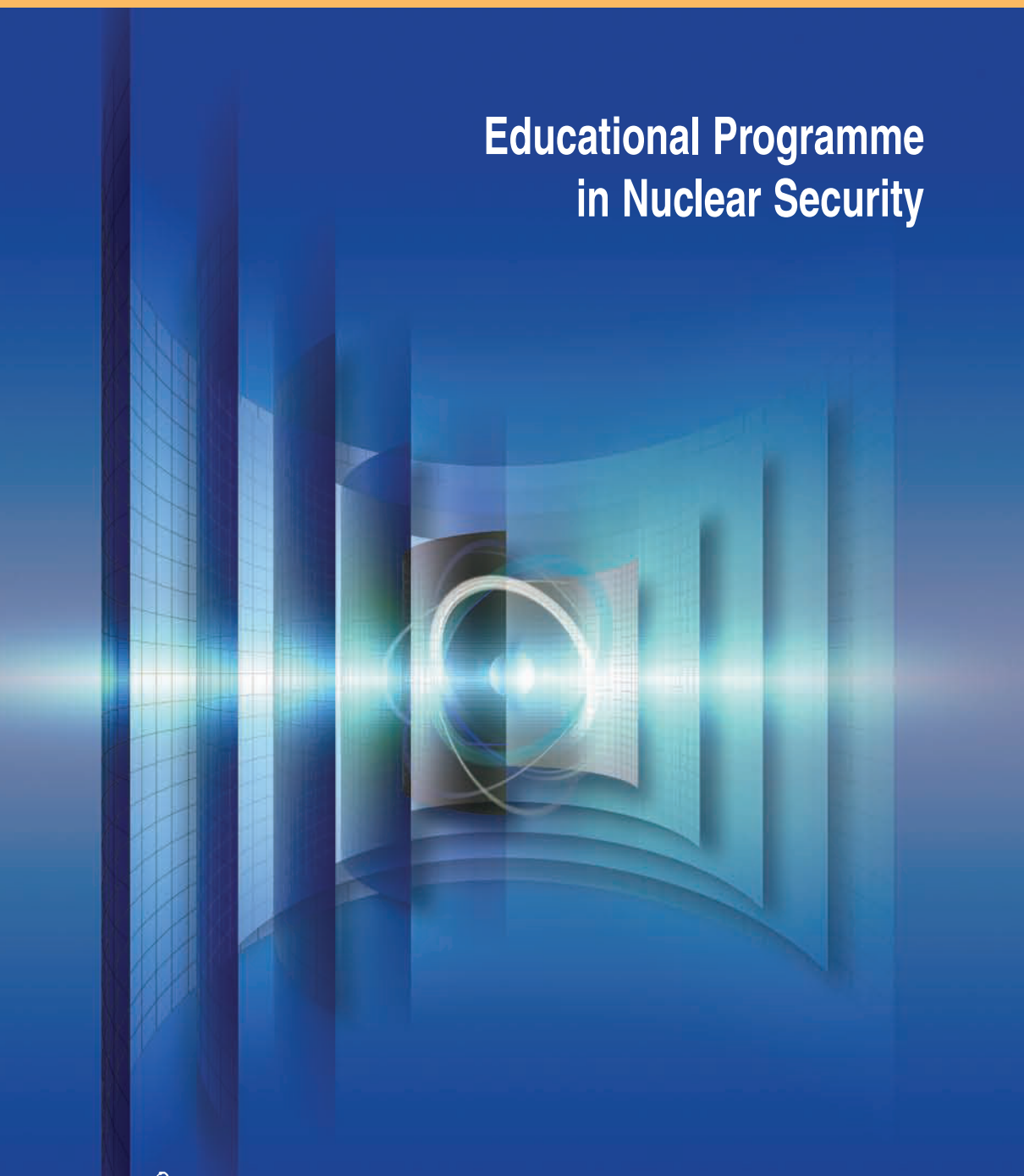
IAEA Nuclear Security Series No. 12

Technical Guidance

Educational Programme in Nuclear Security



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Publications in the IAEA Nuclear Security Series are issued in the following categories:

- **Nuclear Security Fundamentals** contain objectives, concepts and principles of nuclear security and provide the basis for security recommendations.
- **Recommendations** present best practices that should be adopted by Member States in the application of the Nuclear Security Fundamentals.
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DRAFTING AND REVIEW

International experts assist the IAEA Secretariat in drafting these publications. For Nuclear Security Fundamentals, Recommendations and Implementing Guides, open-ended technical meeting(s) are held by the IAEA to provide interested Member States and relevant international organizations with an appropriate opportunity to review the draft text. In addition, to ensure a high level of international review and consensus, the Secretariat submits the draft texts to all Member States for a period of 120 days for formal review. This allows Member States an opportunity to fully express their views before the text is published.

Technical Guidance publications are developed in close consultation with international experts. Technical meetings are not required, but may be conducted, where it is considered necessary, to obtain a broad range of views.

The process for drafting and reviewing publications in the IAEA Nuclear Security Series takes account of confidentiality considerations and recognizes that nuclear security is inseparably linked with general and specific national security concerns. An underlying consideration is that related IAEA safety standards and safeguards activities should be taken into account in the technical content of the publications.

EDUCATIONAL PROGRAMME IN NUCLEAR SECURITY

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

IAEA NUCLEAR SECURITY SERIES No. 12

TECHNICAL GUIDANCE

EDUCATIONAL PROGRAMME IN NUCLEAR SECURITY

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FOREWORD

The potential of a malicious act involving nuclear or other radioactive material is a continuing worldwide threat. Available data indicate circumstances in which nuclear and other radioactive material are vulnerable to theft, are uncontrolled, or are in unauthorized circulation. States must establish sustainable security measures to prevent such acts and to protect society from nuclear terrorism. Appropriate training and education at all levels and in all relevant organizations and facilities can play a major role in this process.

There is increased interest in nuclear applications. Many States have expressed interest in expanding or introducing nuclear power in their country as a result of their own assessment of their energy supply needs, because of climate change, and development requirements. The projected increase in the demand for nuclear energy will increase the number of nuclear reactors worldwide and, consequently, the amount of nuclear material in use. Possible malicious acts involving nuclear or other radioactive material are a real threat. These developments are mirrored by an increase in the use of nuclear techniques in non-power applications. As a result, the need for experts in the area of nuclear security has become of great importance, and both universities and students have shown an increasing interest in nuclear security specialities.

In September 2005, the Board of Governors approved a Nuclear Security Plan covering the period 2006–2009. This emphasized, inter alia, the importance of human resource development to assist States in building capacity to establish and maintain appropriate nuclear security to prevent, detect and respond to malicious acts involving nuclear and other radioactive material. The Nuclear Security Plan envisages the development of guidance for an educational programme in nuclear security that could be used by all States. In pursuit of this goal, this publication has been developed to provide advice and assistance to universities and other academic institutions in developing a graduate (Master of Science) or certificate programme in the area of nuclear security tailored to the individual needs of a country or a region.

This publication is based on an analysis of existing academic programmes, on courses offered at different universities around the world, and on the IAEA nuclear security training programme. It was presented to IAEA Member States at an open-ended technical meeting in August 2008.

The IAEA is grateful to the consultants and Member State representatives for their efforts in the drafting of this publication. The IAEA officers responsible for this publication were A. Braunegger-Guelich, V. Rukhlo and R. Abedin-Zadeh of the Office of Nuclear Security, Department of Nuclear Safety and Security.

EDITORIAL NOTE

This report does not address questions of responsibility, legal or otherwise, for acts or omissions on the part of any person.

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CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

With projections of an increase in demand for nuclear energy and the renewed interest in expanding or developing nuclear power programmes and nuclear applications, possible malicious acts involving nuclear material are an issue of growing concern in the international community. Moreover, it is becoming clearer that this nuclear revival will not be limited to countries with extensive experience in nuclear programmes, but will also affect countries with currently limited nuclear activities and those that plan to expand their nuclear activities in the future. Hence, there is a demonstrated increased need for well qualified experts and specialists in nuclear security.

In addition, the constant loss of qualified personnel due to career development, retirement and administrative changes negatively affects a State's readiness to carry out nuclear security tasks effectively. At the same time, technology and procedures are evolving at an increasing pace with the introduction of new equipment and techniques. Consequently, there is a rapidly growing need for highly qualified experts in nuclear security at the national level, since the responsibility for nuclear security remains entirely in the hands of each State. It is essential that sustainable nuclear security expertise is achieved and maintained in individual States to ensure and strengthen global security. This goal can be reached through appropriate training and education at all levels and in all organizations and facilities involved in nuclear security issues. A well educated and trained workforce is needed to serve in national authorities and nuclear/radiological facilities to lead and contribute to the establishment and maintenance of an effective nuclear security regime.

The need for human resource development programmes in nuclear security was emphasized at a number of IAEA General Conferences and Board of Governors meetings. In September 2005, the Board of Governors considered and approved a new Nuclear Security Plan covering the period 2006–2009,[1] which emphasized the importance of human resource development. This plan forecasts the development of guidance for an educational programme in nuclear security that could be used by all States.

[1] Nuclear Security — Measures to Protect against Nuclear Terrorism: Progress Report and Nuclear Security Plan for 2006–2009, Report by the Director General, GC(49)/17, IAEA, Vienna (2005).

In spite of the recognized need for a well defined human resource development programme in nuclear security, only a few universities[2] in the world have developed technically oriented educational programmes related to this area. Therefore, the IAEA has taken the lead and has developed, together with academics and experts from Member States, an Educational Programme in Nuclear Security providing guidance for a Master of Science (MSc) programme and a certificate programme to assist States in adapting such programmes in the future.

1.2. OBJECTIVE

This publication is intended for university curriculum developers, nuclear security instructors and human resource development managers working at entities responsible for nuclear security. It might also be of value for decision makers, operators, managers at regulatory authorities, law enforcement agencies and managers working at other government nuclear organizations responsible for nuclear security.

The main objectives of this publication are to provide a comprehensive and current overview of nuclear security[3] and to provide guidance for an MSc programme and a certificate programme in nuclear security. It is intended for use by universities and other academic institutions in developing their own curricula in nuclear security or in expanding their academic programmes related to this subject.

The Educational Programme in Nuclear Security should be considered as a guide to facilitate the development of a comprehensive nuclear security human resource development programme (see Section 2) with the purpose of building up and maintaining relevant knowledge and skills, and sustaining qualified personnel dealing with future nuclear security challenges. The programme is designed to provide both the theoretical knowledge and the practical skills necessary to meet the nuclear security requirements outlined in the international framework and in the IAEA Nuclear Security Series publications. Emphasis is placed on the implementation of these requirements and recommendations in States with different systems in place. On the basis of this guide, each university

[2] In this publication, the term *university* is taken to mean all higher education establishments, including colleges, polytechnics and the 'Grandes Ecoles'.

[3] *Nuclear security*: The prevention, detection of and response to theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities (according to the working definition established by the fifth meeting of the Advisory Group on Nuclear Security (AdSec), 1–5 December 2003).

should be able to develop its own unique programme tailored to suit the State's educational needs in this area and to meet the national requirements.

1.3. SCOPE

The scope of this publication is broad and covers education in all areas of nuclear security, ranging from an MSc programme for the development of highly educated staff with in-depth knowledge to a certificate programme for the development of certified nuclear security specialists. Although it does not explicitly outline an undergraduate or a diploma programme, the recommended MSc Programme could be used as the basis for the development of such programmes. It is also not the intention of this publication to cover short courses suitable for continuing education or possible on the job training programmes or fellowship programmes.

General courses focusing on research methods or computing and networking, for example, are not addressed in this publication either, as it is assumed that individual universities would include them in any new curriculum according to their practices and national requirements.

No confidential or restricted information in contained in this publication. However, State or nuclear-facility-specific information is classified as confidential. Therefore, it is expected that universities intending to develop nuclear security related teaching material such as scenarios or case studies should base the contents of this material on hypothetical data.

1.4. STRUCTURE

This publication is divided into four main sections and two appendices.

Section 1 provides an overview of the background, objectives, scope and structure of this publication and points out the relationship to educational programmes containing nuclear security components, and training programmes in this area.

Section 2 focuses on the human resource development aspect of capacity building in nuclear security in general.

Section 3 provides an overview of the recommended MSc programme, including recommended prerequisite courses and a list of required and elective courses. It proposes a pre-thesis practice and touches on the MSc thesis itself. Further, this section indicates a possible schedule for the implementation of the MSc programme, including suggested duration in hours for each course, and illustrates the interrelation between the different MSc courses.

Section 4 gives an introduction to the certificate programme, including a list of core courses and additional courses.

