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Nuclear Security Education and Training in Pakistan

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Abstract

The world's growing dependence on nuclear power as a reliable and clean source of energy demands equal safety and security considerations. The security challenges associated with nuclear materials, facilities, and technologies are emerging at an alarming rate, necessitating corresponding counter measures. Pakistan has invested significant resources in nuclear security education and training to meet the requirements of its expanding nuclear program. For example, Pakistan's Center of Excellence for Nuclear Security is responding to the growing demands of this crucial area and imparting education and training in various sub-domains of nuclear security. Pakistan's focus on nuclear security education and training has led to the development of a program that has received international acclaim, and has made significant contributions toward worldwide nuclear security.

I. Introduction

A. Background

Rising global energy demands, along with renewed focus on climate issues, have led to an increased reliance on nuclear power as a clean source of energy. However, following the Fukushima accident in 2011, the nuclear projections for 2030 dropped approximately seven to eight percent in comparison to the projections made prior to the Fukushima accident. Nonetheless, many states still opted for nuclear energy to meet their growing needs. The latest IAEA report entitled "Energy, Electricity and Nuclear Power Estimates for the Period up to 2050" suggests that the nuclear power generating capacity is projected to increase between 1.9% and 56% by 2030, in relation to the previous estimates [1].

Pakistan is among the countries whose nuclear energy policies remained undiminished in the wake of the Fukushima nuclear accident. Pakistan envisions a greater role for nuclear energy in its Energy Security Plan 2050, and aims to generate 40,000 MW of nuclear energy [2]. Growing dependence on nuclear energy brings the associated concern of nuclear security into focus, and Pakistan was quick to realize that its ambitious nuclear energy program demanded a corresponding effort in ensuring its safe and secure execution. At present, Pakistan has four operational nuclear power plants with a total output of 787 MW [3], and three more reactors in the construction phase. Many nuclear and radioactive sources are also used in medical, industrial, and agricultural sectors.

Responding to the resounding global concerns from various international forums, Pakistan has reaffirmed its support to the cause of nuclear security, and has pledged to make a greater investment. This increased investment will ensure that the national mechanisms are ready to meet any impending threat for a secure nuclear future. An important pre-requisite to ensuring a sustainable nuclear security infrastructure is to develop a comprehensive nuclear security education and training program. Such a program will create a new generation of nuclear security experts, who are equipped with the necessary knowledge and skills to meet emerging challenges.

B. Objective

This paper emphasizes the importance of nuclear security education and training in Pakistan, demonstrates that Pakistan has laid great importance on a safe and secure nuclear program, and expresses Pakistan's vigorous investment in its safety and security. Due to its specific security threats, Pakistan is among the first few states in the world to establish and sustain a strong nuclear security system. Pakistan realized the connection between nuclear security challenges and the necessary knowledge base to meet those challenges. Therefore, Pakistan has adopted a pro-active strategy to understand the need for capacity building in nuclear security education and training, and has allocated significant resources to ensure a sustainable system of nuclear security education and training. With that in mind, this paper draws attention toward efforts made by Pakistan to establish, maintain, and sustain nuclear security education and training, and to assess the future challenges.

C. Scope

This paper focuses on Pakistan's nuclear security education and training program while also making a brief analysis of global practices. It will also provide an elaborate analysis of Pakistan's endeavors in imparting nuclear security education and training, along with its impact, and its prospects. Also highlighted are various institutional mechanism adopted by Pakistan to streamline its nuclear security education and training program, which is now gaining global recognition.

D. Structure

This paper is divided into six sections. The first section introduces the paper by tracing the background of the issue, highlighting its objective, and relaying the scope of the paper. The second section provides a better understanding with a more comprehensive examination of the issue, through an analysis of international practices. The third section explains the unique features of nuclear security education and training in Pakistan, with primary emphasis on its Center of Excellence. This explanation will include an in depth discussion of the three constituents of Pakistan's Center for Excellence: the Training Academy, the National Institute of Safety and Security (NISAS), and the Pakistan Institute of Engineering and Applied Sciences (PIEAS). The fourth section contains an analysis of the impact of nuclear security education and training, and presents key findings from this study. The fifth section describes challenges and the way forward, and the sixth section concludes the paper.

