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U.S. Nuclear Regulatory Commission's Activities Pertaining to Transportation Security for Category 1 and Category 2 Quantities of Radioactive Material

Kim Lukes
U.S. Nuclear Regulatory Commission

Margaret Cervera
U.S. Nuclear Regulatory Commission

Abstract

The regulatory authority and oversight of radioactive materials in the U.S. has continued to expand due to the potential for malevolent use, and thus more focused attention on security and control of these materials following the events of September 11, 2001. The Category 1 and 2 quantities of radioactive sources listed in the International Atomic Energy Agency (IAEA) Code of Conduct on the Safety and Security of Radioactive Sources are considered the most risk significant for the United States and have been the focus of Federal and State efforts to place tighter controls for security - especially during times of elevated risk of loss, theft, and diversion, such as during transport. Transportation security of these risk-significant materials is especially complex due to the number of U.S. Government agencies that have various roles and authority for implementation and enforcement of applicable regulations. This paper will focus on the significant progress that has been made with regard to interagency coordination and communication on the secure transportation of radioactive materials within the U.S. or across U.S. borders and with the adoption of new regulations (10 CFR Part 37) on March 19, 2013. These regulations established security requirements for the use and transport of these risk-significant radioactive materials, as well as for shipments of small amounts of irradiated reactor fuel. Elements of these regulations address areas such as preplanning and coordinating shipments; advance notification of shipment details to the NRC and U.S. States through which the shipment will pass; control and monitoring of shipments that are underway; trustworthiness and reliability of personnel; and information security considerations. This paper will also address NRC's current efforts on performing a retrospective program review of 10 CFR Part 37 to ensure an effective and efficient framework for the security, including transportation security, of radioactive material. The wide expanse of this assessment, which includes an internal and external assessment, analysis of international regulations and standards, and stakeholder outreach will inform decisions made regarding the various provisions addressed by the new regulations, including the area of physical protection in transit.

Background on Transportation of Radioactive Material in the U.S.

The Atomic Energy Act of 1954, as amended, created the U.S. Nuclear Regulatory Commission (NRC) as an independent agency to ensure the safe use of radioactive materials for beneficial civilian purposes while protecting people and the environment. The mission of the NRC is to license and regulate the United States' civilian possession, use, and transfer, of radioactive materials to protect public health and safety, promote the common defense and security, and protect the environment.

In 1966, the U.S. Department of Transportation Act formed the Department of Transportation (DOT) to guide the nation's transportation policy and administration. As part of this mission, the DOT regulates carriers of hazardous materials, including radioactive materials, to ensure the movement of commerce and protection of the public within the United States.

Both NRC and DOT establish safety standards that provide an acceptable level of control of the radiation, criticality, and thermal hazards to persons, property, and the environment associated with the transport of radioactive material. To ensure the development and implementation of consistent and comprehensive transport regulations, in 1979, the NRC and DOT entered into a memorandum of understanding (MOU) that delineated their respective responsibilities and authorities, with respect to activities subject to their jurisdiction. This MOU established the foundation of cooperation and consultation to allow the transport regulatory program to expand to include new program elements and address emerging safety technologies. A simplistic description of how the NRC and DOT separate responsibilities for byproduct material is that NRC regulates licensees that possess, use, and transfer radioactive materials, and DOT regulates the carriers that possess and physically transport these materials. (NRC regulations for byproduct material include an exemption from certain NRC requirements for common and contract carriers, freight forwarders, warehousemen, and the U.S. Postal Service.)

Until the 1990s, regulations for radioactive materials used in medical, academic and industrial applications mandated security and control during transport to address safe handling, prevention of inadvertent exposures to workers and the public, and mitigation of common theft. As a result of past incidents involving orphan sources and loss of control events such as melting sources in smelters, in the late 1990s, the need to improve the control over risk-significant radioactive sources was recognized by radiation safety community. While it was known that these materials could be used for a malicious intent and the regulatory community was taking responsible actions to address these issues, there was a limited sense of urgency. The events of September 11, 2001, resulted in a dramatic change in the global threat environment. The U.S. Congress passed legislations to protect the homeland, and federal agencies looked internally to strengthen security policies and ensure that such policies could adapt to address a fluid threat environment. In 2002, Congress passed the Homeland Security Act which created the Department of Homeland Security (DHS) and assigned it the lead responsibility for

transportation security in the U.S. The NRC, DOT, and DHS immediately recognized the overlapping authorities and there were discussions about a potential MOU to address transportation security. However at that time, the federal government was identifying security gaps within each agency's area of responsibility and implementing policy and/or requirements to remove such gaps. Rather than divert resources at this time to develop an MOU, the agencies continued to follow the principles of the MOU developed for transportation safety.