Appendices I and II provide a brief description of each course and the respective learning objectives, and also detailed information on the different topics to be studied in the individual courses. Where appropriate, practical/laboratory exercises are listed and reference publications are recommended. The references are not exhaustive since they are limited to relevant conventions such as the Convention on the Physical Protection of Nuclear Material and IAEA publications, related IAEA training material, United Nations Security Council resolutions (e.g. 1540), and relevant United Nations conventions, such as the International Convention for the Suppression of Acts of Nuclear Terrorism. This allows university curriculum developers from different countries to recommend any other national or international publications considered relevant for course topics.

1.5. RELATIONSHIP TO EDUCATIONAL AND TRAINING PROGRAMMES IN THE AREA OF NUCLEAR SECURITY AND NON-PROLIFERATION

A number of academic institutions around the world offer educational programmes that deal with nuclear security issues. While some universities provide programmes with a focus on selective elements of nuclear security, such as accounting for and control of nuclear material or the physical protection of nuclear material and facilities, others emphasize security policy, legal and managerial aspects of nuclear non-proliferation or social and political factors of terrorism.

However, no educational programme currently covers all aspects of nuclear security as defined by the IAEA Advisory Group on Nuclear Security (see Section 1.2). Therefore, efforts were made to fill this gap and provide the scientific community with a current and comprehensive overview of nuclear security by developing this publication at an international level. Developers of nuclear security educational programmes might consider broadening some of the topics that are not covered in depth in this publication, but that are already well developed in academic programmes (e.g. nuclear non-proliferation regime, security policies or security management). This could be done, for example, by offering courses on the different topics as additional elective courses.

Training programmes dedicated to nuclear security already exist, developed by the IAEA, other international organizations and governments. The IAEA has developed a comprehensive Nuclear Security Training Programme[4] that could be used by States as a basis for designing their national nuclear security training programme. However, national training programmes in nuclear security should, if applicable, be aligned with the national educational programme in this area.

2. CAPACITY BUILDING IN NUCLEAR SECURITY: HUMAN RESOURCE DEVELOPMENT

Human resource development, including education and training, plays a central role in the development of both individuals and societies since it reinforces sustainable social, economic, technical and cultural growth. Training, in general, and education, in particular, are not subjects of a common global policy. The competence for the contents and the organization of training and studies remains at the national level, which also applies to nuclear security education and training. The provision of an appropriate national nuclear security human resource development programme is therefore essential in order to guarantee the sustainability of nuclear security knowledge and skills in a State. The projected national requirements for experts and specialists in different areas of nuclear security and their number depend on the national nuclear related infrastructure and national nuclear development plans.

Human resource development in nuclear security should aim at building, upgrading and strengthening the knowledge and skills of personnel working at the responsible competent authorities. It should focus on organizational capacity building in nuclear security and be designed to promote a domestic knowledge network. Human resource development is a strategic and coherent approach to the development of people in order to help them to contribute individually and collectively to the achievements of the authorities' nuclear security objectives. It thereby assists in enhancing the national nuclear security infrastructure by promoting educational and training programmes for professionals in support of the State's long term human resource sustainability efforts.

[4] http://www-ns.iaea.org/downloads/security/Nuclear_Security_Training_Catalogue.pdf, as of 25 March 2009.

Before developing a comprehensive human resource development programme, it is recommended that a nuclear security needs assessment be conducted at the national level. All organizations/agencies responsible for nuclear security in a country should be involved in the assessment and in the subsequent development of the tailored human resource development programme. Depending on the results of the domestic needs assessment, the programme could consist of an educational programme and/or a nuclear security training programme.

A national training programme for nuclear security should aim at filling gaps between the actual performance of personnel working in the area of nuclear security and the required knowledge and skills needed to meet the international requirements and recommendations described in United Nations and IAEA documents relating to nuclear security. Based on the needs assessment, such a training programme could take into consideration current interactive teaching methods and consist of one or more classroom training courses in a particular area of nuclear security that needs to be established at the national level, drills, fellowship programmes for junior staff, on the job training, technical visits for senior staff and/or a structured plan for attending selected nuclear security training courses offered by the IAEA or other organizations.

Educational programmes in nuclear security should aim at establishing in-depth and sustainable knowledge and skills, and foster nuclear security culture in a country or region. They should be addressed to people interested in careers in nuclear security working at different entities, such as regulatory authorities, the nuclear industry, the Ministries of Justice, Finance, Health, Environment, Science, Transport, Customs, Police and the intelligence services. *Nuclear security* is multidisciplinary and can therefore offer job opportunities in a wide range of entities.

States can benefit greatly from the services of graduates of nuclear security educational programmes, who, with experience in the field, can become highly qualified experts able to provide the necessary competencies for the effective national nuclear security oversight of nuclear and other radioactive material. They can provide expertise to design, establish, maintain and evaluate measures to prevent and respond to malicious acts involving such material.

However, the decision for any particular educational initiative should consider the broader context of qualifications actually or potentially available that enable knowledge progression in the area concerned. Although terminology may vary between national educational systems, in general, courses in certificate programmes are less demanding than those for diplomas, which are less demanding than in undergraduate degrees; graduate degrees are less demanding than post-graduate degrees. These differences are generally implicitly reflected in differing entry requirements.

In this respect, the national human resource development programme should be prepared in advance, so that it will match the required qualification of nuclear security experts and specialists, and the academic/training programmes. It should be balanced according to the number of staff available and the identified nuclear security education/training needs.

— Staff holding an MSc degree in nuclear security should have in-depth knowledge in the main areas of nuclear security: the prevention and detection of and response to malicious acts involving nuclear and other radioactive material, and at the same time they should have advanced knowledge in these areas according to their selected specialization. Graduates of an MSc programme in nuclear security should serve as nuclear security officers in national authorities and nuclear related companies for managing and carrying out nuclear security measures and should be the backbone of the nuclear security knowledge network in the country. According to their selected specialization, they should be able to analyse the national nuclear infrastructure, evaluate the risk of malicious acts and recommend optimum State nuclear security measures. They should be able to design and evaluate the effectiveness of physical protection systems, assist in the development of new systems, arrange nuclear transport security, and coordinate with response forces. They should be able to establish an effective border monitoring system and have the capability to analyse and resolve problems related to arrangements of border control, detection of nuclear and other radioactive material for combating illicit trafficking and the development of a State's nuclear response plan and related measures. Finally, they should be able to participate in crime scene management and assist in prosecution process.
— Staff holding a certificate in nuclear security should have solid knowledge in the main areas of nuclear security and should be able to apply it to prevent, detect and respond to incidents involving nuclear and other radioactive material. They should be able to perform tasks to effectively establish and maintain the national nuclear security regime and should liaise with the nuclear security officers in the relevant national authorities.
— Personnel attending short training courses or on the job training should be able to apply basic knowledge of specific areas of nuclear security and be aware of the latest developments of equipment and procedures related to their duties.

2.1. OPTIONS TO ESTABLISH NUCLEAR SECURITY EDUCATION AT UNIVERSITIES

It is necessary but certainly not easy to define a concept of how to establish the academic specialization of nuclear security that suits the particular expertise of a university and reflects the national nuclear security needs and capacities in this area. Therefore, different options might be taken into consideration prior to developing a tailored educational programme in nuclear security. In any case, the prerequisites, content and scope of each individual educational programme should be based on the assessed educational nuclear security needs in the individual country and tailored to the identified target audience.

Nuclear security is multidisciplinary and requires experts from several different disciplines in order for it to be successfully established and implemented at universities. It may not be easy to find lecturers at one university or in one State who are experts in all areas of nuclear security. Hence, a multinational approach seems reasonable. This approach could embrace different States in a region where universities with a certain profile have built an official network or where a common educational accreditation system is in place. Different aspects of nuclear security, such as political, economical, social or technical, could be covered by universities according to their expertise. This would allow a full range of nuclear security expertise to be offered to students from an entire region.

Another concept could be that universities or other institutions adopt, as a first step, some courses from the recommended educational programme that fit well into the existing specialization of the university. In this way, the university can expand students' knowledge in one or more particular areas of nuclear security. In parallel, a full MSc programme in nuclear security could be developed and implemented. This would allow enough time to develop the necessary knowledge and adequate teaching material in order to establish nuclear security education. The development of teaching material and the provision of initial courses might be arranged in cooperation with international guest lecturers.

Depending on the State's educational system and governmental needs, it may be most effective to set up an MSc programme in nuclear security as a specialization within Nuclear Engineering. In other countries, nuclear security might be best presented as part of an honours programme where all core topics could be covered in the first year, with specialization during second or even later years.

Another concept could be to tailor the proposed IAEA certificate programme to the State's nuclear security educational needs and nuclear infrastructure. This might be suitable for a country with limited nuclear activities or with a limited number of specialists in this area.

The above outlined options could be considered by universities or academic institutions when defining their individual concepts for nuclear security education. The concepts will most probably differ from university to university, and from State to State.

2.2. ISSUES TO BE TAKEN INTO CONSIDERATION

Most likely, the greatest challenge in establishing the new academic specialization of nuclear security is the training of adequate lecturers qualified to teach the multidisciplinary subject matter and of teaching material, including textbooks.

Many universities are not yet equipped to meet the increased requirements for nuclear security experts with comprehensive in-depth knowledge and adequate skills able to transfer the desired knowledge and competencies to those who will improve and sustain nuclear security at the national and, in the future, at the international level. In addition, the development of adequate teaching material for this new discipline has to be taken into consideration. The IAEA stands ready to assist, upon request, in increasing lecturers' knowledge pertaining to nuclear security and in developing adequate textbooks and other teaching material in cooperation with its Member States. Over the past years, the IAEA and its Member States have produced a broad range of nuclear security training material that could be used as basis for this.

In addition to the above challenges, it is necessary to consider that nuclear security education requires appropriate laboratories equipped with relevant nuclear security instruments. This means that the process of establishing nuclear security at universities will also require technical support.

3. MASTER OF SCIENCE PROGRAMME IN NUCLEAR SECURITY

Assuming that universities provide courses on general education related to a graduate programme (see Section 1.2), the recommended MSc programme in nuclear security is compatible with the requirements for a Master's programme offered in major world universities, with requirements contained in the Sorbonne/Bologna Declarations and with requirements developed for a European MSc by the European Nuclear Engineering Network. However, State

organizations or universities might have different educational requirements in nuclear security depending on the needs identified and general specialization of the universities. Therefore, the educational programme allows for flexibility in the selection of different courses or parts of the programme.

It is expected that the MSc programme in nuclear security would be suitable for graduates of universities who satisfy the prerequisite requirements. Two prerequisite courses are outlined in detail in Appendix I that would be suitable to get the requisite knowledge in applied mathematics and basic nuclear physics.

The structure of the recommended MSc programme in nuclear security consists of a set of 12 required courses providing solid knowledge in the fundamental areas (such as the legal framework, nuclear technologies and applications, radiation protection) and in-depth knowledge in the main nuclear security areas (prevention, detection and response), together with more advanced knowledge in elective courses that could be selected by students to obtain a specialization in certain areas of nuclear security. The design of the MSc programme is characterized by a combination of theoretical and practical sessions (e.g. demonstrations, laboratory exercises, case studies, technical visits and simulations) that should be in line with the teaching policy of the implementing university and defined by the individual academic teachers.

However, all students must satisfy the requirements for the degree determined by the individual university at the time the degree is to be awarded. This should include the preparation of an MSc thesis and its defence in an oral examination. The research topic should be selected in the area of nuclear security, according to the majority of successfully completed elective courses.

3.1. PREREQUISITES FOR AN MSc PROGRAMME

As a prerequisite for an MSc programme in nuclear security, students should hold an academic degree, e.g. a Bachelor's degree or any equivalent degree, and should have the required knowledge in mathematics and nuclear physics (see below).

— Applied mathematics, including:
  - Exponential functions (decay equations); basic probability; random variables and distributions; sampling theory; error propagation; curve fitting; regression and correlation;

— Basic nuclear physics, including:
  - Nuclear excitation, ionization, characteristic X-rays; bremsstrahlung; radioactivity (nuclear stability, unstable nuclei, radionuclides, table of radionuclides); radioactive decay (decay constant, mean life, activity, units, alpha and beta decay, decay chains; spontaneous fission); nuclear reactions (type of reactions, cross-sections, induced radioactivity, fission and fusion, fission products, fission neutrons and prompt gamma, chain reaction).

3.2. PRE-THESIS PRACTICE

Pre-thesis practice should provide practical experience in future nuclear security duties and practical implementation of nuclear security systems and methods aiming at preventing, detecting and responding to incidents involving potential or actual malicious use of nuclear or other radioactive material. The practice could be performed in a security office of a nuclear facility, at an emergency response organization, with law enforcement agencies, such as customs authorities, or at the university under the supervision of a university professor or an experienced nuclear security officer approved by the university. Pre-thesis practice should be performed according to a work plan including elements of analysis, design, evaluation and practical implementation in the selected nuclear security area(s). Depending on the university policy, the pre-thesis practice could be arranged as a separate project or as part of the MSc thesis. A report of the practical work is expected to be presented upon completion of the pre-thesis practice and could be part of the MSc thesis.

