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SAND2020-1201C

Lessons Learned from Developing the Graduate Nuclear Security Curriculum at the Kyiv Polytechnic Institute Primary

Dr. Tymofii Bibik
National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute», Kyiv, Ukraine
Faculty of Heat and Power Engineering
Department of Nuclear Power Plants and Engineering Thermal Physics
Email: tymofii.bibik@gmail.com t: +380673022795

Dr. Adam D. Williams
Center for Global Security and Cooperation,
Sandia National Laboratories*, Albuquerque, NM, USA

February 2020

- History of collaboration between KPI and NNSA/INS
  - Introduce how these engagements helped shape the progression of the curriculum and program's professors
- The structure and description of KPI's nuclear security program
  - Summary description of each course and how the learning objectives of each course correspond to the overall goals of the program
- Lessons learned
  - From both development process and from the initial implementation stages of KPI's curriculum
  - To inform (and, hopefully) assist other nations embarking on developing nuclear security education programs

Preparing the next generation of Ukrainian nuclear security is uniquely important considering:

- Ukraine has recently experienced terrorism operations, resulting in significant amounts of uncontrolled armament in/through the country;
- Ukraine has 15 nuclear power reactors, 1 research reactor, and spent fuel from 13 VVER-1000 reactors stored on its territory;
- There is damaged unit #4 of the Chernobyl Nuclear Power Plant (NPP), plus spent fuel/ radioactive wastes in the northern part of the country;
- Wide peaceful use of radioactive ionizing sources (with resulting waste)
- Territory of the Ukraine is used for transportation of radioactive materials, including transit of both fresh and spent nuclear fuel; and,
- ***Universities did not provide the education of the experts in area of nuclear security***

