Wins Academy Training Course on
Integrated Nuclear Safety and Security Culture

In Cooperation with Amity University and Oak Ridge National Laboratory

Amity University, Noida, India. 26-28 September 2019

REPORT

COURSE OBJECTIVES

From 26-28 September 2019, 70 participants and speakers attended a WINS Academy Training Course on Integrated Nuclear Safety and Security Culture at Amity University in Noida, India. Participants attended from the Amity Institute of Nuclear Science and Technology, Mody University, Indian Institute of Technology (IIT) Madras, IIT Mumbai, Pandit Deendayal Petroleum University (PDPU), University of Petroleum and Energy Studies (UPES) Dehardun, Department of Atomic Energy (DAE), the Bhabha Atomic Research Centre (BARC), the National Safety Council, the Centre for Air Power Studies (CAPS), and the National Institute for Advanced Studies (NIAS).

The purpose of the training course was to help participants better understand the interface between safety and security at nuclear facilities and to learn how to optimise the relationship using their knowledge, skills and professionalism as scientists, technicians and engineers. Throughout the three-day course, participants listened to lectures from Indian subject matter experts, engaged in discussion sessions led by WINS and ORNL, and participated in multiple exercises to reinforce the learning from the course.

The key areas of knowledge covered in the training course included:

- The relevant international instruments covering both nuclear safety and nuclear security and how they define the responsibilities of the State, the regulator and the operator in India.
- The national legal framework and policies related to both nuclear safety and nuclear security in India.
- The objectives of nuclear safety and nuclear security, their similarities and differences, and the importance of a coordinated approach between them.
- The differences and similarities between safety risk and security risk as expressed in both probabilistic safety assessment (PSA) and probabilistic risk assessment (PRA) in safety, as well as the identification of risk based on deterministic and probabilistic methods.
- The fundamental concepts of defense and depth in the design and operation of nuclear facilities.
- The responsibilities of operators to design, implement and maintain technical solutions and other arrangements to satisfy regulatory requirements related to both safety and security.
- How nuclear safety can support nuclear security effectiveness and vice versa and circumstances in which actions to serve one objective can be antagonistic to the achievement of the other.
- What is meant by *safety culture* and *security culture* and how these two concepts share many common elements, including the role of organisational leadership.
- The cultural differences between safety and security professional communities, the problems that may arise because of those differences, and methods to overcome this challenge and facilitate integration.

- The concept of *human reliability* and how it can be applied in both a safety and security context to ensure the safe operation of a nuclear facility.

The event, which was professionally facilitated by **Mr Carl Reynolds,** included expert presentations and hands-on exercises to provide maximum engagement. In addition, an instant electronic voting system was used to allow participants to anonymously share their views on selected questions. Some e-voting questions are reflected in this report.

DAY 1: THURSDAY 26 SEPTEMBER

OPENING CEREMONY

The training course opened with a *lighting of the lamp* ceremony to inaugurate the event. **Dr Alpana Goel, Amity University,** welcomed participants and thanked them for attending. Noting that WINS and ORNL have worked with Amity in past, she said the training course would focus on advanced concepts in nuclear security and safety. She also said that the best speakers from India would present on the topic, including representatives from DAE and BARC amongst other esteemed institutions.

Dr Goel explained that Amity University is a dream institution for its founder, Dr Ashok Chauhan, and that it is the only university in India that provides a bachelor of nuclear science and technology. She also thanked the chancellors and organising team at Amity for their help in putting the event together, noting that it had not been an easy task. In addition, she encouraged participants to suggest future programmes and activities that they would like to participate in and thanked WINS, PNTR and ORNL for their support.

Dan Johnson, WINS, then provided an introduction to WINS. He encouraged participants to take advantage of scholarships and enrol in the WINS Academy. He also encouraged them to complete the examinations, attain the status of Certified Nuclear Security Professional (CNSP), and join the WINS Alumni network.

SESSION I: FUNDAMENTALS OF NUCLEAR SECURITY CULTURE

Dr K L. Ramkumar, DAE, opened the first session with a presentation titled *Fundamentals of Nuclear Security Culture: Challenges in Understanding Good Practices.* Dr Ramkumar focused on the differences among safety, security and safeguards. He explained that safety focuses on the protection of people and the environment from the harmful effects of radiation, whereas security focuses on the protection of nuclear and other radioactive material from people with malicious intent.