The U.S. framework for security and control of radioactive material requires coordination. Several U.S. governmental agencies have authority over radioactive material transport, the three key agencies are Department of Transportation (DOT), Department of Homeland Security (DHS) and NRC.

The Energy Policy Act of 2005 mandated the formation of the Radiation Source Protection and Security Task Force (Task Force) to evaluate and provide recommendations relating to the security of radiation sources in the U.S. from potential terrorist threats, including acts of sabotage, theft, or use of a radiation source in a radiological dispersal device (RDD). Members of this task force include 14 Federal agencies and one State organization; DHS and DOT are active members, and NRC chairs this Task Force. Since 2005, this task force meets routinely and prepares a report to the President and Congress every four years. The first task force report, issued in 2006, acknowledged that the agencies were following the principles of the transportation safety MOU; however, the Task Force recommended a formal MOU between NRC, DOT, and DHS to address transport security. In addition to the Task Force, there were several other interagency groups, e.g., DHS's Critical Infrastructure Partnership Advisory Council (CIPAC), Government Coordinating Council (GCC) for Radionuclides, which ensured the agencies were working routinely with one another on common issues. Because of the extensive coordination already occurring between, NRC, DHS, DOT and the Departments of Energy and State, the MOU development over the years was deferred/delayed while other emergent issues were addressed.

Ultimately, the MOU between NRC, DOT, and DHS regarding transportation security was issued in 2015. This MOU establishes a formal mechanism for the agencies to work together toward achieving, in an efficient and effective manner, the common goal of protection of public health and safety and ensuring common defense and security. This MOU defines each agency's roles and responsibilities as well as interaction mechanisms for coordination and collaboration. The three agencies identified program elements to guide coordination efforts, and a brief description of each is provided below:

- *Risk Assessments*. Risk assessments include studies done to determine radiological consequences of threats to the radioactive material in a mode of transportation. These assessments include specific reviews focused on packaging configurations. Interactions among the agencies regarding

risk assessments leverages each agencies' resources and identifies areas in which consistency between safety and security should be maintained.

- *Strategic Planning*. Each agency performs strategic planning. Security planning is based on risk, and the agencies will strive for consensus concerning measures for the transportation of radioactive material to manage risk at acceptable levels and minimize the consequences of security events.
- *Regulations and Guidance*. Standards, regulations, guidelines, advisories, orders, and directives are the typical means for U.S. Government agencies to issue requirements, guidance, and notices. Coordination of the development of these requirements and the guidance that explains how to implement the requirements leverages the expertise of the respective agencies to minimize redundancy and conflicting conditions.
- *Inspection and Enforcement*. Each agency performs inspection and enforcement activities for the organizations over which it has cognizance. Coordination of such activities serves to maximize available resources. Working arrangements are being established, including protocols for such inspection and enforcement interactions.
- *Technical Support.* This provides a contingency for each agency's limited resources to be supplemented by those of another agency. Depending on emergent events or circumstances, resources may be required over and beyond what is available to a particular agency.
- *Sharing Information during Emergency Response*. Sharing information during an emergency response serves to coordinate agencies' emergency response activities.
- *Legislative Matters.* This provides for coordination in the development of legislation. This element provides for coordination among agencies from the identification of the need for legislation in order to avoid resource-intensive modifications to drafted legislation that is nearing maturity.
- *Budget*. This element clarifies that the MOU does not go beyond the appropriated funds for each agency. This MOU is neither a fiscal nor an obligating document.
- *Communication.* Provides for official points-of-contact within each agency and leverages existing interagency forums for interaction.
- *Intelligence and Information Sharing.* Information sharing, with regard to security incident occurrence in the field, is facilitated with this element to include interagency interactions regarding intelligence, security, and threat information related to the transport of radioactive materials.
- *Background Investigations.* Certain U.S. regulations require background investigations to be performed in granting access to radioactive material and information regarding transports, as well as granting approval for drivers of radioactive material conveyances. The background investigation program element serves to reduce redundancy among the agencies' individual

programs. The program also advocates reciprocity, or acceptance by one agency of another agency's investigation, when possible.