3.3. LIST OF COURSES

The list of courses of the proposed MSc programme in nuclear security is indicated below and described in detail in Appendix I. It is recommended that students successfully complete the 12 required courses and, in addition, select courses from the 11 elective courses so that the total number of hours[5] is fulfilled for each semester according to the recommendations in Section 3.5.

[5] In this publication, one hour represents one hour of class.

To allow more flexibility for States with different levels of nuclear activities, elective course NS16 consists of two parts: 16(a) Physical protection systems for nuclear[6] and other radioactive material,[7] sources[8] and facilities, for States with nuclear activities; and 16(b) Physical protection systems for radioactive material and sources, which is suitable for States with limited or no nuclear activities.

3.3.1. Prerequisite courses

— NS.PR1. Applied mathematics;
— NS.PR2. Basic nuclear physics.

3.3.2. Required courses

— NS1. Introduction to nuclear security;
— NS2. International and national legal framework regulating nuclear security;
— NS3. Nuclear energy, nuclear fuel cycle and nuclear applications;
— NS4. Methods and instruments for nuclear and other radioactive material measurements;
— NS5. Effect of radiation, safety and radiation protection;
— NS6. Threat assessment;
— NS7. Physical protection systems design and evaluation;
— NS8. Physical protection technologies and equipment;

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[6] *Nuclear material*: Plutonium, except that with isotopic concentration exceeding 80% in plutonium-238; uranium-233; uranium enriched in the isotope 235 or 233; uranium containing the mixture of isotopes as occurring in nature other than in the form of ore or ore residue; or any material containing one or more of the foregoing. (GC(49)/17; see footnote 4).

[7] *Radioactive material*: Nuclear material and other radioactive substances which contain nuclides which undergo spontaneous disintegration (a process accompanied by emission of one or more types of ionizing radiation, such as alpha, beta, neutron particles and gamma rays) and which may, owing to their radiological and fissile properties, cause death, serious bodily injury, or substantial damage to property or to the environment (Article I, International Convention for the Suppression of Acts of Nuclear Terrorism).

[8] *Radioactive sources*: Radioactive material that is permanently sealed in a capsule or closely bonded, in a solid form and which is not exempt from regulatory control. It also means any radioactive material released if the radioactive source is leaking or broken, but does not mean material encapsulated for disposal, or nuclear material within the nuclear fuel cycles or research and power reactors (INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

— NS9. Security of nuclear and other radioactive material in transport;
— NS10. Detection of criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control;
— NS11. Interdiction of, and response to, criminal or unauthorized acts involving nuclear and other radioactive material;
— NS12. Crime scene investigation and forensic techniques.

3.3.3. Elective courses

— NS13. Nuclear material accountancy and inventory control of other radioactive material;
— NS14. Vulnerability assessment of physical protection systems;
— NS15. Risk assessment and management of State nuclear security measures;
— NS16(a). Physical protection systems for nuclear and other radioactive material, sources and facilities;
— NS16(b). Physical protection systems for radioactive material and sources;
— NS17. Import/export and transit control mechanism and regime;
— NS18. Nuclear security at major public events;
— NS19. Nuclear forensics and attributions;
— NS20. Infrastructure and procedures for detection and response to incidents involving nuclear or other radioactive material out of regulatory control;
— NS21. Cooperation of stakeholders at national and international level;
— NS22. IT/cyber security.

3.4. PROPOSED SCHEDULE FOR AN MSc PROGRAMME

In an MSc programme of four semesters, it is recommended that the courses listed in Tables 1–4 be combined to last about 200 hours in each semester. The first two semesters are designated to the core courses, the third semester to the elective courses, and the fourth semester to the pre-thesis practice and thesis preparation. The sequencing of courses needs to be carefully considered for prior knowledge requirements (see the flow chart below showing the interconnection of MSc courses). On the basis of the principles discussed above, the following schedule of courses is proposed.

Prerequisite courses:

— NS.PR1 — Applied mathematics (16 hours);
— NS.PR2 — Basic nuclear physics (16 hours).

TABLE 1. FIRST SEMESTER (208 HOURS): REQUIRED COURSES

NS1. Introduction to nuclear security (16 hours)
NS2. International and national legal framework for nuclear security (16 hours)
NS3. Nuclear energy, nuclear fuel cycle and applications (32 hours)
NS4. Methods and instruments for nuclear and other radioactive material measurements (48 hours)
NS5. Effects of radiation, safety and radiation protection (32 hours)
NS6. Threat assessment (32 hours)
NS7. Physical protection systems design and evaluation (32 hours)

TABLE 2. SECOND SEMESTER (192 HOURS): REQUIRED COURSES

NS8. Physical protection technologies and equipment (48 hours)
NS9. Security of nuclear and other radioactive material in transport (16 hours)
NS10. Detection of criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control (48 hours)
NS11. Interdiction of, and response to, criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control (48 hours)
NS12. Crime scene investigation and forensic techniques (32 hours)

TABLE 3. THIRD SEMESTER (192 HOURS): ELECTIVE COURSES

Students chose elective courses for their specialization from NS13–NS22.
NS13. Nuclear material accountancy and control of radioactive material (32 hours)
NS14. Vulnerability assessment of physical protection systems (32 hours)
NS15. Risk assessment and management of State nuclear security measures (32 hours)
NS16(a). Physical protection systems for nuclear and other radioactive material, sources and facilities (16 hours)
NS16(b). Physical protection systems for radioactive material and sources (16 hours)
NS17. Import/export and transit control mechanism and regime (32 hours)
NS18. Nuclear security at major public events (32 hours)
NS19. Nuclear forensics and attributions (32 hours)
NS20. Infrastructure and procedures for detection and response to incidents involving nuclear or other radioactive material (32 hours)
NS21. Cooperation of stakeholders at the national and international levels (16 hours)
NS22. IT/cyber security (16 hours)

TABLE 4. FOURTH SEMESTER (192 HOURS): PRE-THESIS PRACTICE AND RESEARCH/THESIS PREPARATION

Pre-thesis practice — secondment to nuclear security organizations Thesis preparation — xx hours of directed research with written and oral presentations/ examination

Figure 1 illustrates the interconnection between the individual courses of the MSc programme.

4. CERTIFICATE PROGRAMME IN NUCLEAR SECURITY

The availability of qualified specialists in all areas of nuclear security is essential for the establishment of a nuclear security regime in a State. As experienced in other technical areas, the certificate programme in nuclear security could be developed by various institutions, such as universities under their continuing educational programmes, professional societies or governmental organizations.

The prerequisites for participating in a certificate programme in nuclear security should be determined by the respective university or academic institution. In addition, applicants aiming to undertake the certificate programme should have sufficient background knowledge or relevant working experience to be able to follow the course, as per the requirements of the university or academic institution. The recommended prerequisite courses for the participation in the certificate programme are the same as for the MSc programme. The recommended duration of the certificate programme is 16 weeks, which corresponds to a typical university semester. The proposed certificate programme is flexible enough to tailor duration and course contents to the specific nuclear security training needs of individual States.

For the participants of the certificate programme in prevention, detection of and response to malicious acts involving nuclear and other radioactive material, the MSc programme has been modified to fit into 16 weeks of lectures and practical exercises. For this purpose, the duration of the MSc courses selected for the certificate programme could be reduced to 16 hours, while the structure of the list of the individual certificate programme courses remains similar to the MSc programme, including core courses recommended for all participants of the programme, and additional courses that include courses to be selected by the programme developers to offer specialization.

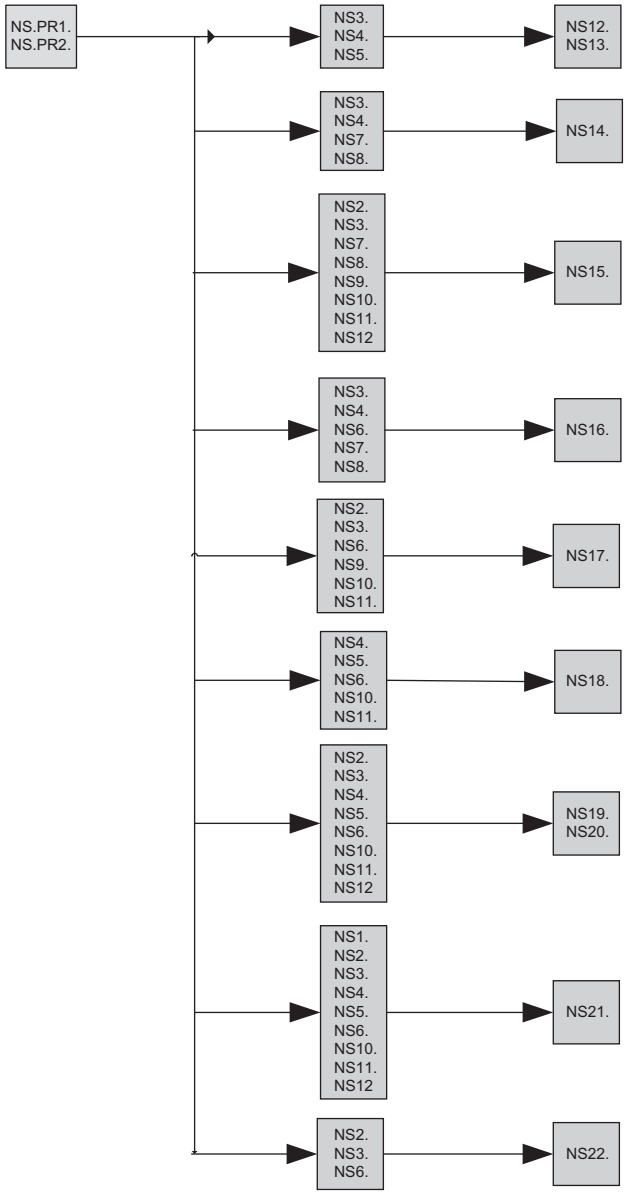

FIG. 1. The interconnection between different MSc courses.

This would produce certified specialists with an overview of all areas in nuclear security and, at the same time, individuals with solid knowledge in a particular topic. Fitting the certificate programme into 16 weeks can be achieved by either maintaining only essential topics of some courses, or keeping all topics in other courses but advising lecturers to reduce teaching hours by focusing on the essential information. This type of syllabus that contains almost all MSc programme courses in modified and/or reduced versions would provide maximum flexibility for creating certificate programmes to satisfy various needs.

It is expected that participants successfully complete 15 courses in total from the list below — 12 core courses and three additional courses selected by the programme developers according to States' needs and identified specialization in nuclear security.

4.1. CORE COURSES

- NS.M1. Introduction to nuclear security;
- NS.M2. International and national legal framework regulating nuclear security;
- NS.M3. Nuclear energy, nuclear fuel cycle and nuclear applications;
- NS.M4. Methods and instruments for nuclear and other radioactive material measurements;
- NS.M5. Effect of radiation, safety and radiation protection;
- NS.M6. State threat assessment and information security;
- NS.M7. Physical protection systems design and evaluation;
- NS.M8. Physical protection technologies and equipment;
- NS.M9. Security of nuclear and other radioactive material in transport;
- NS.M10. Detection of criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control;
- NS.M11. Interdiction of, and response to, criminal or unauthorized acts involving nuclear and other radioactive material;
- NS.M12. Crime scene investigation and forensic techniques.

4.2. ADDITIONAL COURSES

- NS.M13. Nuclear material accountancy and inventory control of other radioactive material;
- NS.M14. Vulnerability assessment of physical protection systems;
- NS.M15. Risk assessment and management of State nuclear security measures;

— NS.M16. Physical protection systems for nuclear facilities, radioactive material and sources;
— NS.M17. Import/export and transit control mechanism and regime;
— NS.M18. Nuclear security at major public events;
— NS.M19. Nuclear forensics and attributions;
— NS.M20. Infrastructure and procedures for detection and response to incidents involving nuclear or other radioactive material out of regulatory control;
— NS.M21. Cooperation of nuclear security stakeholders at the national and international level.

Appendix I

RECOMMENDED COURSES FOR AN MSc PROGRAMME IN NUCLEAR SECURITY

This appendix contains a detailed description of recommended prerequisites (Section I.1), required courses (Section I.2) and electives courses (Section I.3) for an MSc programme in nuclear security. It provides the course title, objectives and short description of each course, and lists the different course modules reflecting the main topics that are recommended to be covered.

I.1. PREREQUISITE COURSES

A. Course title

NS.PR1. Applied mathematics

B. Course objectives

Upon the successful completion of this course, students should be able to apply probability theory and mathematical statistics required for solving applied problems in nuclear material measurement and evaluation, optimization and risk assessment in physical protection systems design.