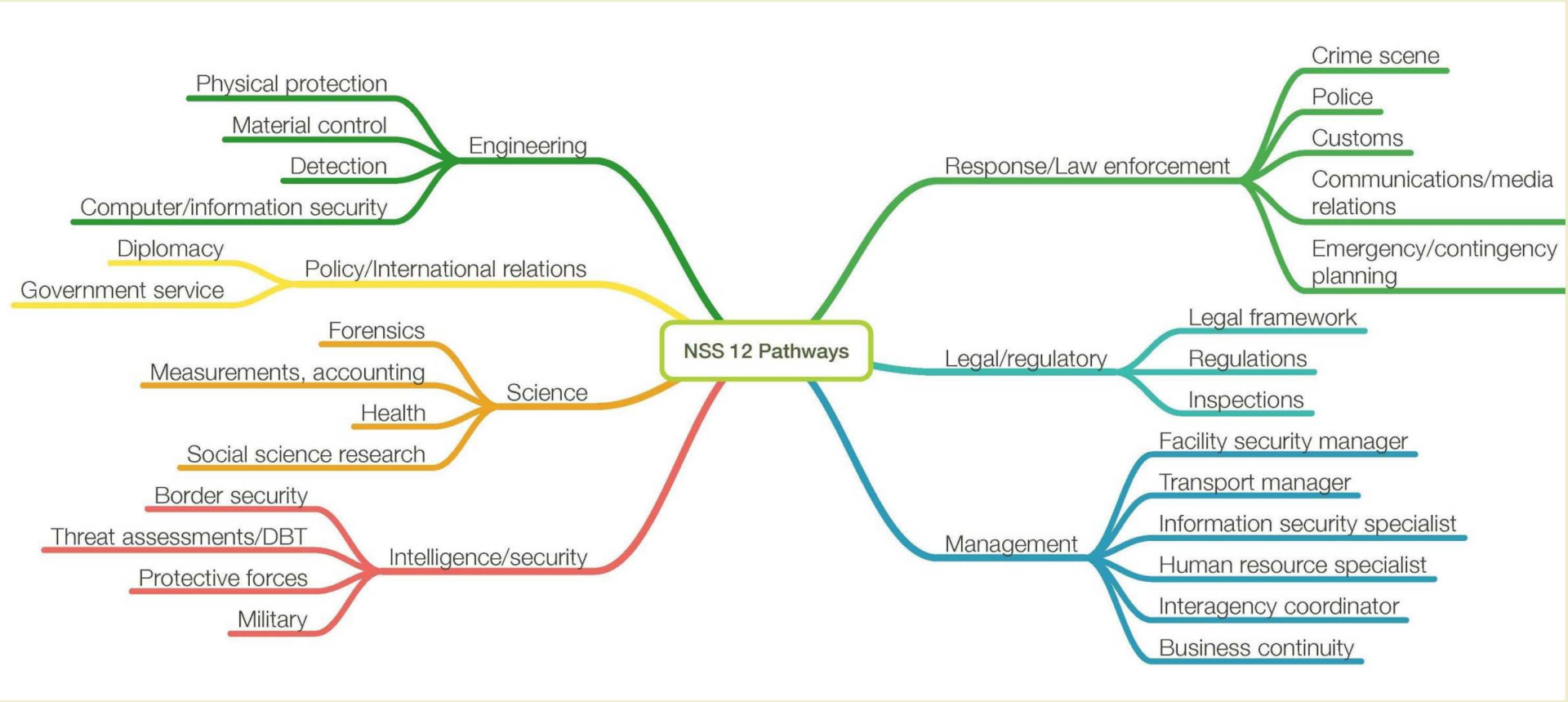
Introduction

In response, the Ministry of Energy and Coal Industry of Ukraine has partnered with the U.S. National Nuclear Security Administration's International Nuclear Security (NNSA/INS) program to develop a graduate curriculum in nuclear security at the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (KPI).

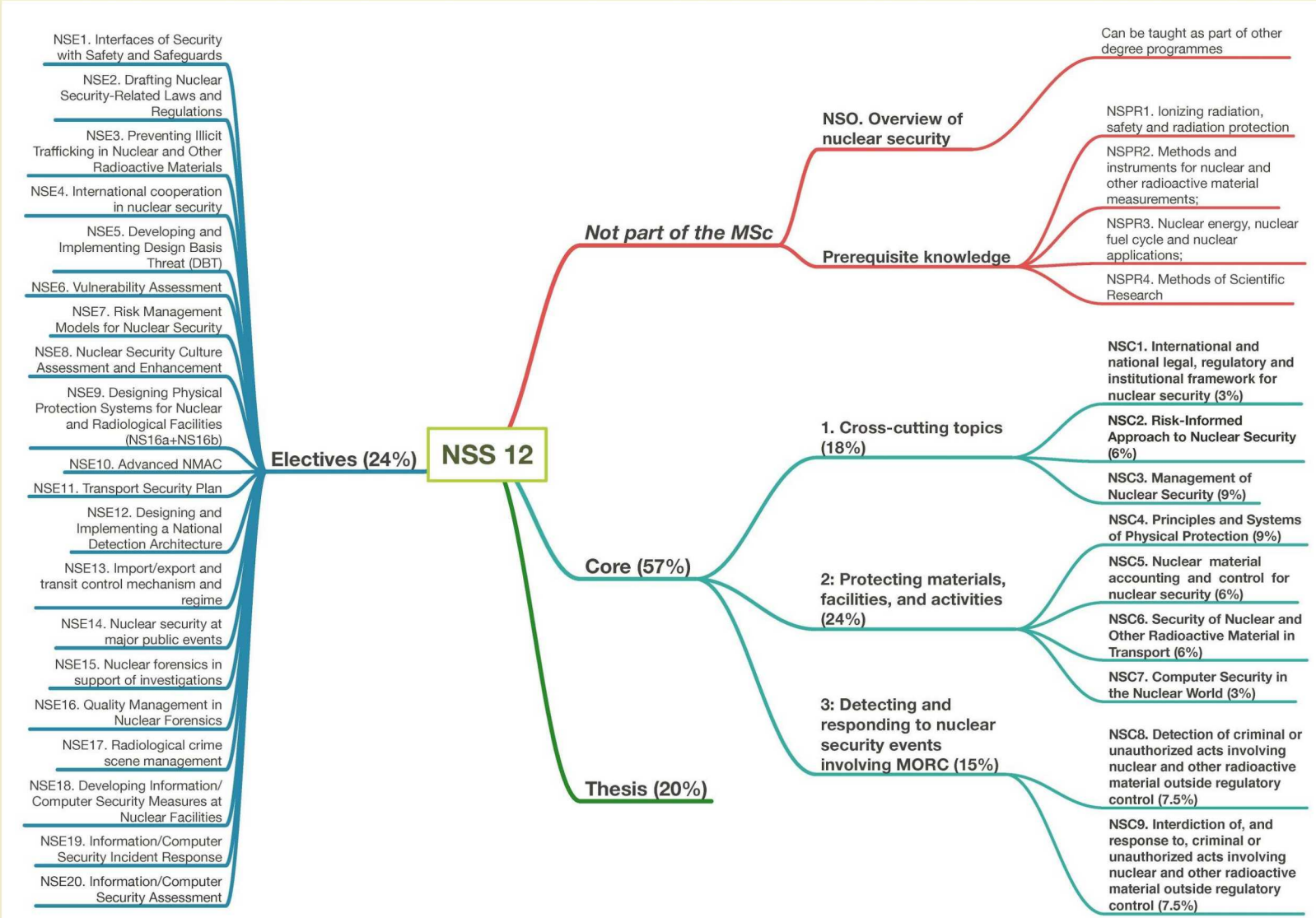
The main criterion of the choice of KPI:

- The availability of a laboratory base in Kyiv (in the center named after George Kuzmich)
- The research reactor BVV-M at the Institute of Nuclear Research of the National Academy of Sciences of Ukraine

Potential pathways from academic disciplines to nuclear security careers.