- *Research and Development.* Research and development enables collaboration of recently completed and on-going safety and security projects. This relationship will save resources and facilitate an overall project management structure to meet two or more agencies' needs, rather than focus solely on one.

This MOU was intentionally developed to be broad in scope, and ongoing activities include developing working arrangements to establish details on interaction protocols that will include frequencies of meetings and notification mechanisms.

NRC Transportation Security Requirements

Category 1 and 2 Threshold Quantities

	Category 1 (TBq)	Category 2 (TBq)
Americium-241	60	0.6
Americium-241/Beryllium	60	0.6
Californium-252	20	0.2
Curium-244	50	0.5
Cobalt-60	30	0.3
Cesium-137	100	1.0
Gadolinium-153	1000	10.0
Iridium-192	80	0.8
Plutonium-238	60	0.6
Plutonium-239/Beryllium	60	0.6
Promethium-147	40,000	400
Radium-226	40	0.4
Selenium-75	200	2.0
Strontium-90(Yttrium-90)	1,000	10.0
Thulium-170	20,000	200
Ytterbium-169	300	3.0

Since September 11, 2001, while the NRC's fundamental goals to protect public health and safety and to protect the environment remained unchanged, the NRC imposed additional security and control requirements on its licensees during transport of radioactive materials. Initially, it was essential for the NRC to act quickly to remove any security gaps by using Orders, rather than the preferable transparent, public process for issuing regulatory requirements. These requirements, which were issued by Order, were consistent with international recommendations and guidance, including the IAEA Code of Conduct on the Safety and Security of Radioactive Sources.

Once these requirements were in place and oversight experience had been gained, the NRC began the public process to establish security requirements by rule. The NRC adheres to the principles of good regulation - independence, openness, efficiency, clarity, and reliability. These principles focus on ensuring safety and security while appropriately balancing the interests of the NRC's stakeholders, including the public

and licensees. There were many insights gained over the years from inspections, self-assessments, and external audits. The challenge was to create a security rule that incorporated realistic approaches to enhancing security that would interface and integrate well with the existing safety rules. Through the NRC's public rulemaking process, over 1,500 comments from licensees, state agencies, industry organizations, individuals and a federal agency were received during the development of 10 CFR Part 37, all of which were considered and addressed by NRC. This new comprehensive security rule, 10 CFR Part 37, for Category 1 and 2 materials, was effective May 20, 2013. All NRC licensees had to fully implement the requirements by March 19, 2014, and all Agreement State[1] licensees were required to implement compatible requirements by March 19, 2016.

For licensees that transport or prepare for transport, Category 2 quantities of material, the 10 CFR Part 37 rule imposes, in general, the following requirements for licensees:

- Prior to transferring materials, verify that transferee's license authorized the receipt, type, form, and quantity of radioactive material to be transferred.
- Use carriers that have established package tracking systems.
- Verify and document (a) the shipment "no-later-than" arrival time and (b) the actual shipment arrival with the receiving licensee.

10 CFR Part 37, Physical Protection of Category 1 and 2 Quantities of Radioactive Material

Subpart	***General Description***
A - General Provisions	*Scope of the rule and definitions to establish the general provisions and of the applicability of the requirements.*
B - Background investigations and access authorization control programs	*Individuals with unescorted access to radioactive materials are trustworthy and reliable and to control personnel access to areas where Category 1 and 2 radioactive materials are stored and used.*
C- Physical protection requirements during use	*Security programs are designed with defense in depth to detect, assess and respond to actual or attempted unauthorized access events and to ensure coordination and response planning between the licensee and local law enforcement agencies. This subpart also includes requirements portable devices when taken out for field use.*
D – Physical protection in transit	*Similar to Subpart C, security programs are designed with defense in depth to address malicious events that could happen during transport and to ensure appropriate coordination between the licensee, the carrier, and the recipient and law enforcement.*
F and G – Records and Enforcement, respectively	*Records that licensees must maintain to demonstrate compliance with the requirements, to ensure that NRC can conduct oversight activities effectively.*

[1] Agreement States are those States that have entered into formal agreements with the NRC, pursuant to Section 274 of the Atomic Energy Act of 1954 (AEA) (Public Law 83 703), to regulate certain quantities of AEA material at facilities located within their borders. Under the Act, the NRC relinquishes to the States portions of its regulatory authority to license and regulate byproduct materials (radioisotopes), source materials (uranium and thorium), and certain quantities of special nuclear materials. Currently, there are 37 Agreement States.