Dr Ramkumar noted that some basic conflicts exist between safety and security. For example, safety wants as many exits as possible from a facility, whereas security wants as few exits as possible. He also discussed global best practices and how to acquire them. Best practices, he explained, either derive from a good culture or are a reflection of culture.

Culture is a human trait that is seldom expressed overtly in words; instead, it is felt and practiced subconsciously and shared seamlessly amongst individuals with common goals

and responsibilities for the overall welfare of society and an organisation. When it comes to security, best practices can differ from one country to another because each has different security considerations. Because security needs to take the surrounding environment into account, one size does not fit all.

Discussion

A question and answer (Q&A) session followed Dr Ramkumar's presentation. Key points included:

- Safety started sharing best practices in the 1970s; in contrast, security did not start sharing best practices until the first decade of the 21st century when the first IAEA security guidance document was published.
- Safety and security need to be integrated together in implementation. This is much easier to do in a new facility than in an existing facility.
- Leadership plays the most important role in deciding how much priority is given to both safety and security.
- Security is increasingly focused on insider threat and human reliability programmes. It is important to stop security problems before someone is hired or becomes a threat.

Dr Ramkumar also provided several examples of how nature illustrates basic security principles. Mr Johnson mentioned the biologist Rafe Sagarin, author of *Learning from the Octopus* and *Natural Security*, who applied lessons learned from nature to resolving security challenges. Examples of Sagarin's observations include:

- Biological creatures use a decentralized process to observe threats, which is analogous to our own immune system.
- Responding to unknown threats means having redundant systems.
- Effective communication requires the ability to share signals in many frequencies.
- Symbiosis and partnerships can help to address threats.
- No adaptation is effective if it is simply a one-time event. Creatures continually adapt to respond to ongoing threats.

In the second presentation of Session I, **Dr M. Sai Baba, National Institute of Advanced Studies (NIAS),** talked about the *Fundamentals of Nuclear Safety and Security.* He noted that India's energy needs are growing and that nuclear accidents have led to very few deaths. In fact, compared to all other energy sources, nuclear is at the bottom as a cause of fatalities.

Dr Baba said that safety and security rely on human reliability programmes (HRP), which can be an excellent tool for decision making and improving employee quality. He explained in detail how an HRP can be used to protect against individuals with malicious intent and noted that HRPs are used in numerous industries, including aviation, mining, transportation and the chemical industry.

Dr Baba also discussed *automation bias*, which means that organisations are placing more trust in machines and less trust in human expertise (even if human expertise is correct).

However, he cautioned, in the age of cyberthreats, automation can be dangerous. New technologies will continue to be developed, and we need to be conscious of both their positive and their negative consequences.

SESSION II: CULTURAL TRAITS OF NUCLEAR SAFETY AND NUCLEAR SECURITY

In Session II, **Karen Kaldenbach** and **Joe Curtsinger**, Oak Ridge National Laboratory (ORNL), USA, led an interactive, discussion-based exercise to help participants think about nuclear safety and security culture. Ms Kaldenbach began by discussing the structure of culture and how it either contributes to or detracts from an effective safety and security culture. She also described specific cultural traits that can either positively or negatively impact culture within an organisation.

Participants were then organised into five teams and asked to develop a skit or other demonstration of good and bad security culture. Examples included:

- A skit depicting a real-life incident that took place at the Doel Nuclear Power Plant in Belgium where a turbine generator was sabotaged.
- An examination of how we make assumptions about people according to their appearance. For example, is an unknown man with a beard less trustworthy than a clean-shaven man? Is a well-dressed person more reliable than a person who is dressed in worn-out clothes?
- A scenario in which a pump is leaking and the director of the facility is notified of the problem but fails to take effective action. The result is that the pump eventually fails and the reactor is forced to shut down.
- A skit involving a nuclear reactor control room. Participants demonstrated bullying behaviour to get through security without a badge, a communication breakdown because individuals spoke different languages, an aggressive boss who discriminated against some staff members, and a failure to follow security protocols.
- A skit involving response to an insider threat.

These sessions generated excellent small group discussions during which many participants shared additional examples of behaviours that conflict with good security

culture. They agreed it is essential to recognise these behaviours and to bring them to the attention of management so the issue can be remedied.

DAY 2, FRIDAY 27 SEPTEMBER

SESSION III: NUCLEAR SAFETY AND SECURITY IN INDIA

Dr Manpreet Sethi, CAPS, New Delhi, opened Session III with a presentation titled *Nuclear Safety and Security in India.* Dr Sethi provided an overview of global nuclear governance and its three-legged stool: safety, safeguards and security.

