

DRAFT

Nuclear Security and Nonproliferation Topics

The Nuclear Security and Nonproliferation portion of the qualification exam is meant to test the student's knowledge of both the policy and technical aspect of this specialty in the NUEN department. Courses that will aid the student for this qualification exam include:

- NUEN 451 Nuclear Security System Design
- NUEN 605 Radiation Detection and Nuclear Materials Measurement
- NUEN 650 Nuclear Nonproliferation and Arms Control
- NUEN 651 Nuclear Fuel Cycles and Nuclear Material's Safeguards

The following outline describes the material covered by the exam:

I. Nuclear Security

- a. Characterize a Design Basis Threat (DBT) that can be used to perform a threat-informed security evaluation
- b. Understand the concepts of detection, delay, and response technologies.
- c. Formulate different response strategies (including deterrence, denial, containment, pursuit, and recapture) for different facilities and considering on-site and/or off-site response.
- d. Understand the issues behind defense-in-depth security and how to achieve balanced protection while minimizing risk to an acceptable level.
- e. Understand how engineering principles are used to generate a cost benefit analysis for upgrading existing nuclear security systems.
- f. Understand the unique security characteristics associated with transportation of nuclear materials, smuggling of nuclear materials, and protection of major public events and be able to apply a risk- and performance-based engineering approach to security systems for these scenarios.
- g. Understand nuclear forensics and consequence management as components of a broad nuclear security system and develop a nuclear security plan that incorporates these elements.
- h. Be able to discuss and critique the deterrence characteristics of nuclear security systems.

II. Nuclear Nonproliferation and Arms Control

- a. Knowledge of the history of nuclear weapons development
- b. Know the countries who have developed nuclear weapons and the political reasons for their development
- c. Understand the skills, capabilities, and materials needed by a proliferator to produce a nuclear weapon.

- d. Knowledge of current the NPT and the Additional Protocols
- e. Be able to calculate HEU and Pu production quantities for various nuclear facilities.
- f. Identify proliferation risks in a nuclear fuel cycle or in a collection of facilities.
- g. Understand the methods for safeguarding nuclear material at declared facilities and describe the technology used to measure bulk nuclear materials.
- h. Describe methods for identifying covert nuclear activities and how they can be applied to treaty verification.
- i. Understand the need for future developments in nonproliferation policy and technology.
- j. Assess the interaction between technology and policy in the nonproliferation arena

III. Nuclear Material Measurements

- a. Know the types “Special Nuclear Material”
- b. Understand the types of radiation that is emitted by SNM in various chemical forms
- c. Understand the challenges of detecting SNM
- d. Be able to calculate uranium enrichment from spectra
- e. Know what detection systems should be used and under what circumstances
- f. Know other radiological footprints that could be used to indicate SNM

IV. Nuclear Fuel Cycles and Nuclear Material’s Safeguards

- a. Describe the different components of an open and closed nuclear fuel cycle
- b. Understand the various forms of SNM for each step of an open and closed fuel cycle
- c. Know what effluents occur at each step of the open and closed fuel cycle
- d. Calculate and identify possible points of MUF
- e. Define and calculate separative work units for uranium enrichment
- f. Be able to describe the methods used for accounting and control of SNM
- g. Discuss the elements of proliferation resistance
- h. Know the quantities of SNM created in SNF for various burnups and reactor types
- i. Be able to discuss advantages and disadvantages of the open and closed fuel cycles
- j. Understand IAEA safeguards terminologies and principles
- k. Statistics applied in safeguards
- l. Describe the fundamentals of how nuclear material safeguards are implemented to secure nuclear material from diversion by the country.