**SYNOPSES**

# Data-Driven Resilience: Integrating Culture, Capability, and Frameworks for Safe and Secure Transport of Radioactive Material

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## Abstract

Malaysian Nuclear Agency (NUKLEAR Malaysia) manages over 200 annual transports of high-activity Category I radioactive materials. To achieve durable resilience against accidents and malicious acts, NUKLEAR Malaysia employs a strategy centred on integrating safety and security cultures, supported by quantitative assessment and formal frameworks. A security culture survey of 430 workers yielded an average score of 3.84/5, identifying critical weaknesses in **Communications** and **Training & Qualifications** (3.78). This quantitative data is validated by operational deficits revealed in multi-scenario drills, where physical security responders demonstrated uncertainty in using radiological monitoring equipment (survey meters/EPD) at incident sites. In response, NUKLEAR Malaysia has formalized its integrated approach by establishing the Nuclear Safety and Security Group (2024) and implementing mandatory joint drills, transparent reporting processes, and targeted training programs. This synthesis of cultural diagnosis, operational testing, and structural reform is essential for maintaining a robust, responsive transport system in an evolving threat landscape.

## 1. The Safety-Security Interface and Operational Challenge

NUKLEAR Malaysia operates key facilities, including a research reactor and over 800 radioactive sources (highest activity up to 400,000 Ci). The integrity of its ≥200 annual RAM transports depends on harmonizing Safety (compliance with Act 304 and minimizing accidental exposure) and Security (preventing theft or sabotage). The interface goal is clear: ensure neither domain compromises the other during emergencies.

## 2. Cultural Assessment and Deficiencies

NUKLEAR Malaysia employs continuous assessment to diagnose cultural vulnerabilities among its workforce.

### 2.1 Nuclear Security Culture (Transportation of Radioactive Material) Findings:

A comprehensive survey confirmed that while **Security Awareness** scored highly (3.93/5), the organizational components supporting execution fell short, notably in **Communications** and **Training** (3.78/5). Demographic analysis highlighted a need for specific intervention for

younger and less experienced staff, whose security perception scores were generally lower, and for Management & Professional personnel whose scores lagged behind technical and support staff.

### 2.2 Safety Culture and Preparedness:

A separate assessment showed good overall worker awareness of emergency preparedness (5.65/7), yet the lowest scoring area was **Training** (4.89/7). This consistency between safety and security assessments indicates a systemic need to strengthen training programs.

## 3. Frameworks for Robust and Responsive Systems

NUKLEAR Malaysia has developed robust frameworks to translate cultural awareness into durable, responsive capability:

- **Integrated Drills and Lessons Learned:** Mandatory, complex, multi-site drills test the system against combined security threats (intrusion, confinement) and radiological risks (source theft, contamination). These drills repeatedly exposed the Operational Integration Deficit, specifically the lack of proficiency among initial security responders in performing immediate radiological assessment upon securing a compromised package.
- **Structural and Procedural Reforms:** Based on drill findings, NUKLEAR Malaysia implemented foundational changes:
    1. **Organizational Merger:** The creation of the Nuclear Safety and Security Group (2024) formally mandates integrated leadership and procedural alignment.
    2. **Transport Control:** Standardized documents, such as the Radioactive Material Transport Document (for Category 1 radioactive materials) and the internal Movement Notification Form, ensure comprehensive safety checks, security protocols (armed escort, personnel vetting), and real-time communication tracking.
    3. **Targeted Training:** The way forward includes mandatory joint safety-security drills and specialized workshops (e.g., National Workshop on Security Culture Self-Assessment) to close the identified gaps in communication and training across all staff levels.

## 4. Conclusion

Achieving a robust, durable, and responsive transport system requires continuous quantitative cultural diagnosis validated by operational stress testing. NUKLEAR Malaysia's experience demonstrates that merging safety and security groups, institutionalizing joint exercises, and focusing targeted training on organizational weaknesses (Communications and Training) are crucial steps toward building integrated resilience that protects personnel, the public, and the integrity of radioactive material transport.

## References:


1. IAEA Safety Standards Series No. SSR-6, Regulations for the Safe Transport of Radioactive Material (2018 Edition).
2. Malaysia Atomic Energy Licensing Act 1984 (Act 304), Radiation Protection (Transport) Regulation 1989.