She noted that there are security concerns in India due to the conflict with Pakistan and the proliferation of terrorist groups. She also said that the global responsibility for nuclear security is a chain that affects everyone. Even non-nuclear countries could be used as transhipment points for trafficked nuclear material.

In addition, Dr Sethi pointed out that IAEA recommendations for security are voluntary, with no enforcement mechanisms. (This is in contrast to safety, which does have required regulations and enforcement mechanisms.) Furthermore, there is a dichotomy between sharing the discovery of security loopholes to improve security globally and the desire to hide security breaches to avoid embarrassment within the international community.

Discussions were robust, with many questions from the participants. Topics included:

Pakistan's nuclear programme

Participants wanted to understand Pakistan's nuclear programme, and Dr Sethi outlined the myriad political considerations involved. She said the emphasis on nuclear security is very high in Pakistan and that the international community is also very focused on it. One major concern, however, is discussions taking place within Pakistan on developing tactical nuclear weapons (i.e. sub-megaton weapons). This type of *battlefield* weapon makes little sense because it will indiscriminately harm nearby populations, including those in Pakistan. Because of their size, tactical weapons are also a greater nuclear security risk and would be attractive to non-state actors.

Indian nuclear policy

India's current doctrine is a policy of *no first use*. However, the government is continually evaluating this policy. Dr Sethi said that political statements have been made in the context of the troubled relationship between Pakistan and India, but there is hope that the government will not revise the policy. No first use has served India's purpose well from a financial, political and ethical standpoint. It also provides stability.

Nuclear Suppliers Group

There was a question on how the Nuclear Suppliers Group (NSG) affects India's policies. Dr Sethi said that although NSG is not allowed to be a member of the NSG, it is not getting in the way of commerce, and Indian export controls have been harmonised with it.

Educating the public

Participants asked several questions about how they can help people better understand the benefits of nuclear. Dr Sethi said that at the highest political levels there is strong bipartisan support for nuclear technology and nuclear weapons as a part of India's security programme. However, the issues are not being discussed in public. In fact, almost no effort has been made to engage with the public at the local level.

Consequently, Dr Sethi said, government needs to do a better job of educating the public about nuclear, without the alarmist tones so prevalent in the media. She said that the Department of Atomic Energy had previously been reticent to engage the public but that this attitude is beginning to change. This is important because DAE's word carries weight and influence at the local level.

Standardisation of nuclear facilities

Participants also discussed the pros and cons of standardised nuclear facilities. India currently uses pressurised heavy water reactors (PHWRs), and any new reactors that it purchases will do so as well. France also uses standardised designs, but China uses multiple reactor types. Dr Sethi said that standardisation is helpful from an economic, sustainability and supply chain perspective. However, whether or not a country uses standardised designs or multiple reactor types shouldn't impact on nuclear safety and security either way.

Police training

India has a large police academy in Hyderabad that teaches nuclear security issues. Specifically, they focus on India's nuclear security challenges, what they should look for in the field, and response to incidents.

SESSION IV: RISK ASSESSMENT METHODOLOGIES FOR SAFETY AND SECURITY

In Session IV, **Dr P V Varde, BARC**, talked about risk methodologies for safety and security, including how they use deterministic vs. probabilistic risk assessment.

Dr Varde said that over 420 nuclear power plants operate worldwide, but only three major safety incidents have ever taken place: Three Mile Island, Chernobyl and Fukishima. He added that there are well-developed risk assessment methodologies for safety and cautioned that the results of safety analyses should be protected for security reasons.

Dr Varde said that it is more challenging to quantify security threats, however. The key factor is human beings, who can be understood at several different levels:

- Cognition, consciousness, conscience, and brain model (C3B)
- Depth of understanding through consciousness (alertness)
- Universal /spiritual, national, institutional, organisational, and individual

Risk-conscious plant management is needed to address these challenges.

SESSION V: SAFETY AND SECURITY BY DESIGN

In Session V, **Dr Vivek Kant, IIT Mumbai**, offered a perspective that combined engineering with cognitive behavioural science. His major area of study is the joint optimisation of human beings and technology.

Dr Kant explained that it is not possible to use linear causal chains in complex systems because complex systems are circular in nature.

Dr Kant also explained that engineers typically hold a *normative* design philosophy, which means there is only one linear path to a good result. However, he believes the *formative* design philosophy is more valid. This approach views human behaviour as variable, which means there are multiple paths to good results. The goal is to identify the limits of behaviour and support variability.