II. Importance of Nuclear Security Education: An Analysis of Global Practices

Following the tragic terror events on September 11, 2001 in the United States, global fears of a nuclear 9/11 rose significantly. The potential threat of a terrorist attack involving a Radiological Dispersal Device (RDD) or an Improvised Nuclear Device (IND) was considered an imminent danger, given the lax nuclear security practices in various countries. Realizing this growing concern, the IAEA Board of Governors approved a Nuclear Security Plan that covered years 2006-2009 [4]. Their plan, along with other measures, emphasized the importance of human resource development to help IAEA member states increase their ability to establish and maintain appropriate nuclear security, in order to “*prevent, detect and respond to malicious acts involving nuclear and other radioactive material.*” The plan sought to establish an educational program in nuclear security that could serve as a reference guide for its member states. The objective of the IAEA’s nuclear security educational program was that it “*should be considered as a guide to facilitate the development of a comprehensive nuclear security human resource development program with the purpose of building up and maintaining relevant knowledge and skills, and sustaining qualified personnel dealing with future nuclear security challenges*” [5].

The IAEA, realizing the absence of a specialized institute offering training and education that covers all areas of nuclear security, took the lead to initiate a worldwide framework of nuclear security education and training. The IAEA developed technical guidance for a Master of Science (M.S.) and a certificate program in nuclear security to bridge any knowledge gaps, and to help member states evolve their nuclear security education and training infrastructures. Since then, participation by nuclear security experts and academics from IAEA member states have led to the successful creation of an active training system and multifaceted education program. The program helps leading universities and other academic institutions develop curricula and train personnel, while also establishing a mechanism for facilitating cooperation and collaboration between educational and research institutions through the International Nuclear Security Education Network (INSEN), which is improving global nuclear security by developing, sharing, and promoting excellence in nuclear security education [6]

In addition to INSEN, whose primary focus is promoting nuclear security education, the IAEA also established the International Network for Nuclear Security Training and Support Centers (NSSC). NSSC aims to enhance nuclear security capacity building through a collaborative network of nuclear security training and support centers, and has paved the way for the establishment of national NSSCs that focus on national nuclear security training programs.

The United States places great emphasis on the importance of nuclear security education, and there are various governmental and nongovernmental initiatives to strengthen the existing nuclear security education infrastructure. At present, a few universities, including Texas A&M University, the University of Missouri, the University of Tennessee, Georgetown University, Ohio State University, the University of Washington, and Washington State, have programs on nuclear security education in their curriculum [7].

In the United Kingdom, King’s College London’s Center for Science and Security Studies (CSSS), with support from the IAEA, INSEN, and the US State Department’s Partnership for Nuclear Security (PNS), has launched Nuclear Security training programs, through which they have introduced various nuclear security training programs with a global outreach [8].

There have also been advances toward creating more University-Industry Partnerships. World Nuclear University, supported by the World Association of Nuclear Operators and the World Nuclear Association, has established a working group on Safeguards and Security Education and Training [9]. These initiatives and global outreach programs have generated more awareness about nuclear security challenges, led to the

search for more solutions, and enabled the member states to learn, and seek assistance from, the experiences of the IAEA and countries with advanced nuclear security systems.

III. Nuclear Security Education & Training in Pakistan

Nuclear security is of the utmost importance - therefore Pakistan has taken measures to ensure that nuclear security is properly developed and nurtured, and strives to invest cumulative and dynamic efforts in dealing with this issue in the rapidly changing security environment. The measures taken by Pakistan align with international practices, especially adhering to the recommendations of IAEA. Pakistan also fully recognized the need to address nuclear security challenges, and has been a proactive advocator of adopting nuclear security measures.

Pakistan has worked hard to ensure safe and secure nuclear activities, and has received accolades for its impressive nuclear security arrangements [9], which are the result of nuclear security education and training programs spanning many years, even pre-dating the Nuclear Security Summit process that brought nuclear security to global attention. Pakistan's Nuclear Security Training Center (NSTC), established under the National Nuclear Security Action Plan Project (2006), was acknowledged as "a model example of what a center is and should be undertaking in terms of nuclear security training, provision of technical advice and education to a state's nuclear security 'competent authorities'" [10]. These initial efforts have laid the foundation for the expansion of nuclear security education, training, and technical support to various national organizations, including designers and users of physical protection systems, front line officers, first responders and emergency response personnel, intelligence and law enforcement authorities, trainers, nuclear regulators, and policy makers in various areas of nuclear security. These early endeavors have also led to the development of Pakistan's Center of Excellence (CoE), an organized nuclear security education and training infrastructure, which is not only responding to national training and education needs, but also to regional and international needs. In 2016, Pakistan hosted the annual Meeting of the International Network for Nuclear Security Training and Support Centers (NSSC) in Islamabad in collaboration with the International Atomic Energy Agency (IAEA). This was the first time the meeting was held outside of the IAEA Headquarters, and it was attended by 29 states [11].