C. Short description

This course will include basic propositions of probability theory and mathematical statistics, avoiding excessive detail and complex mathematical expositions. The students will acquire basic definitions and theories concentrating on probability distributions, uncertainty assessment, statistical hypotheses and curve fitting required for probabilistic analysis in risk assessment and for radiation measurements.

D. Main modules

NS.PR1.1. Basic probability

— Random experiments;
— Concept of probability;
— Independent events.

NS.PR1.2. Random variables and distributions

— Random variable and distributions functions for random variables;
— Independent random variables;
— Distribution of functions of random variables.

NS.PR1.3. Special probability distributions

— Binomial distributions;
— Bernoulli trials;
— Poisson distributions;
— Normal distributions;
— Central limit theorem;
— Chi-square distribution;
— Other distributions.

NS.PR1.4. Sampling theory

— Random sample and random numbers;
— Sampling statistics;
— Sampling distributions;
— Sample means;
— Sampling distribution of means;
— Sample variances;
— Sampling distribution of variances.

NS.PR1.5. Estimation theory

— Point estimates and interval estimates;
— Reliability;
— Confidence intervals for means;
— Confidence interval in normal distribution;
— Error propagation.

NS.PR1.6. Tests of hypotheses and significance

— Statistical decisions;
— Statistical hypotheses;
— Level of significance;
— Test of significance for large and small samples;
— Chi-square test.

NS.PR1.7. Curve fitting, regression and correlation

— Curve fitting;
— Regression;
— Method of least squares;
— Standard error of estimate;
— Linear correlation coefficient;
— Correlation and dependence.

E. Practical exercises for NS.PR1

It is expected that examples of practical implementation of study material will be provided during each lesson and short practical exercises/tasks will be proposed for homework.

F. Laboratory work

No laboratory work is foreseen for this course.

A. Course title

NS.PR2. Basic nuclear physics

B. Course objectives

Upon the successful completion of this course, students should have basic knowledge of nuclear physics required to understand the nature of radiation and the principles of radiation protection in order to detect, measure and verify nuclear and other radioactive material. With the understanding acquired in this course, students should be well prepared for the topics in the specialized nuclear security courses.

C. Short description

This course will provide basic information about nuclear properties, radioactive decay, nuclear reactions and nuclear fission, including interaction of radiation with matter, which will prepare the students for the study of specialized courses in nuclear security.

D. Main modules

NS.PR2.1. Nuclear properties

— Parameters of nuclides;
— Energy levels;
— Stability of nuclei;
— Nuclear models.

NS.PR2.2. Radioactive decay

— Radioactive decay theory;
— Alpha decay;
— Beta decay, electron capture;
— Gamma decay, internal conversion;
— Radioactive decay chain, transuranic nuclei;
— Natural radioactivity.

NS.PR2.3. Interaction of radiation with matter

— Charged particles;
— Gamma rays;
— Neutrons;
— Attenuation coefficient.

NS.PR2.4. Nuclear reactions

— Types of reactions;
— Reaction cross-sections;
— Optical model;
— Direct reactions;
— Resonance reactions;
— Scattering;
— Compound nucleus reactions;
— Fusion.

NS.PR2.5. Nuclear fission

— Fission reactions, fission cross sections, fission energy;
— Spontaneous fission, fission products;
— Neutron emission, neutron moderation, delayed neutrons;
— Chain reaction.

E. Practical exercises for NS.PR2

Practical exercises will be selected by the lecturers for homework.

F. Laboratory work for NS.PR2

Laboratory work will be selected by the lecturers.

I.2. REQUIRED COURSES

A. Course title

NS1. Introduction to nuclear security

B. Course objectives

Upon successful completion of this course, students will have a broad picture of nuclear security components and their interconnections, and of the planning of nuclear security activities at the State and facility level. They will have a basic understanding of motivations and capabilities of adversaries and of counterterrorism.

C. Short description

This course focuses on the basic elements of nuclear security. It examines methods for planning and evaluating nuclear security activities at the State and facility level, establishing nuclear security culture in different types of nuclear and radiological installations, and examines information security measures.

D. Main modules

NS1.1. Nuclear security

— Basic definitions;
— Goals and objectives;
— IAEA Nuclear Security Plan;
— International cooperation.

NS1.2. Overview of the legal framework for nuclear security

— Responsibility of the State for nuclear security;
— International binding and non-binding legal instruments;
— Criminal offences.

NS1.3. Interrelationships between safety, security and safeguards

— Safety;
— Security;
— Safeguards.

NS1.4. Nuclear threat by non-State actors

— Evolution of the nuclear threat throughout history;
  • Conventional adversary acts;
  • Past nuclear threat;
  • Current nuclear threat;
— Attributes of potential adversaries;
  • Motives and goals;
  • Capabilities;
  • Opportunities;
  • Tactics and methods;
  • Funding;
  • Examples of adversaries.

NS1.5. Counterterrorism

— Counterterrorism and its instruments;
— Strategies and approaches of counterterrorism;
— Limits of military power;
— International experience in counterterrorism.

NS1.6. Chemical, biological, radiological and nuclear (CBRN) weapons

— CBRN weapons;
— Potential targets and methods of CBRN adversaries;
— Four main nuclear and radiological concerns;
  • Theft of nuclear weapon;
  • Acquisition of nuclear material and improvised nuclear device (IND) development;
  • Sabotage;
  • Development of radiological dispersal device (RDD) and radiation exposure device (RED).

NS1.7. Basic elements of nuclear security

— Prevention;
— Transport security;
— Detection;
— Response;
— Information security.

NS1.8. Planning nuclear security at the State level

— Legal instruments and State authorities related to nuclear security;
— State nuclear related infrastructure;
— State threat assessment and risk management;
— State nuclear security measures;
— Nuclear security plan;
— Malicious acts and databases.

NS1.9. Planning nuclear security of nuclear/radiological facility

— Creating a visible security policy;
— Conduct, competence, behaviour and trustworthiness of staff;
— Clear roles and responsibilities;
— Physical protection systems;
  • Design basis threat;
  • Physical protection principles, design and evaluation;
  • Response measures and communication;
— Nuclear material accounting and radioactive material inventory control;
— Contingency plans and drills.

NS1.10. Introduction to detection of, and response to, criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control

— Illicit trafficking and relevant databases;
— Detection infrastructure;
— Transport of nuclear and other radioactive material;
— Response arrangements, institutional arrangements and measures;
— Role and responsibilities of the relevant organizations.

NS1.11. Information security

— Sources of risk for nuclear security;
— Classification of information;
— Security policies and procedures;
— Encryption;
— Computer security;
— Information access techniques and control;
— Communication;
— Security zones;
— Balancing heavy control and user-friendly access.

NS1.12. Security culture: Concept and model

— The awareness of institutions and the general public on nuclear security culture;
— The establishment attitudes and beliefs in an organization;
— Behaviour of assigned personnel;
— Formal adequate working methods;
— Organizational and professional culture;
— Model for implementation of nuclear security culture at various types of organizations and institutions responsible for nuclear security.

E. Practical exercises for NS1

NS1.2–1.10. Case study: High enriched uranium (HEU) smuggling: 2003 and 2006 incidents.

NS 1.10–1.11. Case study: Review of information security and nuclear security culture at a facility.

F. Laboratory work

No laboratory work is required for this course.

G. Suggested reading for NS1

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD/NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, Vienna (1996).

INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Development, Use and Maintenance of the Design Basis Threat, IAEA Nuclear Security Series No. 10, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear Accident or Radiological Emergency, IAEA-TECDOC-1092, Vienna (1999).

INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Culture, IAEA Nuclear Security Series No. 7, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources, Standard Syllabus, Training Course Series No. 18, IAEA, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency, EPR-Exercise, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Preparation, Conduct and Evaluation of Exercises to Test Preparedness for a Nuclear or Radiological Emergency — Training Materials, EPR-Exercise/T, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-R-2, IAEA, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Preventive and Protective Measures against Insider Threat, IAEA Nuclear Security Series No. 8, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security in the Transport of Radioactive Material, IAEA Nuclear Security Series No. 9, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD HEALTH ORGANIZATION, Planning the Medical Response to Radiological Accidents, Safety Reports Series No. 4, IAEA, Vienna (1998).

International Convention for the Suppression of Acts of Nuclear Terrorism, A/59/766, United Nations, New York (2005). Nuclear Verification and Security of Material, Physical Protection Objectives and Fundamental Principles, GOV/2001/41, IAEA, Vienna (2001).

Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards, INFCIRC/540 (Corrected), Vienna (1997).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

Nuclear Verification and Security of Material — Physical Protection Objectives and Fundamental Principles, GOV/2001/41, IAEA, Vienna (2001).

The Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4 (Corrected), IAEA, Vienna (1999).

The Standard Text of Safeguards Agreements in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, GOV/INF/276, IAEA, Vienna (1974). (GOV/INF/276/Mod.1) (GOV/INF/276/Mod.1/Corr.1)

The Structure and Content of Agreements between the IAEA and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/153 (Corrected), Vienna (1972).

Treaty on the Non-Proliferation of Nuclear Weapons, IAEA, INFCIRC/140, IAEA, Vienna (1970).

A. Course title

NS2. International and national legal framework for nuclear security

B. Course objectives

Upon the successful completion of this course, students should have knowledge of the concepts and main features of the international legal instruments and required national legal regimes regulating nuclear security. They should also understand the role of international organizations related to nuclear security.

C. Short description

This course provides an overview of the relevant international binding and non-binding legal instruments, and the international organizations involved in nuclear security issues. It will focus on the elements of a national legal framework for nuclear security, including the elements required to fulfil the relevant criminal justice obligations under the aforementioned instruments. It will aim to promote knowledge and understanding of the diversity of legal problems and issues related to nuclear security. Particular emphasis will be placed on practical guidelines for developing a national regulatory system for the authorized use of nuclear and other radioactive material.

D. Main modules

NS2.1. Role of law in implementing nuclear security

NS2.2. History and role of international organizations and programmes related to nuclear security and the United Nations Global Counter Terrorism Strategy

— United Nations Security Council (UNSC);
  - UNSC 1540 Committee;
  - Counter Terrorism Committee;

— International Atomic Energy Agency (IAEA) ;
  - IAEA Nuclear Security Plans (including development and status of Nuclear Security assistance programme;
  - Interrelationships between safety, security and safeguards;
  - ITDB reporting system;

— United Nations Office on Drugs and Crime (UNODC);
  • Global project against terrorism;
  • Other relevant organizations and entities.

NS2.3. International legal framework for nuclear security

Selected binding international instruments

— Convention on the Physical Protection of Nuclear Material (CPPNM) (1980) and its Amendment (2005);
— International Convention for the Suppression of Acts of Nuclear Terrorism (UNGA Resolution 59/290) (2005);
— United Nations Security Council Resolution 1373 (2001), Threats to international peace and security caused by terrorist acts;
— United Nations Security Council Resolution 1540 (2004), Non-proliferation of weapons of mass destruction;
— Treaty on the Non-Proliferation of Nuclear Weapons (NPT);
— Regional nuclear-weapon-free zone treaties;
— Safeguards agreements and Model Additional Protocol;
— Other relevant instruments.

Selected non-binding international instruments

— Code of Conduct on the Safety and Security of Radioactive Sources (INFCIRC/663);
— Guidance on the Import and Export of Radioactive Sources (INFCIRC/663);
— The Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Rev.4/corrected);
— Other relevant instruments.

NS2.4. National legal framework

— National laws relevant for nuclear security;
  • Specific laws on safe, secure and peaceful use of nuclear energy and other nuclear applications;
  • General internal security laws;
  • Criminal code;
  • Export/import laws;
  • Anti-corruption laws;

— National security organizations;
  • National organizations and responsibilities;
  • State/provincial/local organizations and responsibilities;
— Regulatory framework;
  • Organizations;
  • Regulatory functions and responsibilities (standard setting, authorization/licensing, monitoring/inspection, enforcement, public information, regulatory research, other);
— Private security organizations;
  • Responsibilities;
  • Government oversight and controls;
— Transport and export/import control;
  • Licensing and authorization;
  • Customs and border controls;
  • Actions in illicit trafficking incidents (ship or aircraft boarding, etc.);
  • Seizure of material and equipment;
— Emergency response;
  • National emergency plan;
  • Organizations and responsibilities;
— Intelligence gathering and analysis;
  • Organizations and responsibilities.

NS2.5. Criminal justice aspects

— Basic principles of criminal law;
— Criminal offences;
— Criminal jurisdiction;
— The rights of detainees;
— Criminal law enforcement;
  • Investigation (evidence, subpoenas, forensics);
  • Powers of arrest and detention;
  • Prosecution;
  • Penalties;
— Mechanisms and tools for international cooperation;
  • Extradite or prosecute;
  • Mutual legal assistance.

E. Practical exercises for NS2

NS2.3. Case study: Required nuclear security at a nuclear research reactor (depends on infrastructure of the State) based on international legal instruments.

