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Cover Page Footnote

1. Nuclear Security Science and Policy Institute (NSSPI), Texas A&M University, USA. 2. World Institute of Nuclear Security (WINS) Academy, Vienna, Austria

Promoting Nuclear Security Education and Training Activities at Amity University, India

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Abstract

In the present era of global nuclear governance, it is the responsibility of every individual, not only the security personnel, to be accountable for the security of nuclear materials, facilities, and radioactive materials. Amity University and other Indian universities are the largest educational networks for young professionals who will enter the nuclear program in India and who will be involved in the management of nuclear and other radioactive materials in a wide variety of applications, such as hospitals, industrial applications, and nuclear facilities. Amity University Uttar Pradesh is taking a leading part to emphasize the importance of nuclear security amongst the students and faculty members of various Indian institutions and research organizations. Amity University is also motivating women academicians to take the lead in nuclear security. This paper describes details of various events organized in India with the initiative of INSEN, IAEA; Texas A&M University, USA; and WINS Academy, Vienna, Austria.

Keywords: Nuclear security awareness, Education, Training courses, PDCs Workshop and Amity society.

I. Introduction

Nuclear energy plays an increasingly important role not only in India, but for most of the countries around the globe. Non-proliferation is almost universally stated as an aspirational objective of nuclear technology development [1]. Understanding nuclear security in terms of technical, policy, and regulatory aspects is very important for achieving and maintaining globally a high level of safety and security at nuclear facilities. Human, technical, and financial resources are necessary to ensure effective nuclear security [2, 3]. Along with education, comprehensive training programs on nuclear security can strengthen nuclear security capabilities. The International Atomic Energy Agency's (IAEA) emphasis is to educate and train people in nuclear security globally through International Nuclear Security Education Network (INSEN) [4]. INSEN is an educational network of IAEA, using educational and research institutions to promote sustainable nuclear security education. The objective of the network is to enhance the global nuclear security program by developing, sharing, and promoting excellence in nuclear security education. Members of INSEN work together to develop educational materials (e.g., textbooks, instructional material, computer-based teaching tools, exercises and materials for laboratory work), as well as to

conduct faculty development courses in the different areas of nuclear security. Members also collaborate for joint research and development activities to share scientific knowledge and infrastructure. Student exchange programs are also important activities of INSEN to foster international cooperation and exchange of information. Other activities of INSEN implement various degree programs, courses in nuclear security education, quality assurance of nuclear security education, academic thesis supervision, and evaluation, as well as survey the performance of faculty and students on the effectiveness of nuclear security education [5].

The first nuclear security summit was held in Washington, D.C. in 2010 to strengthen the concept of global nuclear security and nuclear governance; then, there were additional summits in Seoul during 2012, Hague during 2014, and finally in Washington, D.C. during 2016 [6–9]. These summits helped to strengthen international collaborations to support nuclear security practices worldwide. In the recent past, many countries have shown an interest in nuclear security education by offering courses and organizing various events on nuclear security. Students, along with faculty members of Indian universities, participated in a one month long “Nuclear Security Training Series (NSTS)” consecutively in both 2015 and 2016. NSTS was organized at Texas A&M University, the Sandia National Laboratory, and the Oak Ridge National Laboratory in the USA. This training series concluded with the International Nuclear Materials Management (INMM) Annual Conference [10, 11].

II. Role of INSEN, IAEA: Motivation for Amity University

INSEN was established under the IAEA during 2010 to reach educational and research institutions to enhance nuclear security education, which can strengthen the nuclear security of nuclear materials and facilities. IAEA provided the opportunities for the Indian universities to be a part of INSEN. The following nine Indian universities became members of INSEN in 2015: Amity University Uttar Pradesh; Mody University, Rajasthan; Pandit Dindayal Petroleum University (PDPU), Gandhinagar; University of Petroleum & Energy Studies (UPES), Dehradun; University of Delhi; Delhi Technological University (DTU); Indian Institute of Technology (IIT), Kanpur; IIT Mumbai; and Jadavpur University, Kolkata. After becoming a member of INSEN, Amity University Uttar Pradesh (AUUP), along with other universities, engaged actively to strengthen nuclear security practices among nuclear science students on campus and at other Indian universities and research institutions. Since 2015, many events were organized with international collaborations to enhance nuclear security education among young professionals. Annual reports of the events have been presented during INSEN annual meetings since 2016. A paper titled “Impact of Nuclear Security Education and Training” was also presented during the International Conference on “Nuclear Security: Commitments and Actions” at IAEA, Vienna in 2016 [12]. The effort of Amity University Uttar Pradesh is to develop and promote excellence in nuclear security education in India, which helped an academicians work in prestigious positions at INSEN, IAEA, e.g., member, vice chair, and chair of working groups under INSEN. The focus of the working groups of INSEN is to exchange information, develop teaching materials for nuclear security education, faculty development in cooperation with universities, and promoting nuclear security education from INSEN. During the annual meeting of INSEN, members from Amity University met other INSEN members to review the activities of the three working groups and activities organized at each member institution. Members also discussed and identified the issues which needed to be addressed, and they also assigned tasks to all of the working groups [5].

