Training Course on Nuclear Safety and Security

Gandhinagar, India 4-6 September 2019

In cooperation with Pandit Deendayal Petroleum University (PDPU), World Institute for Nuclear Security (WINS), and Los Alamos National Laboratory (LANL)

REPORT

Overview of the Training Course

From 4-6 September 2019, 55 participants attended a joint PDPU/WINS/LANL Nuclear Safety and Security Training Course at PDPU in Gandhinagar, India. They came from PDPU, Odisha Power Transmission Corporation, University of Delhi, MUST, Jadavpur University,

UPES Dehardun, Banaras Hindu University, The Science Collective, IIT Madras, IPR, Amity University, The Atomic Energy Regulatory Board, and IIT Kanpur.

The event—which was organised and led by Dr Manish Kumar, Professor, PDPU; Mr. Daniel Johnson, Senior Advisor, WINS; and Dr James Miller, Scientist, LANL—provided a foundational introduction to basic nuclear security concepts and essential aspects of nuclear security. Its major purpose was to help participants consider how their knowledge, skills and professionalism comprise an important asset that can be harnessed to improve security—for colleagues, the facility, the local community and the State itself.

Throughout the three-day course, participants listened to lectures from Indian subject matter experts, engaged in discussion sessions led by WINS and LANL, and participated in multiple tabletop exercises to reinforce their learning.

Some of the major topics addressed during the training include:

- Common threats to nuclear and other radioactive materials
- The potential security risks posed by insiders and how to mitigate the threat
- The intersection between nuclear safety and security and how to integrate the disciplines
- The similarities and differences between safety and security risk
- The personal accountabilities and responsibilities that scientists, technicians and engineers have for security
- The fundamental role of the human factor in security
- Who the stakeholders are in nuclear security and how to communicate effectively with each one
- The balance between sharing information and secrecy
- Key safety and security concepts such as defence in depth
- Radioactive sources and how they are categorised according to activity level
- Risks and threats to radioactive sources
- The role of security culture in improving security
- Real-life case studies of radioactive material in India that has gone out of regulatory control

Participants were encouraged to broaden their nuclear horizons and learn more about nuclear security as well as nuclear policy issues outside their technical areas of study. Participants were also informed about the WINS Academy and strongly encouraged to enrol in it.

Opening Presentation: The Safety and Security Interface

Dr Parikshat Bansal, Scientific Officer at the Atomic Energy Regulatory Board (AERB), opened the training course with a presentation on the safety and security interface. In his remarks, Dr Bansal noted that:

- Nuclear safety and nuclear security are equally important for assuring protection of the worker, public and environment.
- Safety and security measures should be designed and implemented in an integrated manner right from the beginning of the lifecycle of a facility.
- Implementation of security measures at a facility that has already been built with only safety considerations in mind will result in safety-security interfaces that require effective management.
- Effective management includes robust planning, communication and coordination at all organisational levels.
- Effective management of safety and security information is an essential part of organisational culture.
- Effective coordination is required between security personnel and general plant staff.

Dr Bansal also noted that the organisation that handles security of nuclear facilities in India also runs airport and other critical infrastructure security, which is an important difference from many countries.

Discussion

Following Dr Bansal's presentation, Mr Johnson facilitated a discussion with participants. Key outputs include:

Transport

There is an increased danger to nuclear material during transport; however, participants said they believe that transport is well protected in India.

Working with Security

Participants had different experiences in regard to working with security. An Indian participant remarked that he needed equipment for an experiment, but it was delayed by security for several months. Dr Miller said that he works in a high security environment and needs to work closely with security at each stage of implementation to complete his projects.

Secrecy vs. Transparency

A discussion also took place regarding the difference between safety and security when it comes to secrecy and transparency. It was noted that in **safety**, the free flow of information—and free access to it—is a key aspect and encouraged as an important part of safety culture. In contrast, confidentiality and limited access to vital information is key for nuclear **security**. Mr. Johnson said there is a tendency in the nuclear sector to err on the side of secrecy. He added that much of the secrecy is excessive and can be used to cover up mistakes.

Session I: Radioactive Sources: Categorisation, Regulations and Disposal

In the first session of the training course, **Dr N.K. Joshi, Professor, Mody University of Science & Technology**, provided an overview of radioactive sources and radiation. He helped participants understand radiation fundamentals, the difference between sealed and unsealed sources, the IAEA methodology for categorising radioactive sources, and how sources are regulated and disposed of at the end of their lifecycle.