- Initiate an investigation, with the receiving licensee, to determine the location of the licensed material if the shipment does not arrive by the "no-later-than" arrival time.
- If material is determined to be lost or stolen, the law enforcement and then the NRC must be notified.
- Upon discovery of any actual or attempted theft or diversion of a shipment, or any suspicious activity related to a shipment, the NRC must be notified.
- For portable, mobile devices, the licensee must:
  - Have two independent physical controls that form tangible barriers to secure the material from unauthorized removal when the device is not under the licensee's direct control and constant surveillance.
  - When devices are stored in or on a vehicle or trailer, use a method to disable the vehicle or trailer when not under the licensee's direct control and constant surveillance.

In general, for licensees that transport or prepare for transport, Category 1 quantities of material, the following requirements apply:

- Prior to transferring materials, licensees must verify that transferee's license authorized the receipt, type, form and quantity of radioactive material to be transferred.
- Use carriers that have established movement control centers that maintain periodic position information from a location remote from the transport activity of the transport vehicle or trailer. The control center will monitor shipments 24 hours a day, 7 days a week, and have the ability to immediately communicate an emergency to appropriate law enforcement.
- Preplan and coordinate shipment information with each affected U.S. State.
- Preplan and coordinate shipment arrival and departure times with the consignee to ensure minimum delay in reporting the receipt of shipments and the notification of missing, lost, or stolen shipments.
- Provide advance notification of shipments, including a "no-later-than" final destination arrival time, to the NRC and to each affected U.S. State.

NRC Information Technology (IT) Applications

The major IT applications that NRC uses to support Category 1 and 2 source management and protection are briefly described below.

NSTS National Source Tracking System

Tracks transactions of Category 1 and 2 materials from origin (manufacture or import) through transfer to another licensee, to disposition (disassembly, disposal, export, or decay below the level of tracked sources). NSTS is a national registry of sources, consistent with the IAEA Code of Conduct.

WBL Web-Based Licensing

Stores domestic licenses of Category 1 and 2 quantities of material. WBL is more than a license repository, with capabilities that include managing licensing and oversight functions from initial application to issuance, amendment, inspection, reporting, and termination. NRC uses WBL in this capacity and, upon request, provides WBL to Agreement States.

LVS License Verification System

Brokers information stored in WBL and NSTS to confirm that (a) license is valid and accurate; (b) licensee is authorized to acquire quantities and types of radioactive materials; and (c) licensee's Category 1 or 2 inventories do not exceed possession limits.

- For highway shipments, establish redundant communications allowing the transport to contact the escort vehicle (when used) and movement control center at all times.
- For highway shipments of long duration, provide an accompanying individual for the entire shipment.
- Ensure that rail shipments are monitored by a telemetric position monitoring system or an alternative tracking system reporting to the licensee, third-party, or railroad communications center.
- Require an immediate initiation of an investigation if the shipment does not arrive by the designated "no-later–than" time recorded on the advance notification.
- During stops, ensure that at least one individual is awake at all times and maintains constant visual surveillance.
- Develop normal and contingency licensee procedures to cover notifications; communication protocols; loss of communications; and response to actual, attempted, or suspicious activities related to the theft or diversion.
- Protect shipment information from disclosure to unauthorized individuals.
- As soon as possible upon discovery of any actual, attempted, or suspicious activities related to the theft or diversion of a shipment, notify the designated local law enforcement agencies along the shipment route and the NRC.

To support implementation of the rule, the NRC published two guidance documents:

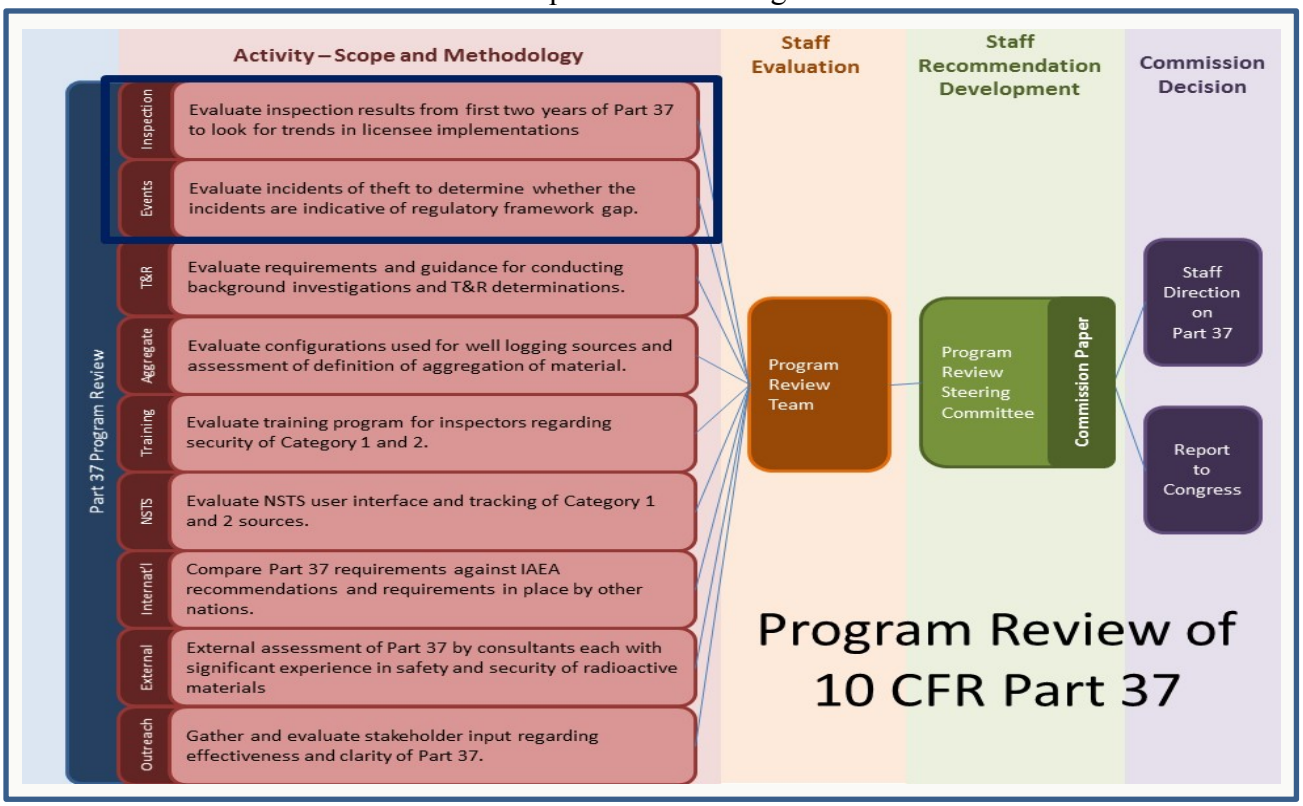
1. NUREG-2155, "Implementation Guidance for 10 CFR Part 37, 'Physical Protection of Category 1 and Category 2 Quantities of Radioactive Material.'" Subsequently, the NRC published Revision 1 to NUREG-2155. This guidance document is intended for use by applicants, licensees, and NRC staff, and describes optional approaches and methods acceptable for implementing the requirements of the regulations. As a guidance document, NUREG-2155 does not establish additional requirements; and licensees are able to propose alternative ways for demonstrating compliance with the requirements in 10 CFR Part 37.
2. NUREG-2166, "Physical Security Best Practices for the Protection of Risk-Significant Radioactive Material." This NUREG provides guidance to NRC licensees and applicants on developing and implementing a physical protection program for the protection of risk significant radioactive material (e.g., Category 1 and Category 2 quantities of radioactive material). The intent of NUREG-2166 is to provide NRC licensees or applicants guidance with specific emphasis on physical security best practices. The approaches and methods in this document are not requirements; however, the NRC considers them to be acceptable for demonstrating compliance with the requirements in 10 CFR Part 37.