- A. There is a need to empower women in nuclear security education to promote gender equality. **One of the important initiatives of Amity University is to enhance representation of women in the Indian nuclear security program and to encourage women academicians to participate in various nuclear security activities in India, as well as overseas.** In 2017, the Director and Head of Amity Institute of Nuclear Science and Technology (AINST) was invited for a lecture and also a panel discussion on the topic of “Role of Women in Nuclear Security”

during the INSEN annual meeting. In the panel discussion, women academicians from various institutions were encouraged to engage more in the field of nuclear security, as well as to inculcate leadership qualities. As a result of that, a woman academician of AINST participated in a panel discussion on “Best Practices in Nuclear Security” during INSEN-IAEA annual meeting in 2018. INSEN member from Amity University also presented a paper on “Evaluation of the Effectiveness of Physical Protection System for Nuclear/Radioactive Materials Used in Research Institutes” during the IAEA International Conference on Nuclear Security (ICONS) in February 2020 [13].

III. Nuclear Security Events at Amity University Uttar Pradesh

The initiation of nuclear security education and training program at Amity University Uttar Pradesh started in August 2014 when a few students of Amity Institute of Nuclear Science and Technology (AINST), along with a faculty member, attended the workshop on “Nuclear Security for Indian Universities” held at IIT Kanpur, which was conducted by Nuclear Security Science and Policy Institute (NSSPI), Texas A&M University, USA [14]. Students were motivated so much after the workshop, and it was decided to organize events of a similar pattern at the Amity University campus to extend the knowledge and understanding of nuclear security. In this regard, a professional development course (PDC) was organized on the topic of “Insider Threats and Security Culture” during 2015 in collaboration with Kings College London [15–18]. The first week was held in June and the second week in August. After the PDCs, nuclear security related courses, such as “Introduction to Nuclear Security” and “Nuclear Security and Security Culture,” were introduced into the existing curriculum of Amity University as elective courses [19, 20]. For further enhancement of knowledge, another PDC was organized in 2016 on “Human factor in Nuclear security,” again in collaboration with Kings College London.

Amity University Uttar Pradesh established the INMM student chapter, which organized various events. Students, with the faculty advisor’s support, regularly organize guest lectures, poster competitions, quiz competitions, and seminars at the university campus, and they also conduct an awareness program on the importance of nuclear technology among school students. The aim of the student chapter on campus is to promote the nuclear security awareness program among young professionals. A paper on “Risk Analysis for Nuclear and Radioactive Materials Used in Research Institutes” was presented at “INMM’s 60th Annual Meeting” during 2019 at Palm Desert, CA, USA [21]. Students of Amity University are carrying out their project work in the field of nuclear security, and a faculty member is also pursuing their Ph.D. in the field of nuclear security. Students and faculty members of AINST have been participating in various national and international competitions, workshops, and conferences, as well as attaining meritorious positions in nuclear security related events.

The success of the PDCs was the driving force to organize an advanced-level workshop on “Nuclear Security Curriculum Review: Lessons Learned, Current Challenges and Best Practices” in collaboration with Texas Engineering Experiment Station at Texas A&M University in 2017. The objectives of the workshop were to exchange the lessons learned, best practices, and challenges faced during teaching nuclear security topics in Indian universities. Most of the lectures were delivered by international subject matter experts from the Center for Nuclear Security Science and Policy Initiatives (NSSPI); Texas A&M University, USA; and a few lectures were also covered by Indian experts. The workshop was attended by participants from IIT Kanpur; IIT Mumbai; UPES, Dehradun; PDPU, Gandhinagar; Mody University, Rajasthan; Jamia Millia Islamia University, Delhi; Jadavpur University, West Bengal; Lloyd Register Consulting; Nuclear Power Corporation of India Ltd (NPCIL), Narora Atomic Power Station (NAPS) Narora, Uttar Pradesh; and Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, Tamilnadu [Pic. 1-2].