In his remarks, Dr Joshi covered such topics as:

- The five IAEA categories of radioactive sources. (Category 1 poses the highest risk to human health, whereas Category 5 poses the lowest risk.)
- The fact that source categorisation is based on the source **activity** (A) and the **D-value** for a particular radionuclide. In RS-G-1.9, the IAEA says that: *The D value is the radionuclide specific activity of a source which, if not under control, could cause severe deterministic effects*. In other words, it is the quantity of radioactive material that could result in permanent injury or death if an individual is exposed to it.
- The lifecycle of a radioactive source, including all stages of its existence from design through disposal.

— The potential for sources to cause unacceptable consequences if used for malicious purposes.

— Regulation of radioactive sources, including guidance from WINS, the IAEA, and AERB as the Competent Authority in India.

Dr Joshi also discussed an August 2009 incident that took place near Pune, India, in which an industrial radiography device containing 2.6 curies of radioactive material fell off a vehicle as it was being transported. Children picked up the device and took it to their village. Although they tried to open it, they were unsuccessful, and the AERB recovered it intact.

Discussion

Following the presentation, WINS facilitated a discussion in which participants were asked to imagine designing a self-assessment of safety and security for an organisation that uses radioactive sources, including the elements that would need to be included in the assessment and who would be involved.

Session II: Assessment of Effectiveness of Physical Protection Systems for Sensitive Facilities

In Session II, **Dr Prabhat Munshi** and **Prof. Pankaj Wahi** from **IIT Kanpur** talked about physical protection systems and key nuclear security concepts. They began by introducing a simulation exercise they have developed that uses Minecraft to simulate an attack on a nuclear facility. Sixty-eight participants participated in the simulation, but only two succeeded in breaking into the facility.

Dr Munshi and Prof. Wahi also discussed how they developed the data for the simulation and the difference between subjective probability and assessment probability. They explained that *subjective probability* relies on expert judgement, whereas *assessment probability* is derived from data collected during Red Teaming exercises that test various security systems.

In addition, Professor Wahi discussed detection methodologies extensively and highlighted spectroscopic radiation portal monitors, which were developed in India for cargo inspections. He also described several additional projects related to nuclear security to give participants an overview of different areas of research that are currently being conducted in India.

Session III: Fear as a Guiding Factor in Security Perception and Practice

In Session III, **Dr Braj Bhushan, Professor, IIT Kanpur**, talked about psychology and emotions, in particular how fear impacts on individuals working in the nuclear industry. He also discussed various fear dynamics (e.g. beliefs and prejudices) and how they work in the social-cultural context.

In addition, he discussed how fear impacts security culture. For example, he said there is increased apprehension and stress in high security organisations because people know they are being watched. This can push some people into paranoia.

Dr Bhushan also talked about the psychology of terrorism and how a terrorist might be motivated by psychological factors. Participants noted that the Indian public is afraid of nuclear power, which has led to many protests and poor reporting on nuclear issues. In addition, they noted, the media is rewarded for writing fear-based articles about nuclear.

Discussion

Following the presentation, Mr Johnson facilitated a discussion based on the following questions:

- What motivations, attitudes and behaviors contribute to security culture?
- What are some examples of good and bad security culture practices?
- What do you think is the difference between good security culture and security compliance?
- What do you think are the primary obstacles that hinder implementation of an improved security culture?
- What might happen to security culture during a crisis?

Session IV: Threat Aware Control Systems Development for Nuclear Installations

In Session IV, **Dr Amitava Gupta, Professor, Jadavpur University**, talked about control and instrumentation in a modern nuclear power plant. In particular, he:

- Provided examples of how to manipulate control systems and the protections that are put in place to prevent this.
- Described an insider scenario in which control systems could be manipulated to cause an accident.
- Explained the consequences of malware on control systems.

Dr Gupta said that facilities in India use proprietary systems for most of their instrumentation and control, which means that they are not as susceptible to malware and other malicious activity as commercial, off-the-shelf software is. He also explained how different types of software are developed and tested on training simulators and how the working system is air-gapped until proven reliable. One of the underlying themes in Dr Gupta's discussion was that every employee has responsibility for nuclear security.