Evaluation of 10 CFR Part 37 Security Requirements

The federal government utilizes a variety of methods to routinely monitor and publicly document the adequacy, efficiency, and effectiveness of federal policies and regulations. These can either be triggered by internal agency policies, e.g. routine self-assessments or an agency's inspector general audit, or external events, e.g. Government Accountability Office (GAO) audit or legislative mandate. In 2015, the NRC commenced a review of the requirements of 10 CFR Part 37 both because of the NRC's commitments in response to GAO audits and a legislative mandate. However, as part of the NRC's commitment to regulatory effectiveness and efficiency, this review is more expansive than directed by legislation. This review will be complete in the fall of 2016, and recommendations from this review will be provided to the NRC Commission. This comprehensive review consists of 9 unique components:

- Evaluation of inspection results from first two years of 10 CFR Part 37 implementation to look for trends in licensee implementation.
- Evaluation of incidents of theft since 2005 (issuance of the post September 11 security orders) to determine whether the incidents are indicative of a gap in the regulatory framework.
- Evaluation of 10 CFR Part 37, Subpart B, requirements and guidance for conducting background investigations and trustworthiness and reliability determinations.
- Evaluation, through inspector interviews, of configurations used for well logging sources and assessment of the definition of aggregation of material.
- Evaluation of the training program for inspectors regarding security of Category 1 and 2 materials.
- Evaluation of the National Source Tracking System.
- Comparison of the 10 CFR Part 37 requirements against IAEA recommendations and requirements in place by other nations. Observations of the differences between the U.S. and other nations would be evaluated and analyzed for possible consideration in 10 CFR Part 37 or supporting guidance.
- External assessment of 10 CFR Part 37 by consultants each with significant experience in the safety and security of radioactive materials. Three consultants were hired to provide reports about:
  - Adequacy and completeness of the 10 CFR Part 37 requirements and staff self-assessment.
  - Clarity of the 10 CFR Part 37 regulations and guidance.
  - Adequacy of the NRC's roll-out of 10 CFR Part 37 requirements and guidance.
- Gathering and evaluation of stakeholder input regarding the effectiveness and clarity of 10 CFR Part 37.

A flowchart to illustrate these activities is provided in the figure below.



The activities were conducted concurrently and were nearly complete by late spring 2016. Each activity resulted in an observation or a possible recommendation for further staff evaluation. In total there were approximately 250 items for further review. A 10 CFR Part 37 Program Review Team (PRT), with representation from across NRC programs (e.g., security specialists, legal counsel, inspectors, etc.), was tasked to evaluate each item for further review. Overseeing the PRT, a Steering Committee, with senior managers from across NRC programs was stood up to deliberate the results from each activity and the PRT recommendations. The staff recommendations will be provided for Commission consideration in late 2016.

10 CFR Part 37 Inspection and Enforcement

The NRC has a long standing, established inspection program. The documentation of the NRC's inspection program is found in NRC Inspection Manual Chapter 2800, "Materials Inspection Program." Associated with Manual Chapter 2800 are specific inspection procedures that are used to verify that licensees are effectively implementing NRC requirements. Inspection Procedure 87137, "10 CFR Part 37 Materials Security Programs," is used to verify that licensees are effectively implementing NRC security requirements. From March 2014 - March 2016, a total of 255 inspections were conducted to confirm NRC licensee compliance with the requirements of 10 CFR Part 37.

The NRC assesses the significance of licensee violations of NRC requirements by assigning a severity level to all violations. The severity level of a violation is established by considering:

- Actual safety consequences,
- Potential safety consequences,
- Potential for impacting the NRC's ability to perform its regulatory function, and
- Any willful aspects of the violation.

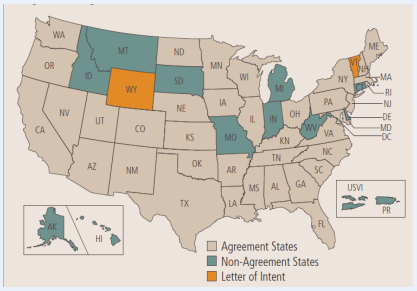
Severity Level designations reflect different degrees of significance and include Severity Levels I, II, III, and IV and minor violations (SLI – highest significance, minor – least significance). For example, SLIV violations are those that are less serious and result in no or relatively inappreciable potential safety or security consequences. Additional information on the NRC Enforcement Program, including full definitions and examples of each severity level designation, is available on the NRC public website.

The staff closely tracked the results of the 10 CFR Part 37 inspections. To ensure consistent application of the enforcement, the NRC's Enforcement Policy and experience used for the Orders was generally applied to the 10 CFR Part 37 inspections; however given that 10 CFR Part 37 included new requirements, there were situations that had not previously been addressed. The staff meticulously identified and tracked precedent-setting violations and examples. The staff, including but not limited to, inspectors, security specialists and general counsel, debated root cause of the violations and agreed upon the appropriate regulatory citation(s).