Picture 1. Lighting of lamp ceremony during inauguration in the Nuclear Security Curriculum Review workshop, 2017 at Amity University Uttar Pradesh, India.

Picture 2. Delegates and participants in the Nuclear Security Curriculum Review workshop, 2017 at Amity University Uttar Pradesh, India.

One of the important topics covered during the workshop was “Comprehensive Nuclear Security Planning and Risk calculation.” Details on various programs for calculating the risk of strengthening the existing nuclear security framework was discussed during the workshop. Senior professionals from various Indian universities presented their journeys on nuclear security curriculum development in their respective institutions.

Based on the feedback from the participants of the workshop organized during 2017, an advanced-level workshop on “Vulnerability Assessment of Nuclear Security System Design” was organized in 2018 in collaboration with Texas A&M Engineering Experiment Station at Texas A&M University, USA and Oak Ridge National Laboratory (ORNL), as well as financially supported by Defense Threat Reduction Agency (DTRA). The workshop was designed for Indian university faculty members, students, and young nuclear professionals [shown in Pic. 3] to understand comprehensive nuclear security system design and how to perform vulnerability assessments. The lectures were on “Nuclear Security from 1.0 to 3.0,” “Comprehensive nuclear security planning,” “Introduction to nuclear security system vulnerability assessment,” “Nuclear security culture,” “Target identification,” “Insider Threat Mitigation,” “Uncertainties in Nuclear Security System,” “Vulnerability Assessment,” and “Effects of Insider Collusion on Nuclear Security System Design.” A table-top exercise was also conducted to design a theft strategy for nuclear materials within a given nuclear power plant layout with a minimum possible probability of getting caught by security persons. Following these lectures, a quiz was organized by young professionals based on the understanding of the lectures of this workshop. Later, all the participants provided their feedback on this workshop. A concluding meeting was held by all the delegates from DTRA, ORNL, Texas A&M University, and faculty members of AINST for future collaboration and to increase the number of programs on nuclear security.

Picture 3. Delegates and participants in Vulnerability Assessment of Nuclear Security System Design workshop, 2018 at Amity University Uttar Pradesh, India.

A workshop on “Nuclear Security Design Vulnerability Assessments & The Battle Board Table-top Exercise” was conducted during 2019 in a continuation of the previously organized workshop for participants from various Indian universities and research organizations [Pic. 4]. Hobbs et al [22] defined Table-top Exercise (TTX) as a discussion-based interactive exercise to engage participants with a hypothetical scenario and this can be performed “on top of a table.” TTX is important because it can provide a practice-based approach to thinking about real-life problems and a clear theoretical understanding [23]. The duration of the workshop was increased to four days based on the feedback received from participants, and the emphasis was more on the hands-on exercises (i.e. the table-top exercises) for a better understanding of nuclear security and security culture in a nuclear facility. The main objective was to assess the state of security in nuclear facilities, check and assess their vulnerabilities with the help of battle board table-top exercises, and then analyze the security of the facilities of high strategic significance. The topics of the lectures during the workshop were on physical protection systems, the vulnerability assessment process, nuclear security risk calculation, adversary threats, and adversary threat diagrams (ASD). Battle board table-top methodology and an overview of a hypothetical nuclear facility were introduced to the participants before the table-top exercise [Pic. 5]. Participants analyzed the insider collusion effect in the security scenario of a nuclear facility with the help of battle board table-top exercises. The workshop also provided hands-on training on the vulnerability software based on the EASI (Estimate of Adversary Sequence Interruption) model. The model is a single path analysis model and use to estimate the Probability of Interruption (PI) of Physical Protection Systems (PPS) in a nuclear facility [24]. The adversary sequence diagrams were created to find the most vulnerable paths, and the risk values associated with them were calculated with the help of the EASI model. Further, the change in risk numbers due to changing the physical protection system parameters were also calculated. The probability of neutralization calculations was done with the help of the software drawn on lines of an established code of probabilistic safety assessment. In the last day of the workshop, honorary professorship was conferred to three scientists and academicians from the field of nuclear science and technology.