IAEA recommended curriculum for master's in science in nuclear security



Ukrainian Background for Nuclear Security Education

- In the Ukrainian context, the number of nuclear security specialists under the responsibility of the Ministry of Energy and Coal Industry of Ukraine is more than 1230 people.

- In addition, the annual need for training specialists in higher educational institutions averages approximately 20-30 people.

Development of the Graduate Nuclear Security Curriculum at KPI

- The development of this nuclear security education began with a meeting of all interested stakeholders in Ukraine
  - Including representatives of the NNEG “Energoatom“, Ministry of Energy and Coal Industry of Ukraine, State Nuclear Regulatory Inspectorate of Ukraine, Institute for Nuclear Research of National Academy of Sciences of Ukraine and KPI.

- As a result of this meeting, a preliminary list of courses to be developed was identified and specific KPI professors were selected to help develop this program.

- The next step was to further develop the nuclear security expertise within these professors via a *train the trainer* program.

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Summary of Activities for KPI Professors during the 2016 Summer Nuclear Security Education Technical Tour

	Texas A&M University
Tours/ Facilities	• Radiation Detection Laboratories • Disaster City (Emergency Operations Training Center) • Nuclear Science Center – TRIGA Research Reactor
Nuclear Security Topic	• Nonproliferation & Arms Control (Course NUEN650) • Radiation detection & materials measurement (Course NUEN605) • Nuclear security system design (Course NUEN451) • Nuclear/Radiological Response and Consequence Management (Course NUEN689) • Nuclear fuel cycles and materials safeguards (Course NUEN651) • Radiochemistry & nuclear forensics (Course CHEM689) • Nuclear terrorism threat assessment & analysis (Course INTA669)

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Summary of Activities for KPI Professors during the 2016 Summer Nuclear Security Education Technical Tour

	Sandia National Laboratories
Tours/ Facilities	• National Museum of Nuclear Science & History • Nuclear Forensics & Radiochemistry Laboratory • Sandia's Training, Technology & Demonstration Area • Test facilities at Security Equipment Performance Testing at TA-III & Access Delay Bunker • Virtual Tour of Integrated Security Facility (TA-V)
Nuclear Security Topic	• Systems approach to nuclear security • Introduction to connections between security, safety & safeguards • International & national nuclear security obligations • Risk informed approaches to nuclear security • Radiation protection for security • Design and Evaluation Process Outline (DEPO) • Physical protection system (PPS) design • Nuclear material accountancy and inventory control for security applications • PPS evaluation and vulnerability assessment • Nuclear security culture & human factors influencing nuclear security • Insider Threat & Analysis Techniques • Security of nuclear materials in transit • Materials outside of regulatory control • Cyber security & its relationship to nuclear security • Differences in security design/analysis for different NFC facilities

Continued collaboration between KPI, Sandia, and INS

- Supported development of the curriculum
- Supported professional development of KPI professors

In addition, there were three in-person meetings in Kyiv to assess progress in detail. These in-person meetings—which included:

- Program structure development (Spring 2017),
- Preliminary course curriculum review (June 2018),
- Post course development curriculum review (June 2019)—also included site visits to the campuses of both KPI and GKTC to tour several of the hands-on facilities intended to be used to support the nuclear security curriculum

KPI's Masters Program in Nuclear Security

- To meet Ukrainian higher education requirements, this nuclear security specialization consists of ***90 credits*** and is designed to be completed over ***two academic years***

- To meet these requirements, the ***15 total nuclear security courses*** consist of nine core (#1-#9) and six elective (#10-#15) courses that span hard and soft science academic disciplines

- Courses themselves include:
  - Lecture-based, seminar-based, and experiment-based approaches
  - A full range of student assessment tools (e.g., homework, quizzes, term papers, exams)