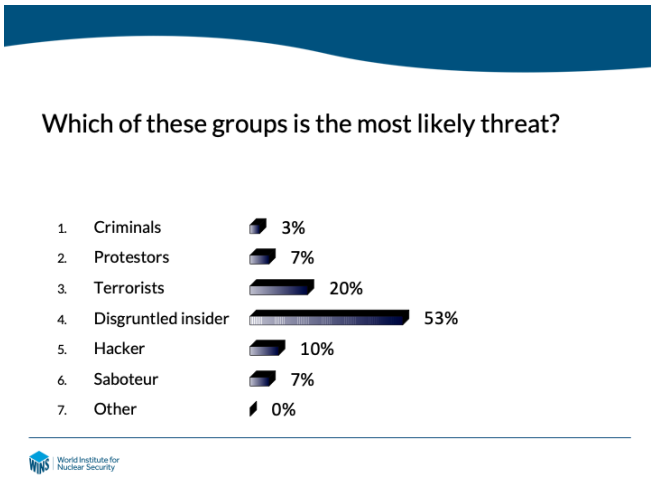
Formative design views human behaviour as a product of both the person and the environment. Therefore, the basic unit of analysis is a combination of the environment and the person rather than the person alone. For such reasons, human behaviour must be incorporated into overall system design. Dr Kant also explained that human factors include physical, cognitive and organisational aspects.

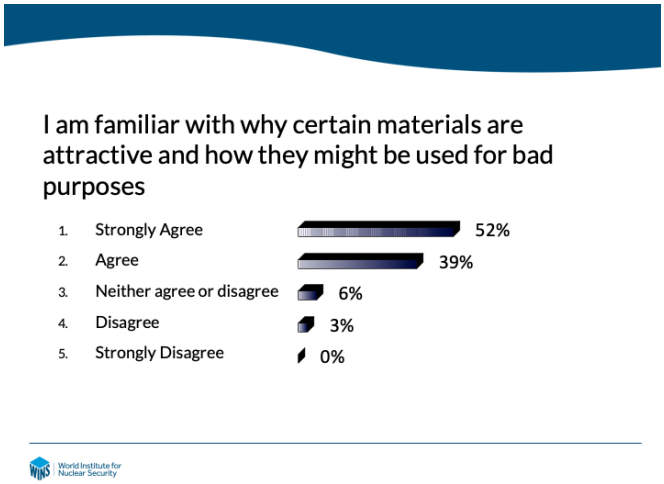
Important aspects of formative design include:

- Conceptual structures for designers
- Interactive design
- Operator studies

SESSION VI: APPLIED RISK ASSESSMENT TO A NUCLEAR FACILITY

In Session VI, **Dan Johnson** and **Carl Reynolds** led a tabletop exercise that involved applying risk assessment to a nuclear facility. They began with two e-votes. The first one asked participants what they think the most likely threat is, and the second asked how familiar they are with the elements that make certain materials attractive and how they might be used for bad purposes.





The exercise consisted of a threat assessment divided into three parts:

Exercise 1: Threat Assessment for a State

Exercise 2: Threat Assessment for a Facility

Exercise 3: Identification of Attack Pathways

Exercise 1 was conducted on Day 2, and Exercises 2 and 3 were conducted on Day 3.

Exercise 1: Threat Assessment for a State

The output of the first stage of the exercise was a threat assessment document describing the overall threat environment and all known credible threats that the States needs to consider. After receiving information about a fictitious country profile, participants analysed the information and evaluated its potential relevance to nuclear security.

Teams then drafted and presented a short report that addressed the following information:

- Potential adversaries
- Adversary type (e.g. terrorists, criminals, activists, extremists, etc.)
- Key attributes and characteristics of the potential adversaries
- Ranking of potential adversaries from highest to lowest threat

DAY 3: SATURDAY 28 SEPTEMBER

SESSION VII: APPLIED NUCLEAR SAFETY AND SECURITY CULTURE IN PRACTICE

In Session VII, **Prof. N. Ramamoorthy, NIAS, Bangalore**, talked about nuclear safety and security culture in practice. Because he has worked as a division director at the IAEA, a consultant to AERB, and an employee of DAE, he has acquired an extensive background in nuclear issues.

Prof. Ramamoorthy explained that safety and security have traditionally existed in separate silos. After 9/11, however, there was a recognition that security does not consist of physical protection alone and that it cannot be assessed in isolation. Instead, security encompasses everything: technology, safety systems, management systems and strategy. This requires periodic self-assessment and peer review.