Picture. 4. Delegates and participants during the workshop on “Nuclear Security Design Vulnerability Assessments & The Battle Board Table-top Exercise,” 2019 at Amity University Uttar Pradesh, India.

Picture 5. Subject matter experts and participants during “Board Table-top Exercise,” 2019 at Amity University Uttar Pradesh, India.

The goals of nuclear safety and security are to protect people, facilities, and the environment from the harmful effects of ionizing radiation, and different elements of safety are integrated to a nuclear facility. However, the interface between safety and security has not achieved the same level of integration. At the facility level, disparity between the maturity of safety and security can result in friction and a lack of staff participation in security improvement initiatives. The effective implementation of an insider threat program may be compromised if security and nuclear safety-related services do not work closely together. Closer integration is designed to close the knowledge gap on both sides. In this regard, a training program was conducted for “Scientists, Technicians and Engineers on Nuclear Security” in collaboration with World Institute of Nuclear Security (WINS) Academy [25], Vienna, Austria in 2018.

The subject matter experts were from WINS Academy; ORNL, USA; and Indian universities and institutions. Participants were young nuclear professionals from UPES, Dehradun; PDPU, Gandhinagar; University of Delhi, Delhi; Mody University, Rajasthan; and SDS Life Sciences Pvt. Ltd. [Pic. 6].

Picture 6. Mr. Carl Reynolds with the participants discussing the objectives of the training program during WINS Academy Training Course

The training was based on the WINS Academy elective course on nuclear security for scientists, technicians, and engineers, and was complemented by the work of Indian experts who used lectures, discussions, case studies, and exercises to further explore areas and issues of direct relevance to the audience. Topics covered during the training program were “Nuclear Security in Indian context,” “Introduction to nuclear security – key concepts- Understanding the Threat,” “Key Nuclear Security Concepts of India,” “Nuclear Security Policy of India,” “Nuclear Security and Security culture, nuclear materials and nuclear forensic,” “Nuclear Security in the context of nuclear fuel,” and “Nuclear Security in the context of detection instruments.” “Table-top Exercise (TTX) on insider threat” was also conducted to provide hands-on experience to find out a theft strategy for nuclear materials within a given nuclear power plant layout with a minimum possible probability of getting caught by security persons [Pic. 7]. This exercise also provided to the participants a realistic feel of a theft situation inside a nuclear power plant.

Picture 7. Dr. Manit Shah from ORNL with the participants during “Table-top Exercise (TTX) on insider threat” in WINS Academy Training Course.

An advanced-level training program was organized for participants again in collaboration with WINS Academy and ORNL, USA on “Integrated Nuclear Safety and Security Culture” in 2019. The event was attended by participants [Pic. 8] from various Indian universities, institutions, and research organizations. The program covered lectures on “Fundamentals of nuclear security culture: Challenges in understanding good practices,” “Nuclear safety and security in India,” and “Safety and security by design technical.” Interactive sessions and exercises were on nuclear safety and security culture traits and applied risk assessment to a nuclear facility, as well as improving safety and security at a nuclear facility. In the first day of the training program, an INMM Amity University student chapter conducted expert lectures by nuclear physicists of India.

One can possess the best technology and the legal architecture, but it is up to the individual to play by the rules, which requires a culture where nuclear safety and security can be taken seriously. In this view, other Indian universities like PDPU and IIT Kanpur are also members of INSEN, IAEA and actively participating to increase awareness of a nuclear security program. Many events were organized since 2013 in regular intervals. Students and faculty members are also attending national and international events on nuclear security.

Picture 8. Delegates Dr. M. Saibaba, Dr. P.V. Varde, Dr. D.K. Srivastava, Mr. Daniel Johnson, Dr. K. L. Ramakumar, and Prof. A.K. Jain during the book launch of Dr. D.K. Srivastava in “WINS Academy Training Course on Integrated Nuclear Safety and Security Culture.”

IV. Outcomes of the Events

A. Establishment of “Amity Society for Nuclear Security”

“Amity Society for Nuclear Security” was established in 2018 under the umbrella of AINST, AUUP, Noida, India. The idea of launching such a society was introduced by the president of Amity Education Group. The society was inaugurated [26] in the presence of senior officials, faculty members, and students from reputed national and international organizations [Pic. 9-10]. The specific objectives of establishing the society were to bring together academicians and subject matter experts from the field of nuclear science and technology, as well as nuclear security for better insight of the global positioning of India. The society also aimed to discuss the challenges as well as opportunities of the emerging nuclear governance architecture.