AGREEMENT STATE PROGRAM

The Atomic Energy Act authorizes NRC to relinquish to individual states portions of its regulatory authority to license and regulate byproduct materials.

The mechanism for the transfer of NRC's authority to a state is an agreement signed by the governor of the state and the Chairman of NRC. Such states are thus referred to as "Agreement States," of which there are currently 37. Agreement State regulations must be equivalent to NRC's regulations covering the same subject matter.



The Integrated Materials Performance Evaluation Program (IMPEP) ensures the protection of public health and safety through routine evaluation of Agreement States' and NRC Regions' regulatory oversight of licensees under their jurisdiction and provides NRC and Agreement State management with a systematic and integrated approach to evaluate the strengths and weaknesses of their nuclear material licensing and inspection programs.

The majority of NRC's 10 CFR Part 37 inspections, 181 or 72%, were clear with no findings. The remaining 71 inspections resulted in 189 specific violations issued to 61 NRC licensees. Of the 189 specific 10 CFR Part 37 violations, 19 were SLIII violations, and 170 were SLIV. Looking closely at the SLIII violations, five were cited against Subpart B (Background Investigations and Access Control Program) and 14 were cited against Subpart C (Physical Protection Requirements During Use). Of the 170 SLVIV violations, one was cited against Subpart A (General Provisions); 70 against Subpart B; 98 against Subpart C; and one against Subpart

D (Physical Protection in Transit). The low number of NRC licensee violations cited under Subpart D could be an underrepresentation since the majority of large manufacturers and distribution companies that consistently ship Category 1 and 2 materials are licensed by Agreement States. Additionally, for licensees that transport their own sources, the security requirements for transportation in 10 CFR Part 37 are not that much different than the Orders that existed for compliance with safety requirements, so these requirements are well-understood. More than 50% of the violations of 10 CFR Part 37 resulted from the licensees' failure to appropriately transition from the requirements of the post September 11 Orders to those in the 10 CFR Part 37 rule.

Events

Reporting the loss or theft of radioactive materials has been a long standing requirement for NRC and Agreement State licensees and these reporting requirements are found in 10 CFR Part 20. For Category 1 and 2 materials, 10 CFR Part 37 imposes reporting requirements beyond those of 10 CFR Part 20 related to attempted, or actual theft, sabotage or diversion of material. The NRC collects the information related to these event reports within the Nuclear Materials Events Database (NMED). Since May 2006, when licensees were required to be in compliance with the Orders, there have been no (0) thefts of Category 1 materials and six thefts of Category 2 materials. The six reported thefts of Category 2 materials were of radioactive cameras containing Iridium-192 (Ir-192). A summary of the events is as follows:

- 2006, Truck stolen with radiography device onboard. While transporting radiography device, radiographers stopped at gas station convenience store. One radiographer went into store and left radiographer with vehicle and device. While the first radiographer was in store, the second radiographer decided to go into store as well, while leaving the vehicle unlocked with the keys on the floorboards. The vehicle was stolen. The perpetrator was subsequently apprehended; the vehicle and intact device were recovered by local police.
- 2006, Truck stolen with radiography device onboard. While the radiographer rested at a hotel, the device was stored in the vehicle in the parking lot. The keys to the vehicle and the darkroom were left in the vehicle door, and the vehicle immobilization device

RISK SIGNIFICANT SOURCE TRANSACTIONS

NSTS tracks transactions associated with more than 77,000 NRC and Agreement State Category 1 and 2 sources. (Approximately 50% are Category 1 and 50% are Category 2). Of those transactions, manufacture (23%), transfer (38%), and receipt (27%) are the most common transactions followed by export (11%) and disposal (<1%).

Of the total sources, roughly:

90% are Cobalt 60, commonly used in industrial irradiation, panoramic irradiators, and external beam radiation therapy units. These sources are replaced every 5 years.

5% are Cesium-137, commonly used in blood and research irradiators. With a half-life of 30 years, these sources typically are not replaced over the lifetime of the device.

4% are Iridium-192, commonly used in radiography applications, and the source decays below its usefulness in about 3 months. The Iridium-192 sources transactions, which include manufacture, transfer and receipt make up 97% of the transactions reported in NSTS.

and monitoring system were not activated. The abandoned vehicle and intact device were recovered by local police.