Prof. Ramamoorthy noted that it took 10 years to agree on the definition of nuclear security culture at the IAEA. Stakeholders all understood what was meant by the term, but it was challenging to get the words exactly right. After Chernobyl, the concept of safety changed from *safety culture* to *culture of safety* because it places a stronger emphasis on the attitudes and commitment of individuals.

Prof. Ramamoorthy also addressed human reliability. He said that human reliability—which is beyond the scope of the human resources department—encompasses many factors, including stress, depression, complacency, nature of work (e.g. repetitive, slow career progression), human aspiration (hopes vs the reality of a job and its future prospects), family issues, financial problems, indoctrination, blackmail, etc. This is why holistic attention to human factors is essential. At the same time, it is also important to understand that each country is different when it comes to their national laws governing how they address the right to privacy, human rights and other human reliability issues.

Prof. Ramamoorthy also noted that incidents have occurred in India involving the security of radioactive material, a few of which have involved injury and death. One challenge is that

organisations with radioactive technology sometimes have a high attrition rate and turnover of qualified staff.

To improve their security culture, he recommended that organisations with radioactive sources:

- Advocate for and foster the adoption of Corporate Radiation Responsibility (CRR) similar to Corporate Nuclear Responsibility (CNR).
- Display a Quality Policy Statement in offices that establishes nuclear and radiation safety commitments.
- Adopt an Oath of Commitment to Nuclear/Radiation Safety similar to the Hippocratic Oath of Ethics.

Discussions focused on how to keep staff motivated. Prof. Ramamoorthy said that *recognition* is a primary motivation for human beings. Special recognition might be routine, or it could be related to performance incentives, safety/security awards, etc. Conversely, if someone is flagged because of something identified through the human reliability programme, the person should not be automatically terminated. The objective should be to help the person, perhaps by moving them to a desk job or less sensitive position.

Participants also discussed future job opportunities for nuclear engineering students. One area of particular need in India is medical radiation physics. Participants also said that job opportunities exist in other countries as well.

EXERCISE CONTINUED

Dan Johnson and **Carl Reynolds** then continued the tabletop exercise they had begun on the second day.

Exercise 2: Threat Assessment for a Facility

Using the nuclear security threat assessment report developed in Exercise 1, the teams developed a risk-informed threat assessment for a fictitious nuclear facility. They began by identifying nuclear material and other facility targets that could be associated with unacceptable consequences as a result of a malicious act.

Exercise 3: Identification of Attack Pathways

Building on the analysis developed in Exercises 1 and 2, teams then developed a ***pathway analysis,*** which involved identifying and analysing the paths that an adversary might take during a theft or sabotage attempt. The goal of each team was to complete a path with the least likelihood of being stopped by the protection systems. Each team's report included the following information:

- Identified adversary
- Material targeted
- Outline of the attack scenario
- Attack pathway (diagram)
- Probability of detection, as well as assessment and response at each stage of the attack pathway

Teams developed a variety of attack scenarios, many of which focused on stealing or sabotaging material while it was being moved onsite or offsite in transport. Lessons

learned included how people with malicious intent might create distractions to divert attention so they can access material and how useful it would be to have an insider support the attack.

The exercise helped participants better understand who potential adversaries could be (internal and external), what vital areas are, what kind of material is important, why someone with malicious intent would want the material, and some of the ways in which a nuclear facility could be vulnerable to a security event.

CONCLUSION

At the conclusion of the training course, **Dr Ashok Chauhan**, founder of Amity University, visited the classroom and asked for participants' feedback on the course. They replied that it had been a great workshop because they had not only learned about nuclear security, safety and safeguards, but also about the politics, psychology, and other aspects of nuclear security. In addition, they had learned some of the personal traits that lead to an effective security culture and the importance of adopting a questioning attitude.

The training course also provided an opportunity for the Institute of Nuclear Materials Management (INMM) Amity University Chapter to hold an event, where **Prof. Dinesh Srivastava** discussed the release of his new book, *Seven Scientific Adventures of Shaurya & Maya.* The book—which is based on common real-life observations—involves two characters who learn a variety of scientific lessons. Examples include how humans evolved, how birds fly, how trees make food, how fruit ripens, Newton's laws of motion, the Lotus effect, and an advanced computational algorithm based on the foraging behaviour of ants.

We hope that the participants of the WINS training course at Amity University will be inspired to continue their scientific explorations into nuclear security challenges and apply the nuclear security principles they have learned in their careers as the next generation of nuclear professionals.