NS2.3–2.5. Case study: Act of nuclear terrorism?

F. Laboratory work

No laboratory work is required for this course.

G. Suggested reading for NS2

African Nuclear-Weapon-Free Zone Treaty, United Nations Document A/50/426, United Nations, New York (1995).

Agreement of 13 December 1991 between the Republic of Argentina, the Federative Republic of Brazil, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials and the International Atomic Energy Agency for the Application of Safeguards, INFCIRC/435, IAEA, Vienna (1994).

Communication Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment and Technology, INFCIRC254/Rev. 6/Part 2 and Rev. 7/Part 1, IAEA, Vienna (2005).

Communication Received from Members Regarding the Export of Nuclear Material and of Certain Categories of Equipment and other Material, INFCIRC/209/Rev. 1, IAEA, Vienna (1990).

Convention on International Civil Aviation 1944 (The Chicago Convention), 8th Edition, ICAO, Montreal.

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INTERNATIONAL ATOMIC ENERGY AGENCY, Statute of the International Atomic Energy Agency, IAEA, Vienna (1957, as amended up to 14 August 2007).

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INTERNATIONAL MARITIME ORGANIZATION, International Maritime Dangerous Goods Code, including Amendment 30-00, 2000 Edition, IMO, London (2000).

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Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operations (Proc. Int. Conf. Vienna, 1997), IAEA, Vienna (1998).

Safety of Transport of Radioactive Material, GOV/1998/17, IAEA, Vienna (1998).

South Pacific Nuclear Free Zone Treaty, INFCIRC/331, IAEA, Vienna (1986).

Southeast Asian Nuclear Weapon-Free Zone Treaty, Association of Southeast Asian Nations, Jakarta (1997).

The Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4 (Corrected), IAEA, Vienna (1999).

The Standard Text of Safeguards Agreements in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, GOV/INF/276, IAEA, Vienna (1974). (GOV/INF/276/Mod.1; GOV/INF/276/Mod.1/Corr.1).

The Structure and Content of Agreements between the IAEA and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/153 (Corrected), Vienna (1972).

Treaty for the Prohibition of Nuclear Weapons in Latin America, United Nations Document A/6663, United Nations, New York (1967).

Treaty on the Non-Proliferation of Nuclear Weapons, IAEA, INFCIRC/140, IAEA, Vienna (1970).

UNITED NATIONS COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS, Recommendations on the Transport of Dangerous Goods, United Nations, New York (1956).

UNITED NATIONS COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS, Recommendations on the Transport of Dangerous Goods: Model Regulations, 12th Revised Edition, United Nations, New York (2001).

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR), ECE/TRANS/140, UNECE, New York and Geneva (2001).

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID), 2001 Edition, UNECE, Geneva (2001).

UNITED NATIONS, Non-proliferation of Weapons of Mass Destruction, United Nations Security Council S/RES/1540, United Nations, New York (2004).

UNITED NATIONS, Security Council Resolution 1373, United Nations, New York (2001).

A. Course title

NS3. Nuclear energy, nuclear fuel cycle and nuclear applications

B. Course objectives

Upon the successful completion of this course, students will be able to understand basic nuclear technologies and their applications. Students will be able to outline the main physical principles and processes used in nuclear and radiological facilities, list and describe nuclear related equipment and material, and identify their application.

C. Short description

The course will provide a general overview of the most common nuclear technologies and their applications in science, industry, medicine and agriculture. Nuclear reactors, nuclear fuel cycle facilities, radioisotope production and radioisotope applications will be considered in more detail.

D. Main modules

NS3.1. Nuclear energy

- Fission and fusion reactions, neutron cross sections of uranium and plutonium isotopes, fission products;
- Neutron diffusion, neutron multiplication, chain reaction, critical mass, criticality;
- Nuclear reactors, nuclear fuel, moderators, coolants, reflectors;
- Homogeneous and heterogeneous reactor cores.

NS3.2. Nuclear reactors

- Reactivity, excess reactivity, delayed neutrons and criticality control, control rods, burnable poisons, reactivity coefficients;
- Fuel burnup, transuranium element production;
- Types of thermal reactors;
- Conversion coefficient, fast breeder reactors;
- Reactor shielding.

NS3.3. Nuclear reactor safety

— Basic principles of nuclear safety;
— Safety aspects of different reactor types;
— Operational safety;
— Accident management.

NS3.4. Nuclear fuel cycle

— Overview of fuel cycles and fuel cycle facilities;
— Uranium resources, mining, conversion;
— Uranium enrichment techniques;
— Fuel fabrication;
— Nuclear power plants;
— Spent fuel and radioactive waste management;
— Reprocessing;
— Safety at fuel cycle facilities.

NS3.5. Non-power application of nuclear technologies

— Research reactors and their application;
— Application of radionuclides in industry, geology, medicine, biology and other sectors;
— Nuclear research (nuclear physics, nuclear chemistry, etc.);
— Types of accelerators, neutron generators and their applications;
— Nuclear research equipment;
— Nuclear reactions and methods of radioisotopes production;
— Categorization of radioactive sources;
— Table of isotopes, characterization of sources.

NS3.6. Nuclear energy development

— Description of proposals for making nuclear energy development proliferation safe;
  - International fuel bank;
  - Global Nuclear Energy Partnership, International Project on Innovative Nuclear Reactors and Fuel Cycles, Generation IV International Forum;
  - International Uranium Enrichment Centre.

E. Practical exercises for NS3

NS3.2–3.3. Case study: Security aspects of different types of nuclear installations.

NS3.4. Case study: Selection of technologies and equipment for medical radioisotopes production (for given isotopes, production rate and available nuclear infrastructure.

NS3.2–3.5. Visits to nuclear facilities and installations

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS3

INTERNATIONAL ATOMIC ENERGY AGENCY, Advances in Radiation Chemistry of Polymers (Proc. Tech. Mtg Notre Dame, USA, 2003), IAEA-TECDOC-1420, IAEA, Vienna (2004).

INTERNATIONAL ATOMIC ENERGY AGENCY, Analytical Applications of Nuclear Techniques, IAEA, Vienna (2004).

INTERNATIONAL ATOMIC ENERGY AGENCY, Directory of Cyclotrons Used for Radionuclide Production in Member States, 2006 Update, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Energy, Electricity and Nuclear Power: Developments and Projections, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Irradiation as a Phytosanitary Treatment of Food and Agricultural Commodities, IAEA-TECDOC-1427, IAEA, Vienna (2004).

INTERNATIONAL ATOMIC ENERGY AGENCY, Managing the First Nuclear Power Plant Project, IAEA-TECDOC-1555, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Multilateral Approaches to the Nuclear Fuel Cycle, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Medicine Resources Manual, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Optimization of the Coupling of Nuclear Reactors and Desalination Systems, IAEA-TECDOC-1444, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Organization of a Radioisotope Based Molecular Biology Laboratory, IAEA-TECDOC-1528, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Radioisotope Handling Facilities and Automation of Radioisotope Production, IAEA-TECDOC-1430, IAEA, Vienna (2004).

INTERNATIONAL ATOMIC ENERGY AGENCY, Spent Fuel Reprocessing Options, IAEA-TECDOC-1587, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Status and Trends in Spent Fuel Reprocessing, IAEA-TECDOC-1467, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Transition from 2-D Radiotherapy to 3-D Conformal and Intensity Modulated Radiotherapy, IAEA-TECDOC-1588, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Trapping Guidelines for Area-Wide Fruit Fly Programmes, IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, Trends in Radiation Sterilization of Health Care Products, IAEA, Vienna (2008)

INTERNATIONAL ATOMIC ENERGY AGENCY, Use of Chlorofluorocarbons in Hydrology: A Guidebook, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Use of Isotope Techniques to Trace the Origin of Acidic Fluids in Geothermal Systems, IAEA-TECDOC-144, IAEA, Vienna (2005).

Nuclear Power for the 21st Century (Proc. Int. Ministerial Conf. Paris, 2005), IAEA, Vienna (2005).

A. Course title

NS4. Methods and instruments for nuclear and other radioactive material measurements

B. Course objectives

Upon the successful completion of this course, students will be able to comprehend different methods and techniques for measurement of nuclear and other radioactive material and to identify and select proper detection methods and radiation detectors and instruments.

C. Short description

The focus of this course will be on different radiation detectors and instruments, their practical applications and the value of these tools as part of a national nuclear security system. The course will provide detailed description of physical principles of the most common detectors of alpha, beta, gamma and neutron radiation, and the current detection methods for nuclear and other radioactive material. Special attention will be paid to practical application of theoretical knowledge.

D. Main modules

NS4.1. Counting statistics

— Precision and accuracy;
— Biased errors and random errors;
— Limits of detectability.

NS4.2. Radiation detectors

— Ionization chambers;
— Proportional counters;
— Geiger-Mueller counters;
— Scintillation detectors;
— Semiconductor detectors.

NS4.3. Neutron detection

— Neutron reaction, neutron moderation;
— Neutron detectors;
— Prompt and delayed neutrons;
— Detection methods;
— Neutron sources, pulse neutron sources.

NS4.4. Detection of charged particles

— Electron detection;
— Alpha particles detection and alpha spectroscopy.

NS4.5. Gamma spectroscopy

— Energy and efficiency calibration, measurements;
— Isotope identification;
— Isotopic composition measurements.

NS4.6. Activation analysis

— Selection of nuclear reaction and irradiation time;
— Sensitivity of activation analysis.

NS4.7. Destructive analysis

— Radiochemistry methods;
— Mass spectrometry;
— Particle analysis.

NS4.8. Quantitative nuclear material measurements (using neutron coincidence counting, calometry, destructive analysis, gamma spectrometry, etc.)

E. Practical exercises for NS4

NS4.2. Demonstration of radiation detectors and hands-on exercises.

F. Laboratory work

NS4.3–NS4.4. Measurement of alpha, beta, gamma and neutron sources.

NS4.5. Energy calibration of NaI and Ge detectors. Identification of unknown radiation sources.

NS4.5. Measurement of U-235 enrichment and quantity in uranium sample.

G. Suggested reading for NS4

FIRESTONE, R.B., BAGLIN, C.M., FRANK-CHU, S.Y., Table of Isotopes, 8th edn, Wiley, New York (1999).

A. Course title

NS5. Effect of radiation, safety and radiation protection

B. Course objectives

Upon completion of this course, students will be able to apply basic theoretical and practical knowledge in radiation protection and the safe handling of nuclear and other radioactive material. Students will show initial practical experience in the implementation of international recommendations and standards on radiation protection and the safe use of radioactive material.

C. Short description

The course will provide an overview of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. Focus will be on the mechanisms of different types of biological effects following exposure to ionizing radiation and methods and procedures for radiation protection.

D. Main modules

NS5.1. Quantities and measurements

— Quantities and units (radiometric quantities and interaction coefficients, dosimetric quantities, radiation protection quantities);
— Dosimetric calculations and measurements;
— Radiation detection and measurement for radiation dose control (dosimetry systems, measurement techniques).

NS5.2. Biological effects of ionizing radiation

— Effects of radiation at molecular and cellular level;
— Deterministic effects;
— Stochastic effects.

NS5.3. Principles of radiation protection and the international framework

— Radiation protection principles;
— Conceptual framework;
— Development of a safety culture.

NS5.4. Regulatory control

— Legal framework for radiation protection and safe use of radiation sources;
— Regulatory system;

NS5.5. Assessment of external and internal exposures

— Assessment of occupational exposure due to external sources of radiation;
— Point source;
— Line source;
— Area source;
— Assessment of occupational exposure due to intakes of radionuclides;
— Inhalation;
— Ingestion.

NS5.6. Protection against public exposure

NS5.7. Protection against occupational exposure

— Organization and management;
— Methods of protection and safe use of radiation sources (time, distance, shielding, and other methods);
— Individual and workplace monitoring;
— Health surveillance;
— Potential exposure;
— Protection against occupational exposure.

NS5.8. Intervention in situations of emergency exposure

— Types of events;
— Basic concepts for emergency response.

E. Practical exercises for NS5

NS5.1. Demonstration of different types of dosimeters.
NS5.6. Hands-on exercises with monitoring instruments and practical exercises related to workplace monitoring for external radiation exposure.

F. Laboratory work

NS5.8. Radiological survey and surfaces decontamination.

G. Suggested reading for NS5

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, Vienna (1996).

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS, WORLD HEALTH ORGANIZATION, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-R-2, Safety Requirements, IAEA, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Dangerous Quantities of Radioactive Material (D-Values), EPR-D-Values, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources, Standard Syllabus, Training Course Series No. 18, IAEA, Vienna (2002).

A. Course title

NS6. Threat assessment

B. Course objectives

Upon the successful completion of this course, students will be able to analyse motivations and capabilities of adversaries and have basic information about protection against terrorism. They will be able to describe the methodology and the steps in performing State nuclear threat assessments, and in developing, implementing, and maintaining design basis threat (DBT) policies. They will be able to describe the relationship between DBT policy, risk analysis and protecting against terrorism.