Picture 9. Dignitaries Dr. W. Selvamurthy, Dr. Ashok K. Chauhan, Air Marshal Vinod Patney, and Dr. Alpana Goel during the inauguration of Amity Society for Nuclear Security.

Picture 10. Participants from various Indian organizations during the inauguration of Amity Society for Nuclear Security.

B. Development of Nuclear Security Curriculum

The introduction of nuclear security into the curriculum of Amity University was an opportunity to update existing educational programs to address the need for sustainable knowledge to improve nuclear security and safety culture in Indian universities. Availability and accessibility of necessary resources is very important as per the development of a comprehensive nuclear security educational program. In this regard, the experts from industry and academia, along with the faculty of the Amity Institute of Nuclear Science and Technology (AINST), contributed to developing nuclear security courses. Courses related to nuclear security and security cultures were introduced into the existing AINST curriculum in 2016 [20]. Recently in 2019, two more courses, “Physical protection systems” and “International and national legal framework for nuclear security,” were also introduced in the existing curriculum of Amity University Uttar Pradesh. The purpose of introducing these courses was to enhance the understanding of all the elements of physical protection systems, policy, and regulators as well as international and national legal regimes regulating nuclear security. These courses are offered as elective courses to the students from various disciplines, including law. The courses were introduced according to the guidance given in various IAEA documents [27–32].

C. New Pathways for Students

This workshop has opened a new pathway for the students to carry out their training and development program on nuclear security in reputed institutions in India as well as abroad. It has been decided to launch an online nuclear security education portal among the members of the society, where all the members of the network can contribute in terms of providing nuclear security-related study materials and online lectures towards developing curriculum in Indian universities.

D. Future Workshops

The future workshops will be conducted for 1- or 2-weeks’ duration to discuss in detail the technical aspects of nuclear security from the basic to advanced levels. This will also motivate junior researchers to carry out research on nuclear security. More hands-on exercises on nuclear security are planned.

Enhancement of the AINST lab facility was promised to support experimental exercises on nuclear security for other Indian universities in the future.

E. WINS Academy Participation

Participants were encouraged to enroll in the WINS Academy through the WINS Academy scholarship fund. As a result of the nuclear security events, many students have enrolled in WINS academy for certification program, and a few faculty members and students of Amity University and other Indian universities are the alumni of WINS Academy.

V. Future Plans

Nuclear security events organized at Amity University provided an excellent opportunity to the Indian participants to analyze the current status and the efforts to ensure nuclear security and safety of various nuclear materials and facilities as well as future challenges to tackle. The presence of truly experienced international subject matter experts and distinguished Indian scientists enabled cross-cutting discussions on a variety of topics related to nuclear safety and security. In the future, workshops will be conducted on various other aspects (e.g. physical protection, transport security, cyber security, etc.) to formulate concrete solutions and action proposals. Subject matter experts from various reported Indian organizations (e.g. Department of Atomic Energy (DAE), Government of India, Institute for Defense Studies and the Analysis, Global Centre for Nuclear Energy Partnership (GCNEP)) will also be invited to deliver lectures on Indian policy regarding nuclear security. Collaborations will continue with nuclear aspirants on various activities that promote awareness of nuclear safety and security. The idea of establishing a remote laboratory was discussed during the INSEN annual meeting in 2017. This helped us to step forward in establishing a remote laboratory at Amity University Uttar Pradesh, India. We are in the process of establishing a state-of-the-art laboratory facility at Amity University Uttar Pradesh in collaboration with Texas A&M University and supported by DTRA for Indian universities to use so that particle training can be provided on nuclear security. A workshop on “Practical Training of Nuclear Security” using various detectors is planned at Amity University Uttar Pradesh, Noida, India in collaboration with Texas A&M, USA during August-September 2020. With the initiative of WINS Academy, Amity University will be organizing an advanced-level workshop during September 2020.

VI. Conclusions

The motives of INSEN are to promote sustainable nuclear security education among institutions, organizations, and universities globally as well as to provide materials for education. In pursuit of this goal, many events on nuclear security were conducted at Amity University with the collaboration of national and international organizations. INSEN members from Indian institutions actively participated in the events and also shared their journey in the field of nuclear security and nuclear security programs. These programs were able to promote best practices in nuclear security among the participants. Now, Amity University offers courses related to nuclear security to strengthen Indian nuclear security program amongst young professionals.

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