Session V: Mayapuri Cobalt-60 Radioactive Accident: Overview and Lessons Learned

In Session V, **Dr Suresh Kumar, Assistant Professor & Radiological Safety Officer, University of Delhi (DU),** described a radioactive accident that occurred in 2010 and some of the lessons learned. The incident occurred when the University of Delhi's Chemistry Department sold a disused radioactive source containing cobalt-60 to scrap metal dealers in Delhi's Mayapuri Scrap Market. Scrap workers tried to recover the steel and lead cladding by prying open and melting the radioactive cell. As a result of their exposure to Co-60, a Category I material, one person died and six were sickened by radiation exposure.

Professor Kumar explained how the incident happened, the response to the incident, the government inquest, the press response, and lessons learned. Following are some of the underlying factors that precipitated the incident:

- The user of the gamma cell had retired 25 years before the incident occurred.
- The Chemistry Department lacked personnel who were trained in radioactive source safety and security.

- DU staff lacked awareness of the dangers of radioactive sources.
- There were gaps in knowledge, infrastructure and legislation when it came to handling radioactive materials.

Six professors at Delhi University were charged with criminal negligence. The University accepted its liability and paid compensation to the survivors, as did the government. In addition, the incident received substantial negative press coverage.

Exercise

Following his presentation, Dr Kumar led an exercise in which participants took on the roles of different stakeholders—including the public—who are responding to a similar incident. The ensuing debate was quite robust.

Nuclear Security Tabletop Exercises

James Miller, LANL, and Dan Johnson, WINS, also conducted several tabletop exercises and roleplaying activities during the event.

Tabletop Exercise #1

The first tabletop exercise consisted of a scenario based on a fictional fuel fabrication facility called *PDPU Nuclear Enterprises*. During a routine end of quarter inspection of the organisation's accounts, an accountant finds a discrepancy in the mixed oxide fuel pellet assembly plant. The plant supervisor temporarily stops production until this can be sorted out, and a committee of reviewers is assembled from other areas of the company to review the situation.

Participants were organised into small groups, where they took on the roles of various members of the committee. They gradually received injects with additional information until they could make a finding on what had happened. Following are some of their conclusions:

- The organisation had a poor nuclear security culture. There were no control procedures, and staff were poorly trained and complacent.
- Production was more important than either safety or security.
- Coordination among departments was poor.
- Every staff member in the hypothetical company was partially at fault.

Tabletop Exercise #2:

Participants then participated in an exercise that gave them a first-hand understanding of the defence in depth principle.

To begin with, they were told that they had a fixed amount of funds ($200) with which to add protection upgrades to a hypothetical nuclear facility. Examples of protection upgrades included fences, cameras, guards, behavioural observation programmes and cybersecurity programmes. Each upgrade had a monetary value; participants were asked to decide which upgrade(s) to purchase—given their limited budget—in order to achieve the highest level of security.

Participants then created attack scenarios for their facility and rolled dice to see if their infiltrator could get through the protection and reach nuclear material. They also had the option to run an 'insider threat wild card' to defeat any one security feature of their choice.

Tabletop Exercise #3: Whom should we allow inside?

In exercise three, participants were organised into three teams to participate in a competition, and the team with the most correct answers won prizes.

To perform the exercise, participants were given basic information about 10 real applicants who had undergone the clearance process in a real nuclear facility. The teams were asked to discuss each applicant and determine whether or not they should be granted a security clearance to work in the facility.

Only one applicant was denied clearance by all of the groups; all of the other applicants were granted clearance by at least one group. At the end of the exercise, participants learned that the real organisation had denied clearance to all 10 applicants.

Final Role Play Exercise

During the final exercise, five participants volunteered to rehearse and present a mini play that demonstrated how NOT to communicate with the public in an emergency. The emergency—which involved a demonstration carried out by anti-nuclear activists at a nuclear facility—clearly showed the negative effects of poor communication between a senior nuclear engineer, his colleagues, boss and the media.

Conclusion

Throughout the training course, many participants expressed their concern about a challenging job market. They explained that the nuclear industry and government in India do not hire nuclear engineers out of graduate school; instead, there is a narrowly defined pipeline of individuals trained by the government.

To address this concern, **Urvashi Rahore, Nuclear Policy Researcher**, talked about her career experience in the nuclear industry. She explained that although she has a technical background, she has worked in nuclear policy for several organisations. Ms Rahore recommended that participants broaden their horizons and explore policy, cyber, simulation and other fields in addition to their nuclear engineering studies.

Final Remarks

Upon conclusion of the training course, Mr Kumar, Mr Johnson and Dr Miller thanked participants for their active participation in the event. Special thanks were given to the student organisers of the event. It was also noted that improving security culture in India will take time and may require a generational challenge.