C. Short description

The course will provide a general description of adversaries (their tactics and methods, psychological aspects and adversary organizations), the role of threat information in developing appropriate security measures and counterterrorism methods. It will also focus on detailed study of threat assessments and DBT development and implementation.

D. Main modules

NS6.1. Threat assessment

— Definition of threats;
— Operating assumption for threat assessment;
— Range of potential generic threats;
— Threat of civil society;
— List of threat characteristics;
— Sources and analysis of threat related information;
— External threats;
— Internal threats;
— Review of actual, planned and possible threat actions;
  • Events, training events, planning for events;
  • Flagging events that are CBRN or similar;
— Review of known threat entities;

— Analysis of threat related data;
  • List of threat attributes and characteristics;
  • Confidence assigned to data and/or analysis;
— Practical application of threat assessment for malicious acts.

NS6.2. Design basis threat

— International recommendations for DBT;
— Audience for DBT;
— Roles and responsibilities;
— Screening of output of threat assessment (TA);
  • Capabilities;
  • Intentions;
— Translating specific threats in TA to generic adversary attributes and characteristics;
— Modifying generic adversary attributes and characteristics based on policy concerns;
— Assigning which attributes and characteristics are part of DBT, and which are excluded;
— Addressing other remaining credible threat attributes and characteristics that are not included in final DBT;
— DBT and another alternative threat based approach;
— Implementing DBT;
— Maintaining DBT.

NS6.3. Threat informed security: Role of threat analysis in developing adequate security measures

— Relationship between protection features and the threat;
— Graded protection;
— DBT approach versus alternatives.

E. Practical exercises for NS6

NS6.1. Case study: Threat assessment for a facility (nuclear or radiological facility).

NS6.2. Case study: DBT development for a State.

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS6

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Development, Use and Maintenance of the Design Basis Threat, IAEA Nuclear Security Series No. 10, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

The Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

A. Course title

NS7. Physical protection systems design and evaluation

B. Course objectives

Upon the successful completion of this course, students will be able to present and discuss the fundamental principles of a physical protection, plan and implement the process of physical protection system (PPS) design, and design and evaluate PPSs for different types of nuclear installations and facilities.

C. Short description

The course will provide all important elements of the process of PPS design, such as target identification, PPS evaluation approaches, response and communication, vulnerability assessment, performance testing, operating principles and contingency plan. Definition of system requirements and physical protection system design and evaluation will be described in detail. Some theoretical parts of the course will be supported by practical exercises.

D. Main modules

NS7.1. Fundamental principles of physical protection

— Roles and responsibility of international, national, local authorities and operators;
— State threat evaluation;
— Physical protection requirements, graded approach;
— Concept of several layers and methods, defence in depth, balanced protection, no single point failures, redundant equipment;
— Quality assurance;
— Emergency plan;
— Confidentiality.

NS7.2. Overview of process of system design and evaluation

— Definition of system objectives and requirements;
— Facility characteristics;
— Target identification;
— Threat assessment and risk management;
— Consequences analysis;

— Design of physical protection system;
— Evaluation of PPS design.

NS7.3. Target identification

— Basic concepts;
— Techniques for target identification;
— Target identification for nuclear or radiological facilities;
— Fault trees and target list for a facility.

NS7.4. Approaches to defining security measures

— Prescriptive based approach;
— Performance based approach;
— Combined approach;
— Additional protective measures.

NS7.5. System requirements

— Categorization of nuclear material and physical protection requirements;
— Consequences analysis, radiological consequences of sabotage;
— Risk equation;
— Threat assessment and DBT;
— Trade-off and policy factors in use of DBT for PPS design;
— Maximum adversary threat against which PPS is reasonably assured;
— PPS effectiveness;
— Metrics;
— Performance and prescriptive approaches.

NS7.6. Design of physical protection system

— Effective measures for detection, delay and response;
— Physical protection plan;
— PPS functions;
— Design elements and criteria;
— Principle of timely detection and critical detection point;
— Design of PPS.

NS7.7. Response and communication

— Role and arrangement of response forces;
— Rules of engagement;
— Communication to response forces;
— Performance measures;
  • Response force time;
  • Probability of communication;
  • Probability of neutralization.

NS7.8. Vulnerability assessment

— Risk assessment;
— Quantitative and qualitative evaluation analysis;
— Path and scenario analysis;
— System effectiveness;
— Use of evaluation results.

NS7.9. Performance tests

— Test strategies and planning;
— Sampling plans;
— Detection and confidence levels.

NS7.10. Contingency plan

— Goals of contingency plan;
— Development of contingency plan;
— Guidance to licensee personnel in case of threat, theft or sabotage;
— Identification of required resources;
— Response exercises;
— Communication to the public.

NS7.11. Operating principles of PPS

— Implementation of PPS at any stage of its life;
— Inspection and enforcement regime, compliance with licence;
— Insurance of required quality and performance.

NS7.12. Physical protection inspections at nuclear facilities

— Inspection fundamentals;
— Inspection at site;
  • Regulatory documentation;
  • Access to the site;
  • Access control system operation;
  • Perimeter detection devices;
  • Physical barriers;
  • Internal detecting devices;
  • Closed circuit TV system;
  • PPS communication system;
  • Information collection, processing and display systems;
  • Functional tests.

E. Practical exercises for NS7

NS7.5. Case study: Identification of physical protection requirements and objectives for a hypothetical nuclear facility.

NS7.6. Case study: Design of a physical protection system according to the previously identified requirements.

NS7.8. Case study: Evaluation of the previously designed physical protection system of the facility.

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS7

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance and Consideration for the Implementation of INFCIRC/225/Rev.4, IAEA-TECDOC-967, (Rev.1), IAEA, Vienna (2000).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operations (Proc. Int. Conf. Vienna, 1997), IAEA, Vienna (1998).

The Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4, (Corrected), IAEA, Vienna (1999).

A. Course title

NS8. Physical protection technologies and equipment

B. Course objectives

In this course, students will acquire an in-depth understanding of current technical methods, sensors and instruments in physical protection and will learn how to select the appropriate equipment to satisfy the requirements for different physical protections systems.

C. Short description

In this course, the main focus will be on different physical principles, technical methods and instruments used in physical protection systems. Theoretical study will be combined with intensive demonstrations of the different technical instruments and practical exercises in the laboratories.

D. Main modules

NS8.1. Function of physical protection system

— Deterrence;
— Detection;
— Assessment;
— Delay;
— Response.

NS8.2. Intrusion detection

— Performance characteristics;
  - Probability of detection;
  - Nuisance alarm rate;
  - Vulnerability to defeat;
— Sensors classification;
  - Active/passive;
  - Cover-visible;
  - Volumetric line of detection;
  - Application.

NS8.3. Sensors

- — Sensor application;
  - Buried line sensors;
  - Fence associated sensors;
  - Freestanding sensors;
- — Perimeter sensor systems;
  - Design concept and goals;
  - Combination and configuration of sensors;
  - Site specific systems;
  - Environmental effects and sensor selection;
- — Boundary penetration sensors;
- — Electromechanical sensors;
- — Passive sonic sensors;
- — Active infrared sensors;
- — Fibre optic cable sensors;
- — Interior motion sensors;
- — Microwave sensors;
- — Passive infrared sensors
- — Dual technology sensors;
- — Pressure sensors;
- — Proximity sensors;
- — Other sensors.

NS8.4. Integration of physical protection systems

- — Selection and integration of different sensors;
- — Integration with video assessment systems;
- — Integration with access delay systems.

NS8.5. Alarm communication and display

- — Performance measures;
  - Probability of assessed detection;
  - Operator workload;
- — Alarm reporting systems;
- — Alarm communication systems;
  - Communication architecture;
  - Transmission methods;
  - Communication security;

— Alarm display and ergonomics;
— Alarm processing;
— Additional design considerations.

NS8.6. Alarm assessment

— Performance measures;
  • Probability of assessment;
  • Light to dark ratio;
  • Resolution;
— Alarms assessment systems;
— Video alarm assessment system;
  • Video camera and lens;
  • Resolution and field of view;
  • Lighting systems;
  • Video transmission;
  • Real time surveillance;
— Additional design considerations;
— Alarm assessment by response force.

NS8.7. Entry control

— Performance measures;
  • Probability of detection;
  • Nuisance alarm rate;
  • False alarm rate;
  • Vulnerability to deceit;
  • False accept/false reject rates;
— Personal identity verification;
— Personal tracking;
— Credentials;
— Biometric identification and verification;
— Access control.

NS8.8. Contraband detection

— Performance measures;
  • Probability of detection;
  • False alarm rate;
  • Vulnerability to deceit;

— Criteria;
— Detectors and scanners;
— Bulk and trace explosive detection;
— Nuclear material detection.

NS8.9. Access delay

— Performance measure;
  • Time to defeat barrier (as a function of barrier material and tools);
— Role of access delay;
  • After detection;
— Passive/fixed barriers;
— Active/dispensable barriers;
— System configuration.

NS8.10. Response force equipment

— Communication equipment;
— Weapon, protection gears;
— Other equipment.

E. Practical exercises for NS8

NS8.3. Case study: Selection of sensors for the research reactor perimeter (according to provided drawings and descriptions).

NS8.3. Case study: Selection of sensors for the research reactor control room, fresh and spent fuel storages (according to provided drawings and descriptions).

NS8.3.–8.9. Practical exercise: Selection of required equipment, design and evaluation of physical protection system satisfying the described requirements.

F. Laboratory work

NS8.3. Familiarization with sensors. Sensitivity level of selected sensors;
NS8.5. Review of video images. Alarm assessment.

G. Suggested reading for NS8

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance and Consideration for the Implementation of INFCIRC/225/Rev.4, IAEA-TECDOC-967, (Rev.1), IAEA, Vienna (2000).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

Physical Protection of Nuclear Materials: Experience in Regulation, Implementation and Operations (Proc. Int. Conf. Vienna, 1997), IAEA, Vienna (1998).

The Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4, (Corrected), IAEA, Vienna (1999).

A. Course title

NS9. Security of nuclear and other radioactive material in transport

B. Course objectives

Upon the successful completion of the course, the students will be able to outline international transport security requirements, use practical guidelines for developing security measures for transportation of nuclear and other radioactive material, and select and implement transport security technologies.

C. Short description

The course is based on the IAEA training courses on transport security prepared and conducted with assistance of IAEA Member States. It will provide a comprehensive description of international transport security and safety requirements and regulations, and practical measures for transport security arrangements, including definitions of security measures, preparation of a security plan and selection of required security technologies.

D. Main modules

NS9.1. Objectives of transport security

— Aspects of transport security;
— Types of threats;
— Possible consequences;
— Guidance on security in transport.

NS9.2. International and national requirements and guidance

— International legal instruments for nuclear and other radioactive material;
— State responsibilities;
— Cooperation with other States and the IAEA;
— International institutions for transport security (ICAO, IMO, UNECE, WNTI);
— Physical protection of nuclear material;
— Transport of dangerous goods;
— Security of radioactive sources;
— Radioactive material transport security.

NS9.3. Transport regulations

— IAEA transport security guidelines for radioactive material;
— Transport indexes and relevant security levels;
— Safety of radioactive material transport;
— Package preparation;
— Licensing;
— International transport container database.

NS9.4. Security of nuclear and other radioactive material during transport

— Security levels and categories of packages;
— Customs information database;
— State and operator's responsibilities;
— General security principles for security regime development;
— Activity thresholds for radioactive packages;
— Security provisions (security level, security locks, training, personnel identity, tracking, communication, security plans, notification, etc.);
— International shipment.

NS9.5. Transport security plan

— Objectives and contents of transport security plan;
— Administrative requirements;
— Description of security system (planned and alternate routes, communication, positional tracking, etc.);
— Response planning.

NS9.6. Transport security technologies

— Cargo and escort vehicles;
— Transport security technologies (e.g. sensors, alarms, communication, delayed access, remote disablement).

E. Practical exercises for NS9

NS9.5. Tabletop exercise: Identification of security measures and preparation of transport security plan for transportation of irradiated high enriched uranium (HEU) fuel assemblies from the storage facility.

F. Laboratory work

No laboratory work is required for this course.

G. Suggested reading for NS9

Convention for the Suppression of Unlawful Acts against the Safety of Civil Aviation, Montreal (1971).

Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, Rome (1988) and Protocol (2005).

Convention for the Suppression of Unlawful Seizure of Aircraft, The Hague (1970).

Convention on International Civil Aviation 1944, The Chicago Convention, 8th Edition, ICAO, Montreal.

Convention on Offences and Certain Other Acts Committed on Board Aircraft, Tokyo (1963).

