture, standardization, global harmonized management systems.

The Urgency of Safety and Security Measures in the Management of Radioactive Materials

Radioactive substances have potential risks such as safety risk that cause radiation hazards to humans or the environment as well as security risk in the form of potential misuse, theft, or sabotage [2]. Along with this increase in use, the need for the transportation of radioactive substances has also increased. The transportation of radioactive substances is defined as the transfer of radioactive substances that meet the technical requirements for radiation safety in the transportation of radioactive substances, from one place to another via public transportation networks, using land, water, or air transportation [1]. The occurrence of finding radioactive materials in a BATAN employee's home [13] and the 2025 discovery of scrap metal tainted with Cesium 137 [14] were some cases in accordance with transportation radioactive substances.

Integrated Management System and Safety Culture Development

Safety and security incidents have encouraged IAEA member states to adopt a Nuclear Safety and Security Culture that integrates visible elements—policies, procedures, and behaviors—with underlying values and beliefs, ensuring compliance, preventing errors, and closing gaps. Indonesia reinforces this through Government Regulation No. 58/2015, aligning national safety and security measures with IAEA standards. To support consistency, IAEA standards promote Integrated Management Systems (IMS) covering safety, health, environment, quality, and security. Implementation is facilitated by ISO’s High-Level Structure (Annex SL), based on the PDCA cycle, which harmonizes standards and strengthens organizational culture. Standards like ISO 9001, ISO 28000, and ISO 22301 adopt this framework. Adopting international management system principles in IAEA TS-G-1.4 enhances efficiency, interoperability, and acceptance through HLS, risk-based thinking, supply chain security, continuity, quality, and regulatory harmonization.

Table 1. Recommendation of the Use of International Standards for IAEA TS-G-1.4

Area	Contribution of International Standards	Recommendations for Integration into IAEA TS-G-1.4
Structure	Annex SL (ISO 9001, 28000, 22301)	IAEA should adopt Annex SL so that TS-G-1.4 documents are aligned with the international management system framework, improving integration of quality, safety, security, and continuity.
Risk Management	ISO 31000 (Risk Management), ISO 9001 (risks & opportunities), ISO 28000 (security risk), ISO 22301 (business impact analysis)	IAEA may add an integrated risk analysis methodology (safety, security, continuity) compatible with ISO frameworks, so it can be applied across sectors.
Transport Security	ISO 28000 focuses on supply chain security, while TS-G-1.4 focuses more on safety & radiological security	Create a dual assurance model: physical security and radiation safety, aligned with ISO 28000's approach to reduce duplication of controls
Continuity	ISO 22301 emphasizes business continuity with RTO (Recovery Time Objective) / RPO (Recovery Point Objective) & recovery plan.	Add annexes in TS-G-1.4 on continuity of transport operations when radiological incidents occur (e.g., diversion policy, backup vendors, public communication).
Quality	ISO 9001 regulates document control, internal audits, and CAPA (Corrective and Preventive Action).	Integrate document control, audits, and CAPA mechanisms from ISO 9001 to strengthen lessons learned in radiological incidents.
Competence	ISO 9001 and ISO 28000 require competence & awareness.	IAEA standards should include cross-functional competence requirements: technical radiation, supply chain security, stakeholder communication. External certifications based on ISO should be recognized as proof of competence.
Communication	ISO 22301 (crisis communication)	Add communication protocol and inter-agency coordination based on ISO 22301 to increase credibility & transparency.
Audit	ISO 9001/28000/22301 require internal audits & management review.	IAEA may add integrated audit guidelines (safety, security, continuity) to be more efficient and avoid duplication of audits.
Improvement	PDCA cycle is used in all ISO Standards	TS-G-1.4 should emphasize PDCA implementation, facilitating benchmarking and performance improvement of radioactive material transport.

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