- 2011, Truck broken into and radiography device stolen. Radiographers locked the device to the dark room and locked the dark room. The vehicle's tailgate was left unlocked and the alarm on the security zone was not activated. The radiographers stayed in a hotel overnight and parked the truck storing the device in the parking. Overnight, the darkroom was broken into and the device stolen. The device was not recovered. (More information about this event and response, can be found in PATRAM 2016 paper titled "Multijurisdictional Response to Lost and Stolen Radioactive Material" by Gentry Hearn, Kim Lukes, and Margaret Cervera.)
- 2012, Truck broken into and radiography device stolen. The radiographer returned to the company location and failed to transfer the radiography device from the truck to the company storage vault. Several vehicles at the company were broken into, and the device was among the items stolen. Surveillance video at the company identified the vehicle of the perpetrator. The device was recovered intact by police in the vehicle at the perpetrator's residence.
- 2015, Truck stolen with radiography device onboard. While transporting a radiography device, a radiography crew stopped at a convenience store. The crew went inside the store and left the keys within the unlocked vehicle. The radiography company used their truck GPS tracking device to locate the vehicle. The perpetrators abandoned the vehicle when the radiographer showed up. The device was recovered intact.
- 2015, Employee theft. A radiographer with the vehicle and device did not show up at job site and attempts to contact him were unsuccessful. The company contacted family members and co-workers, checked travel routes, and checked the job site for the no-show radiographer. Late that evening, the radiographer drove to his father's house in the vehicle with the device. The vehicle and intact device were returned to the company's Radiation Safety Officer by the radiographer's father within an hour.

Following an event, the NRC or Agreement State conducts an assessment to determine the appropriate response, and for instances of loss or theft of risk-significant materials, conducts a reactive inspection. The events listed above were thoroughly investigated by the licensee's regulator at the time of occurrence, and appropriate enforcement actions were taken against the licensee (including enforcement actions against individual radiographers, as appropriate). The NRC reviewed the circumstances of these cases against the safety and security requirements of 10 CFR Parts 20 and 37 to evaluate whether there are any "gaps" in the requirements that would have allowed these events to occur had the licensee been in compliance with 10 CFR Parts 20 and 37 at the time of the event and found none. On the contrary, the staff found that if the licensee had followed the regulatory requirements, it would have prevented such events from occurring.

Other Reportable Events

Events that can impact public health and safety but do not have a correlation to criminal or suspicious activity are also reported and tracked. This included incidents where sources have fallen off/out of a truck, been left at a job site, left in a vehicle, lost by the shipping company, or otherwise unattended. Although it may be perceived that sources being left unattended is a frequent occurrence, given the number of radioactive sources in use and in transit in the U.S., incidents are rare. Not including the six thefts discussed above, since 2005, there were 29 incidents involving Category 1 and 2 quantities of radioactive material. Some these reports were of instances where devices were inadvertently left unattended for some period of time but were retrieved. More commonly though, they resulted from shipments that were not received when anticipated by were ultimately located and delivered correctly. This was the case in 13 of the 29 events. None of these events were security-related.

Conclusions

The NRC's fundamental goals to protect public health and safety, to promote the common defense and security, and to protect the environment, have remained unchanged since the events of September 11, 2001. The NRC has focused significant attention on preventing the theft or diversion of radioactive materials, in particular IAEA Code of Conduct Category 1 and 2 radioactive materials, during transport since this could lead to their use in a malicious act. Initially, the NRC evaluated its regulations, conducted security assessments, identified areas where security could be enhanced and, as an interim solution, issued Orders imposing additional security beyond the existing requirements. Since issuance of the Orders, the NRC transitioned to regulatory requirements and IT solutions to enhance the security and control of radioactive materials. The NRC's efforts in ensuring the security of radioactive material did not end with the publication of the new 10 CFR Part 37 rule, NRC continuously assesses its programs to ensure that new or emerging threats or vulnerabilities are appropriately addressed and to ensure the existing security policy is effective. Since March 2014, the analysis of NRC inspection results and events reported by licensees thus far is positive. Generally, Category 1 and 2 radioactive materials are secure during use and transport. Most issues with the regulated community are administrative in nature (e.g. lack of complete documentation). The NRC continues its self-assessment and the details and results of this comprehensive effort will be publicly available at the end of 2016.

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