INTERNATIONAL ATOMIC ENERGY AGENCY, Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series No. TS-G-1.1 (ST-2), IAEA, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators, IAEA Nuclear Security Series No. 3, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transportation of Radioactive Material, IAEA Safety Standards Series No. TS-R1 (ST-1, RV), IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security in the Transport of Radioactive Material, IAEA Nuclear Security Series No. 9, IAEA, Vienna (2008).

INTERNATIONAL MARITIME ORGANIZATION, International maritime Dangerous Goods Code, including Amendment 30-00, 2000 Edition, IMO, London (2000).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

Safety of Transport of Radioactive Material, GOV/1998/17, IAEA, Vienna (1998).

The Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

UNITED NATIONS COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS, Recommendations on the Transport of Dangerous Goods, United Nations, New York (1956).

UNITED NATIONS COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS, Recommendations on the Transport of Dangerous Goods: Model Regulations, 12th Revised Edition, United Nations, New York (2001).

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR), ECE/TRANS/140, UNECE, New York and Geneva (2001).

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE, Regulations Concerning the International Carriage of Dangerous Goods by Rail (RID), 2001 Edition, UNECE, London (2001).

A. Course title

NS10. Detection of criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control

B. Course objectives

Upon the successful completion of this course, students will be able to explain and apply the principles of detection of criminal or unauthorized acts involving nuclear and other radioactive material, which is an important element of a comprehensive nuclear security system. Students will be able to outline the main detection systems and make recommendations for prevention and detection strategies at borders, strategic points and other locations of importance. In addition, students will be able to comprehend the design features, the procedures for performance monitoring and the sustainability of detection systems.

C. Short description

This course will emphasize the need for a robust second line of defence in a State, i.e. effective capabilities to detect and interdict unauthorized movement of nuclear and other radioactive material both at borders and within the State. The course will provide the fundamental components necessary for developing and implementing effective detection strategies and for maintaining detection systems.

D. Main modules

NS10.1. Introduction to detection of criminal and unauthorized acts

— Detection systems;
  - Radioactive detection by instruments;
  - Intelligence gathering and assessment;
  - Medical symptoms;
  - Regulatory non-compliance including loss of control through theft;
  - Others;

— Types of detection instrumentation;
  - Fixed radiation portal monitors (RPMs);
  - Personal radiation detectors (PRDs);
  - Hand held radionuclide identification devices (RIDs);
  - Hand held neutron search detectors (NSDs);
  - Active detection systems;
  - Others;

— Purpose of instruments;
  - Detection;
  - Assessment and localization;
  - Identification;
  - Search and survey.

NS10.2. Implementation strategy for the deployment of radiation detection equipment at:

— Land borders;
— Seaports;
— Airports;
— International mail;
— Internal strategic locations;
— Other locations of importance.

NS10.3. Radiation searches and surveys

— Equipment for radiation searches and surveys;
— General search and survey procedures;
  - Radiation surveys;
  - Background mapping;
  - Principles of search operations;
  - Pedestrian search;
  - Package and cargo search;
  - Transport vehicle search (cars, trucks, airplanes, ships and other modes and means of transport).

NS10.4. Control of legal shipments of nuclear and other radioactive material

— Threat of illegal transport of nuclear and other radioactive material during declared shipments;
  - Falsification of transport declarations at border;
  - Substitution of one type of radioactive material by another;
  - Addition of illicit nuclear material into legal shipment;
  - Falsification of quantity and quality of radioactive material in the customs declaration, etc.;
— Verification of transport documents, documents identity (licences, container certificates, transport documents) and use of documents database;
— Verification of transport category and transport index;
— Verification of declared content in the container.

NS10.5. Illicit trafficking in nuclear and other radioactive material

— Basics on illicit trafficking;
— Obligations of front-line officers related to combating illicit trafficking in nuclear and other radioactive material;
— Need for detection infrastructure within a country, including intelligence resources and State level trafficking information;
— Effective mechanisms to prevent illicit trafficking in nuclear and other radioactive material;
— Effective detection systems at border crossings and other strategic locations;
— Need for technical support and systematic process for human resource development in the area of radiation detection.

NS10.6. Design specifications and sustainability of detection systems

— Selection of instruments and design specifications;
— Procurement and acceptance tests;
— Performance monitoring;
— Preventive and corrective maintenance;
— Extending the life span of detection systems.

NS10.7. Detection response and verification of instruments alarms

— Basic principles for responding to a radiation instrument alarm;
— Types of instrument alarm;
— Investigation levels and instrument alarm settings and thresholds;
— Evaluation of alarms and procedures for response to instrument alarms;
  • Monitoring of pedestrians and their luggage;
  • Monitoring of vehicles;
  • Developing procedures for secondary inspection;
— Technical support for verification of alarms;
— Notification of events.

E. Practical exercises for NS10

NS10.2. Demonstration of deployment and operation of radiation detection equipment at land borders, seaports, airports, and other locations of importance.

NS10–NS10.6. Tabletop and field exercises: Detection response procedures to be implemented in different cases.

NS10.3. Hands-on exercises: Operation of hand-held devices to locate and identify hidden source in a vehicle.

F. Laboratory work

NS10.1. Familiarization with portal radiation monitors.
NS10.1. Familiarization with hand-held radiation detection equipment.
NS10.1. In-field use of spectroscopic techniques.

G. Suggested reading for NS10

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Identification of Radioactive Sources and Devices, IAEA Nuclear Security Series No. 5, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators, IAEA Nuclear Security Series No. 3, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

UNITED NATIONS, Non-proliferation of Weapons of Mass Destruction, United Nations Security Council S/RES/1540, United Nations, New York (2004).

UNITED NATIONS, Security Council Resolution 1373, United Nations, New York (2001).

A. Course title

NS11. Interdiction of, and response to, criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control

B. Course objectives

Upon the successful completion of this course, students will be able to identify and apply the operational requirements and techniques for interdicting and responding to criminal or unauthorized acts involving nuclear and other radioactive material.

C. Short description

In this course, emphasis will be placed on interdiction of, and response to, criminal or unauthorized acts involving nuclear and other radioactive material. The course will contain a detailed description of all aspects of interdiction and response including radiation detection instrumentation and personal protective equipment, characterization of the scene, response management and emergency procedures, radiological assessment, contamination control and medical first aid.

D. Main modules

NS11.1. Introduction

— Regulations overview;
— Regulator role;
— Response organizations;
— National response plan;
— Crime scene operations;
— International requirements.

NS11.2. Response to alarms

— Response to instrument alarms;
— Response to alarm by intelligence gathering and assessment;
— Response to alarm as a result of nuclear and radioactive material being out of regulatory control;
— Response to alarm by notification of nuclear security event.

NS11.3. Interdiction of criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control

— Interdiction at the facility level;
— Interdiction at borders;
— Interdiction in transport;
— Interdiction at strategic locations;
— Technical support and reachback to experts.

NS11.4. Response management

— Priorities;
— Response organizations;
— Prompt response plan;
— Readiness.

NS11.5. Emergency procedures and preparedness

— Basic elements and responsibilities;
— Emergency response plan;
— Taking mitigating and protective action;
— Required infrastructure;
— Coordination of emergency response;
— Preparedness.

NS11.6. Application of detection and personal protective equipment during interdiction

— Ambient gamma measurement;
— Surface contamination measurement;
— Air contamination measurement;
— Isotope identification;
— Dosimeters and dose assessment;
— Personal protective equipment (PPE);
— Respiratory protection.

NS11.7. Seizure of radioactive material

— Radiation protection measures;
— Investigation and collection of evidence;

— Temporary storage and transport;
— Notification and return to under regulatory control.

NS11.8. Medical response

— Priorities;
— Precautions;
— Transfer to the hospital;
— Follow-up.

NS11.9. Informing the public

— Media relations and strategy;
— Media reception point;
— Communication methods;
— Written press releases;
— Electronic media;
— Needs and operations of press offices.

NS11.10. Prosecution

— Legal provisions under national legislation;
— Roles and strategies of key national governments agencies;
— Processes and methods for collecting, documenting and preserving evidence for prosecution.

NS11.11. Consequence management

— Assessment of, search for, and identification and neutralization of RDDs;
— Dispersion of radioactive material, basics of incident management system including assessment, rescue, recovery and restore;
— Recovery and return of nuclear and other radioactive material under regulatory control;
— Interagency cooperation and coordination;
— Legal parameters and constraints;
— Managements of mass casualties.

E. Practical exercises for NS11

NS11.6. Personal protective equipment exercise.

NS11.4–11.5. Tabletop exercise: Incident response management and emergency procedures.

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS11

INTERNATIONAL ATOMIC ENERGY AGENCY, Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, IAEA-TECDOC-1092, Vienna (1999).

INTERNATIONAL ATOMIC ENERGY AGENCY, Identification of Radioactive Sources and Devices, IAEA Nuclear Security Series No. 5, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Manual for First Responders to a Radiological Emergency, EPR-First Responders, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Method for developing Arrangements for Response to a Nuclear or Radiological Emergency, EPR-METHOD 2003, IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, Monitoring for Radioactive Material in International Mail Transported by Public Postal Operators, IAEA Nuclear Security Series No. 3, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-R-2, IAEA, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Training Material for First Responders to a Radiological Emergency, EPR-First Responders/T, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD HEALTH ORGANIZATION, Generic Procedures for Medical Response During Nuclear and Radiological Emergency, EPR-MEDICAL, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD HEALTH ORGANIZATION, Planning the Medical Response to Radiological Accidents, Safety Reports Series No. 4, IAEA, Vienna (1998).

INTERNATIONAL ATOMIC ENERGY AGENCY, WORLD HEALTH ORGANIZATION, Training Material for Medical Preparedness and Response to a Nuclear or Radiological Emergency, EPR-MEDICAL/T, IAEA, Vienna (2002).

UNITED NATIONS, Non-proliferation of Weapons of Mass Destruction, United Nations Security Council S/RES/1540, United Nations, New York (2004).

UNITED NATIONS, Security Council Resolution 1373, United Nations, New York (2001).

A. Course title

NS12. Crime scene investigation and forensic techniques

B. Course objectives

Upon the successful completion of this course, students should be familiar with crime scene investigation and classical and nuclear forensics. Students will be able to identify the basics of crime scene management, collection of evidence and forensic techniques, which provide essential insights into methods of production and sources of illicit radioactive material. The students' understanding of nuclear forensics will be most powerful when combined with traditional methods of investigation, including intelligence sources and traditional detective work.

C. Short description

This course has two main goals: to offer introductions to crime scene management and to forensic techniques. The available tools, techniques and methods of traditional forensics will be introduced. In particular, the course will focus on nuclear forensics, which can play a decisive role in attributing and prosecuting crimes involving radioactive material. Basic principles of nuclear forensics and nuclear forensic interpretation will be presented and discussed. The course will include lectures on international cooperation, the principles of incident response and nuclear forensics plan of action.

D. Main modules

NS12.1. Introduction to traditional forensics

— Crime scene techniques and methods;
— Traditional forensic evidence.

NS12.2. Radiological crime scene — organization and fundamental stages

— Securing the incident site;
— On-site analysis;
— Collection of radioactive evidence;

— Traditional forensics related to a radiological crime scene;
  • Inked and latent finger prints;
  • Toxicology and forensic entomology;
  • Serology, nuclear and mitochondrial DNA analysis;
  • Impression forensics: Firearms, tool marks, shoe and tire prints;
  • Document analysis and digital evidence;
— Final survey and release of scene;
— Evidence holding site;
— Transportation of evidence;
— Involvement of national regulatory authority;
— Case treatment by the national courts;
— Arrangements for safe handling of the radioactive material.

NS12.3. Nuclear forensics plan of action

— On-site action plan;
— Investigations to be foreseen at the specialized national nuclear forensics laboratory.

NS12.4. Introduction to nuclear forensics analysis and attribution

— Analytical techniques for nuclear forensics analysis;
— Source attribution;
— Route attribution;
— Forensics analysis of interdicted nuclear and other radioactive material;
— Characterization of nuclear material for source and route data.

NS12.5. International cooperation

— Nuclear Smuggling International Technical Working Group Nuclear Forensics Laboratories;
— Catalogue of radioactive sources and devices;
— Inter-laboratory forensic exercises;
— Procedure for requesting assistance in nuclear forensic investigations through the IAEA.

E. Practical exercises for NS12

NS12.1. Examples of traditional forensic evidence.
NS12.2. Examples of a statement of nuclear forensics work.

NS12.2. and NS12.3. Tabletop exercise: Transportation and storage of evidence.

F. Laboratory work

NS12.4. Determination of the source of radioactive material and its method of production.

G. Suggested reading for NS12

Advances in Destructive and Non-Destructive Analysis for Environmental Monitoring and Nuclear Forensics (Proc. Int. Conf. Karlsruhe, 2002), IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Identification of Radioactive Sources and Devices, IAEA Nuclear Security Series No. 5, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Forensics Support, IAEA Nuclear Security Series No. 2, IAEA, Vienna (2006).