A. Pakistan's Center of Excellence for Nuclear Security

Pakistan's Center of Excellence (CoE) for Nuclear Security was created to provide education and training in wide-ranging nuclear security activities. In 2012 at the Nuclear Security Summit in Seoul, the CoE was offered to countries in the region and beyond, as a training hub for interdisciplinary training and education needs in various nuclear security areas [12]. The CoE is composed of three organizations that cover training and education: the Training Academy at Chakri, the National Institute of Safety and Security (NISAS) at Pakistan Nuclear Regulatory Authority, and the Pakistan Institute of Engineering and Applied Sciences (PIEAS).



1. The Training Academy

Under the CoE, Pakistan has established a state-of-the-art training academy at Chakri, Islamabad. Founded in 2012, the training academy serves as a milestone in Pakistan's continued efforts towards strengthening nuclear security [13]. The training is extensive and focuses on areas like capacity building, human resource development, security management, understanding the nuclear security regime, and security culture.

The Director General of the IAEA, Mr. Yukiya Amano, visited Pakistan's CoE in 2014 and admired its impressive training activities. He also noted its organized systemic and operational manner [13]. The Training Academy has courses for nuclear security-force personnel to learn to protect fixed installations, escort transports carrying special nuclear materials, and respond to any nuclear related emergency [14]. The training academy will also house a physical protection exterior lab (PPEL) that is being designed and built with the assistance of the IAEA [15].

2. National Institute of Safety and Security (NISAS)

Every organization needs highly skilled, qualified, and experienced professionals. The same is the case for a nuclear regulator, as the licensing and inspection of nuclear power plants, research reactors, equipment manufacturing plants, and radiation facilities are challenging tasks that require skilled personnel to ensure a smooth performance. For this purpose, the Pakistan Nuclear Regulatory Authority (PNRA) established two training institutes in 2006 through two Public Sector Development Program (PSDP) projects: the School for Nuclear and Radiation Safety (SNRS) and the Nuclear Security Training Center (NSTC) under the Nuclear Security Action Plan (NSAP) [16].

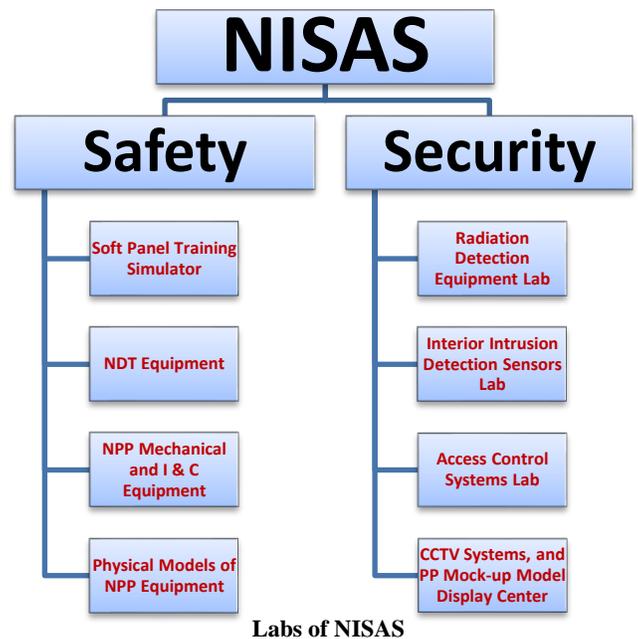
In 2014 PNRA merged SNRS and NSTC to streamline the training activities through the establishment of the National Institute of Safety and Security (NISAS), inaugurated by DG IAEA Mr. Yukiya Amano [17]. As an integral part of

Pakistan's Center of Excellence, NISAS provides training and education in various disciplines of nuclear safety, radiation safety, and nuclear security. In addition, it conducts management and refresher courses for PNRA officers, staff, and its stakeholders, and trains other national stakeholders who have a role in maintaining the safety and security of radioactive sources in the country. The laboratories in the NISAS are equipped with necessary tools for training sessions, including a soft panel training simulator, physical models of nuclear power plant components, physical protection labs (both interior and exterior), and a radiation detection equipment laboratory with trouble shooting capabilities.