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#	Title	High Level Objectives
1	Overview of nuclear security	• Introductory, standalone course • Overview of entire nuclear security field
2	International and national legal, regulatory and institutional framework for nuclear security	• Understanding the prerequisites of nuclear security • General principles/concepts of developing documents/regulations • Overview of the legal framework • Understanding the role of international organizations
3	Use of nuclear material accounting and control for nuclear security	• Describe NMAC functions at nuclear and radiological facilities and during transportation • Fundamental components necessary for developing/ implementing/maintaining effective detection strategies • Detailed description of radiation detection instrumentation and personal protective equipment, & emergency management
4	Developing and implementing Design Basis Threat	• Overview of threats to nuclear security • How to describe potential adversary groups, their intentions, capabilities and targets of interest • Conducting threat assessments • Developing, using and maintaining a DBT
5	Nuclear security culture	• Provide definition and history for nuclear security culture • Define the roles of States, organizations, managers, and individuals in promoting good nuclear security culture • Provide a model for elements of good nuclear security culture • Describe guidance on evaluating/improving the nuclear security culture of a facility or organization
6	Physical protection systems design and evaluation	• Discuss the fundamental principles of physical protection • Describe how to plan/implement the physical protection system (PPS) design process • Provide an understanding of the PPS and the possibilities of their application • Explain the main functions of the PPS and their interaction • Provide basic knowledge of PPS design and reliability assessment
7	Non-Destructive Assay of Nuclear Materials	• Provide fundamentals, approaches, technique and equipment on NDA • Discuss the fundamentals of nuclear radiation and its detection • Explore the basics of radiation detectors, counting statistics and spectra analysis
8	Information and computer security	• Discuss computer security related to nuclear security • Explore options for protection of sensitive and secret information • Provide principles for constructing/protecting computerized control systems of technological processes at sites with nuclear and other radioactive materials
9	Nuclear security management at national and facility level	• Provides an overview of the main aspects and principles of nuclear security management • Describe the features of stakeholder cooperation – including at the local, national, and international levels

Elective Courses

#	Title	High Level Objectives
10	Legal drafting for nuclear security	• Discuss the main components and elements of comprehensive national nuclear security legislation • Provide experience and knowledge necessary to develop and draft regulations and other documents related to nuclear security
11	System of Radioactive Waste Management	• Discuss common approaches and principles for the classification of radioactive waste • Provide a general overview of radioactive waste management systems in Ukraine and abroad • Explore concepts and requirements for radioactive waste disposal facilities
12	Nuclear Facility Vulnerability Assessment and Risk Management	• Provide information about risk management • Evaluate and optimize methods for physical protection systems evaluation
13	Preventing and protecting against insider threat.	• Describe the insider threats facing nuclear organizations • Analyze the complex nature of insider threats • Describe how organizations and individuals can secure themselves against this threat
14	Physical protection technologies and equipment.	• Provide an understanding of existing technical methods, sensors and tools • Learn how to choose the right equipment to meet the requirements for various physical protection systems
15	Management of Emergency and Crisis Situations at Nuclear Facilities	• Discuss features of crisis management and crisis response in the field of nuclear security • Describe the features of stakeholder cooperation – including at the local, national, and international levels

KPI's Masters Program in Nuclear Security

- The representatives of the University, with the support of the Ministry of Energy of Ukraine, conducted a wide advertising campaign.

- This approach, during the summer introductory campaign, allowed to attract **9 full-time** students and **29 part-time** students to enroll in the program that officially began in September 2019—demonstrating that this program meets the target populations

Conclusions, Lessons Learned and Future Challenges

- Success of KPI's nuclear security masters program resulted from leveraging
  - International best practices
  - Bilateral collaboration
  - Tacit knowledge of state-level needs

- EX: IAEA NSS-12 provided a great start for scoping the topics, but needed to be tailored to Ukraine's nuclear security-related requirements

- Collaboration between KPI, Sandia, and NNSA/INS → the foundation for strong graduate-level education program in nuclear security

- Bilateral cooperation → prepared a cadre of dedicated academic faculty to provide the courses associated with this KPI graduate program.

Conclusions, Lessons Learned and Future Challenges

- As the KPI program matures and evolves, expected future challenges are serves as targeted opportunities for improvement
  - EX: Any university that considers such a graduate program must be considerate of maintaining (and managing) student throughput
- At minimum, programs must attract enough students to meet university-based course viability requirements and state-level need for graduates
- Need to continually build the theoretical/practical expertise in nuclear security could initiate additional cooperation to support this program

Conclusions, Lessons Learned and Future Challenges

- This KPI program is well positioned to incorporate R&D activities beyond those included as practical exercises within individual courses
- And, with its strategic partnership with GKTC, KPI is positioned to push the cutting edge of academic R&D in nuclear security
- This new KPI masters program can help increase the Ukrainian voice in the international discourse on nuclear security

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We are open for collaboration

Thank You!