The IAEA's Integrated Regulatory Review Service (IRRS) recognized NISAS's role in national capacity building on its mission to Pakistan. While highlighting Pakistan's good practices, the IRRS team acknowledged the establishment of "a comprehensive national education system to support the nuclear program, and a well-developed PNRA training program to maintain staff technical and regulatory competence during a rapid expansion" [18].

3. Pakistan Institute of Engineering & Applied Science (PIEAS)

Following a meeting at the IAEA in August 2007 for the development of the Master of Science nuclear security education program curriculum guidelines, the Pakistan Institute of Engineering and Applied Sciences (PIEAS) introduced Nuclear Security as an area of specialization in its existing M.S. Nuclear Engineering program. The PIEAS, in an indigenous effort to launch a formal nuclear security degree program in Pakistan, used the IAEA guidelines for curriculum development, and chose faculty members from both PNRA and PIEAS.



The program introduced the courses “Introduction to Nuclear Security” and “Introduction to Physical Protection of Nuclear and other Radioactive Materials” in the third and fourth semesters of the M.S. Nuclear Engineering program. PNRA also offered comprehensive, thesis-based research work in various areas of nuclear security [19]. PIEAS plans to introduce more courses related to nuclear security after developing necessary infrastructure at PNRA and PIEAS, which includes trained faculty and laboratories that are fully equipped with nuclear security equipment. The M.S. Nuclear Engineering specialization in nuclear security is designed to meet the needs of professionals who are required to be competent in the field of nuclear engineering, and to understand the requirements of nuclear security matters. The program covers the main areas of nuclear security, such as prevention, detection, and response to theft or unauthorized use of nuclear materials.

The M.S. Nuclear Security program faced numerous logistic challenges at the conceptual stage. The IAEA nuclear security series for education helped tremendously in developing the PIEAS guidelines, but as IAEA is not an academic institute, it did not offer a perfect teaching model. Additional obstacles included the acquisition of textbooks, trained faculty members, lab facilities, and the creation of a syllabus, which required collaboration with other universities. Despite these difficulties, PIEAS and PNRA launched the M.S. Nuclear Security program with indigenous faculty, trained through an IAEA assistance program. One advantage of conducting the M.S. Nuclear Security program as a sub-specialty of the M.S. Nuclear Engineering program is that its specialized nuclear security students are also qualified in nuclear engineering. These students have a comprehensive understanding of the technical aspects of both nuclear security and nuclear engineering.

IV. Impact of Nuclear Security Education and Training in Pakistan

The CoE of Pakistan has made great advances toward creating nuclear security awareness and evolving a nuclear security culture in Pakistan through education, training, and information dissemination among relevant stakeholders. The impact of training in various areas is evaluated regularly to ensure that it meets desired national standards and needs. In this regard, the CoE has prepared evaluation methodology and tools to collect valuable data on the effectiveness and overall impact of training programs. Based on the analysis of participant feedback,¹ the impact of the training programs is regularly re-examined. Feedback is also used to identify areas where improvement is needed and whether any additional training courses are required to meet the needs of the participants. The impact of existing nuclear security education, based on the analysis of participant feedback and the number of trainings in a particular field, can be evaluated in both organizational and social terms.

A. Organizational Impact

Nuclear security education has enhanced the capacity of various relevant organizations, especially those with direct nuclear security responsibilities, i.e. regulators, operators, policy makers, first responders, front line officers, and law enforcement agencies, all of which are members of the target audience for the CoE’s training program. From 2011 to 2015, NISAS has conducted 61 training courses in nuclear security, in which more than 1,250 officials from various organizations have participated. Additionally, in 2015, training was provided to a total of 155 participants from different national organizations [20].

¹At the end of each training course, participants are asked for extensive feedback, intended to assess the impact of the training and gather suggestions for future courses of action.

B. Social Impact

The training courses in various areas of nuclear security have helped participants expand their knowledge base and improve nuclear security culture within their respective organizations. The ultimate effect of the training is the improvement in the working environment of national organizations. Moreover, the trained professionals have added their experiences to the promotion of nuclear security culture in the country. The following results have been achieved to enhance Pakistan's standing at an international level through a proactive and robust nuclear security program:

- 1) Prevention of incidents involving radioactive material, and preparedness for the mitigation of consequences in case of a radiological dispersal. This has been achieved through arranging tabletop and field exercises for personnel from response organizations, district managements, law enforcement agencies etc., related to their roles in responding to malicious acts involving nuclear and other radioactive material [21]. To increase awareness among the general public about the hazard of radioactive sources, special seminars, lectures, training programs, and public awareness campaigns were conducted by NISAS at educational institutes, and industrial and medical centers throughout the country.
- 2) Control of illicit trafficking of nuclear and other radioactive material. The Pakistan Nuclear Regulatory Authority, through a Memorandum of Understanding (MoU), is providing training to Pakistan Customs to strengthen its institutional capability for banning illicit trafficking of nuclear and other radioactive materials [22]. Pakistan Customs received hands-on training with radiation detection equipment and in response to radiation alarms, which ultimately helped in equipping the entry and exit points of Pakistan's international border.
- 3) Minimization of the probability of melting radioactive sources in scrap metal through training on the hazards associated with orphan sources. Seminars are periodically arranged for scrap dealers and steel mill owners etc. with the aim to make them aware of radioactive sources and their harmful effects if they are not used in a prescribed manner.²
- 4) Preparation of skilled personnel to promote nuclear security education in Pakistan. Personnel from operating, regulatory, and security organizations benefit from the M.S. in Nuclear Security program of PIEAS [23].

Pakistan's CoE for Nuclear Security has made tremendous efforts to develop a sense of responsibility among the nuclear community and associated professionals. The progress in developing a nuclear security infrastructure has provided assurance to the international community and enhanced their support of the CoE's efforts. In his speech at the International Conference on Nuclear Security: Commitments and Actions, 2016, the IAEA Director General praised the CoE as "a very impressive center in Pakistan, where training is offered in every aspect of nuclear security" [24]. The substantial achievement of Pakistan's nuclear security training program has enabled it to, not only ensure the safety and security of its own people, but also that of the world.

In summary, the role of Pakistan's Center of Excellence on Nuclear Security to provide nuclear security education and training in Pakistan has been crucial. As highlighted above, it has provided assistance in various areas with its vast capabilities and wide-ranging capacities in nuclear security. One unique aspect of Pakistan's Center of Excellence is that it has both professional trainings and academics. The CoE offers basic and advanced level training through different types of training courses (OJT's, workshops, fellowships etc.) in various sub-domains of nuclear security. It also provides expertise and information sharing at the expert level, through participation and contribution in IAEA missions. Additionally, the CoE can impart training for selection, procurement, testing, and maintenance of radiation detection and physical

²Authors gathered this information from various information dissemination brochures and flyers, distributed at different international and national seminars, conferences, and workshops.

protection equipment at regional and global levels under the umbrella of IAEA. Lastly, the CoE also provides technical assistance to the IAEA in the form of both expert personnel and services during major public events in any member states.

V. Challenges and Way Forward

Despite its extensive capabilities, the CoE needs to evolve and expand to meet growing needs, and continue to sustain its expected high standards of nuclear security education and training. While the CoE is successfully managing the existing requirements, there are potential future challenges. The following paragraphs discuss these challenges, as well as some possible solutions.

Nuclear security training will require more advanced technology labs, equipped with all the necessary tools. More simulation- and animation-based techniques should be used to make training both easy and impactful. In addition, emerging challenges in nuclear security demand that further courses be introduced to manage them.

In nuclear security education, additional courses must be added to the existing PIEAS M.S. program, which will set the stage for launching the complete M.S. Nuclear Security degree program in the near future.

Continuous international cooperation and collaboration is essential, therefore it is necessary to make connections with international universities that offer programs in nuclear security through Student/Research exchange. Furthermore, to diversify education, nuclear security should be introduced into the existing programs of more public-sector universities, such as Quaid-e-Azam University and the National Defense University. Lastly, students should receive special offers in terms of training and research opportunities to attract them to nuclear security research.

VI. Conclusion

Nuclear technology has become complex over time, and the benefits associated with a split atom have made it the most attractive option for sustainable energy in the future. Therefore, a knowledgeable and well-trained group of nuclear security experts increases a state's confidence in the peaceful use of nuclear technology as a sustainable source of energy. Pakistan has always emphasized the importance of nuclear security education and training in global efforts to deal with emerging security challenges. This paper highlighted the initiatives taken by Pakistan for nuclear security education and training programs, especially the establishment of its Center of Excellence and its role in the provision and growth of professional knowledge in the country.

Through these initiatives, Pakistan has made great progress in terms of nuclear security education and training, and has rightfully earned global recognition for its practices in concordance with international standards. In future, similar efforts should be made to sustain such initiatives. Considering the rapid development of new technologies, a continued global effort to share advanced technologies, research, and development can make a reality of Pakistan's vision of peace.

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