I.3. ELECTIVE COURSES

A. Course title

NS13. Nuclear material accountancy and inventory control of other radioactive material

B. Course objectives

Upon the successful completion of this course, students will be able to define and describe a State system of accounting for and control of nuclear and other radioactive material. After this course, the students will become familiar with international safeguards. They will be able to arrange national nuclear accountancy and control systems at bulk and item facilities, perform national inspections and analyse and report results of physical inventory taking (PIT) as a part of broader State nuclear security measures.

C. Short description

The course will describe a national accountancy and control system, and its function at nuclear and radiological facilities. Special attention will be paid to performance of national inspections and PIT activities. This course will also focus on international safeguards, which will help students to understand the IAEA's function, and international safeguards measures and activities.

D. Main modules

NS13.1. Role and functions of national safeguards authority

— Legal basis of nuclear and other radioactive material accountancy and control;
— National and international objectives;
— Authority and responsibilities;
— Ensuring compliance;
— Licensing, inspections.

NS13.2. National nuclear material accountancy system

— Responsibilities;
— Nuclear material accountancy (measures to maintain knowledge of quantities and locations);
— Material control (access control, containment and surveillance, seals, monitoring, etc.);
— Records verification (nuclear material (NM) listing, NM transfers, inventory data, production and shipper/receiver data, etc.);
— State system of accounting for and control of the nuclear material (SSAC) information system;
— Reporting to national authority;
  • Reports of facilities;
  • Reports of customs;
  • Nuclear and other radioactive material in transit;
— State level accountancy system;
— Physical protection.

NS13.3. Nuclear material accountancy at the facilities

— Responsibilities;
— Independence from production management;
— Type of facilities, location outside facilities (LOFs), nuclear related sites;
— Facility accounting system;
— Item and bulk facilities;
— General ledger and other facility records;
— Book inventory, physical inventory, material balance area;
— Reported NM, batch, flow and inventory key measurement points, material balance period;
— Closing the NM accounting balance;
— NM process and NM movement monitoring.

NS13.4. National inspections and physical inventory taking

— National interim inspections and PIT;
— Book auditing;
— Sampling plan and types of nuclear material measurements;
— Nuclear material inventory verification;
  • Mining and conversion;
  • Enrichment facilities;
  • Fuel fabrication facilities;

  - Nuclear reactors;
  - Reprocessing facilities;
  - Waste treatment and storage facilities;
  - LOFs;
- Nuclear material flow verification;
- Uncertainties of verification results;
- Material unaccounted for (MUF);
- NM production;
- Shipper/receiver difference;
- NM loss and gain;
- Material balance evaluation;
- Cumulative MUF.

NS13.5. International safeguards

- Safeguards agreements, comprehensive safeguards, integrated safeguards;
- Subsidiary arrangement, DIQ, facility attachment;
- State reports and declarations;
  - Types of reports;
  - Inventory change reports (ICRs), physical inventory listings (PILs), material balance reports (MBRs);
  - Code 10;
  - Additional protocol declarations.

NS13.6. Safeguards evaluations

- Traditional safeguards criteria;
- State evaluation;
- Remote monitoring and satellite imagery;
- Environmental sampling;
- Evaluation of open source information;
- Safeguards conclusion; annual implementation report.

NS13.7. IAEA verification activities

- Facility and state-level safeguards approaches;
- Safeguards inspections;
- Inspection activities;
- Design information verification;
- Complementary access.

NS13.8. Safeguards measures

— Containment and surveillance measures;
— Radiation monitors;
— Unattended and remote monitoring;
— Non-destructive NM verification;
— Destructive analysis;
— Environmental sampling.

NS13.9. Control of other radioactive material

— Inspections at radioisotope production laboratories;
— Control of radioactive sources;

E. Practical exercises for NS13

NS13.3. Practical exercise to design the nuclear accountancy and control system at a nuclear reactor with associated isotope production hot cell laboratory (MBAs, control of NM production and loss, receipt of target NM, shipment of NM and radioactive sources, frequency of national inspections, PIT).

NS13.4. Practical exercise to evaluate PIT results at a bulk facility and prepare a material balance report to the State authorities including calculated values of MUF, CuMUF, SRD, nuclear loss and production.

F. Laboratory work

No laboratory work is foreseen in this course.

G. Suggested reading for NS13

INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Safeguards Glossary, International Nuclear Verification Series No. 3, IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Safeguards: Aims, Limitations, Achievements, IAEA Safeguards Information Series No. 4, IAEA, Vienna (1983).

INTERNATIONAL ATOMIC ENERGY AGENCY, IAEA Safeguards: Guidelines for States' Systems of Accounting for and Control of Nuclear Materials, IAEA, Vienna (1980).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Material Accounting Handbook, Services Series No. 15, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Safeguards Techniques and Equipment, International Nuclear Verification Series No. 1, IAEA, Vienna (2003).

INTERNATIONAL ATOMIC ENERGY AGENCY, The Evolution of IAEA Safeguards, International Nuclear Verification Series No. 2, IAEA, Vienna (1998).

Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards, INFCIRC/540 (Corrected), Vienna (1997).

Nuclear Verification and Security of Material — Physical Protection Objectives and Fundamental Principles, GOV/2001/41, IAEA, Vienna (2001).

The Agency's Safeguards System (1965, as Provisionally Extended in 1966 and 1969), INFCIRC/66/Rev. 2, Vienna (1968).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4 (Corrected), IAEA, Vienna (1999).

The Standard Text of Safeguards Agreements in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, GOV/INF/276, IAEA, Vienna (1974). (GOV/INF/276/Mod.1) (GOV/INF/276/Mod.1/Corr.1)

The Structure and Content of Agreements between the IAEA and States required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/153 (Corrected), Vienna (1972).

Treaty on the Non-Proliferation of Nuclear Weapons, IAEA, INFCIRC/140, IAEA, Vienna (1970).

A. Course title

NS14. Vulnerability assessment of physical protection systems

B. Course objectives

Upon the successful completion of this course, students will be able to perform a comprehensive evaluation and propose an optimization of different physical protection systems. Further, they will be able to perform a qualitative and quantitative risk assessment.

C. Short description

The course aims to provide students with knowledge of system analysis, risk management, evaluation and optimization methods and their application for physical protection systems evaluation.

D. Main modules

NS14.1. System analysis

— Fault and event trees;
— Fault tree construction and analysis;
— Data reliability;
— Expert opinion.

NS14.2. Risk management

— Risk definitions, acceptable risk;
— Methods of quantitative risk assessment;
— Elements of risk management;
— Decision theory, decision tree;
— Uncertainties;
— Critical path method;
— Expert evaluation of uncertainties.

NS14.3. Risk management in physical protection

— Estimating security risk;
— Risk reduction strategies;

— Cost effectiveness and acceptable risk;
— Impact of risk management decisions.

NS14.4. Evaluation and optimization of physical protection system

— Adversary path; scenario and path analysis;
— Probabilistic and graph-analytical methods in evaluation of physical protection systems;
— Insider analysis;
— Reliability analysis;
— System effectiveness evaluation;
— Optimization methods in evaluating the effectiveness of systems;
— Uncertainties in evaluations;
— Decision making under risk and uncertainties; managing security risk.

E. Practical exercises for NS14

NS 14.2–NS14.4. Case study: Risk assessment, evaluation of effectiveness and optimization of physical protection system of a large nuclear reactor.

NS14.4. Case study: Evaluation of the physical protection system of a facility or radiological installation.

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS14

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4 (Corrected), IAEA, Vienna (1999).

A. Course title

NS15. Risk assessment and State management of nuclear security measures

B. Course objectives

Upon completion of this course, students will be able to select and optimize nuclear security measures in States with different nuclear related infrastructures and nuclear activities. Students will be able to estimate the risk of different adversaries' scenarios in these States and analyse the effectiveness of State security measures.

C. Short description

In this course, emphasis will be placed on analysis of State nuclear related infrastructure and possible nuclear security measures. Further focus will be on detailed description of risk assessment application for evaluating the effectiveness of State nuclear security measures and on the use of optimization methods for improving the proposed State nuclear security measures. The course will also include lectures on the analysis of detected inconsistencies and/or undeclared nuclear related activities as indicators of possible adversary activities in the State.

D. Main modules

NS15.1. Analysis of State nuclear related infrastructure and possible security measures

— State nuclear infrastructure and nuclear activities;
— Nuclear material acquisition and IND fabrication;
  • Analysis of State nuclear related infrastructure and nuclear activities;
  • Nuclear adversaries' scenarios in the State and possible State prevention measures;
— Nuclear sabotage;
  • Analysis of State nuclear related infrastructure and nuclear activities;
  • Nuclear adversaries' scenarios in the State and possible State prevention measures;
— Dispersion of radioactive material (e.g. a 'dirty bomb');
  • Analysis of State related infrastructure;
  • Adversary scenarios in the State and possible State prevention measures.

NS15.2. Review of analysis of adversary activities in the State and possible nuclear adversary characteristics (State threat assessment)

— Analysis of adversaries' activities in the State;
— Likelihood of nuclear or radiological attacks;
— Possible nuclear adversaries' characteristics in the State.

NS15.3. Evaluation of resistance of State nuclear activities and infrastructure to adversary

— Quantitative evaluation of technical difficulties in completion of each adversary's scenario;
  • Mathematical methods;
  • Quantitative evaluation of the scenarios before application of State nuclear security measures;
  • Quantitative evaluation of the State nuclear security measures;
— Qualitative estimation of possible adversary's capability in the State to complete each adversary's scenario;
  • Evaluation of maximum expected adversary's capabilities for each adversary's scenario;
  • Possible uncertainties in the evaluation.

NS15.4. Risk assessment of State nuclear activities and infrastructure and effectiveness of State security measures

— Mathematical methods for quantitative nuclear and radiological risk assessments in the State;
— Quantitative risk assessment for each of the adversaries' threats in the State;
  • Quantitative evaluation for feasible adversaries' scenarios before application of State nuclear security measures;
  • Quantitative evaluation of effectiveness of the State nuclear security measures for the adversary scenarios.

NS15.5. Optimization of State nuclear security measures

— Mathematical method for optimization of the State security measures;
— Optimization of the State security measure;
  • Contribution and effectiveness of different State nuclear security measures in the total risk reduction for all three threats (acquisition of NM and manufacture of IND, sabotage, radiological threats);

- Cost of different State nuclear security measures;
- Optimized State security measures;

— Effectiveness of the State security measures.

NS15.6. State action plan for implementation of the State nuclear security measures

— State organizations responsibilities;
— Design of the State action plan and distribution of the responsibilities.

NS15.7. Analysis of detected inconsistencies and unauthorized nuclear related activities as indicators of possible adversary activities in the State

— Possible inconsistencies and undeclared nuclear activities;
- Accountancy and results of State inspections;
- Undeclared nuclear research or other nuclear activities;
- Undeclared use of nuclear equipment and nuclear material production;
- Undeclared radioisotope production;
- Illicit trafficking;
- Import/export of nuclear and other radioactive material;
- Import/export of nuclear equipment or technologies;

— Analysis of detected nuclear inconsistencies and undeclared activities;
— Possible follow-up actions to improve State nuclear security measures.

E. Practical exercises for NS15

NS 15.1. Case study: Evaluation of a State nuclear related infrastructure and possible nuclear security measures.

NS15.2. and NS15.5. Case study: Analysis and optimization of the State security measures for a State (according to provided State infrastructure and State nuclear activities).

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS15

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4 (Corrected), IAEA, Vienna (1999).

A. Course title

NS16(a). Physical protection systems for nuclear and other radioactive material, sources and facilities

This course provides a comprehensive overview of physical protection of nuclear and other radioactive material, radioactive sources, and related facilities. The course NS16(b) represents a simplified version of NS16(a) and could be used at universities of countries where the development of nuclear facilities is not envisaged in the near future.

B. Course objectives

Upon completion of this course, students will be able to apply specifics of physical protection measures and national regulations for security of nuclear and other radioactive material and facilities. They will be able to design and evaluate a physical protection system for such facilities.

C. Short description

This course will describe the essential components of the process of physical protection system design specific for nuclear and radioactive material, sources and facilities. A significant part of the course (up to 50% of the course time) is devoted to a comprehensive project. The objective of this project, which is included in the practical exercise of this course, is to synthesize the material from NS7, NS8 and NS16(a) and (b). Therefore, some previously studied topics (NS16a.2) are included to refresh the students' knowledge. Application of other topics (NS16a.5) related to protection of nuclear and other radioactive material and facilities, as well as the new topics (NS16a.3, NS16a.4, NS16a.6) will be described in detail.

D. Main modules

NS16a.1. Introduction to physical protection of nuclear and other radioactive material and facilities

— The Convention of Physical Protection of Nuclear Material (CPPNM) and its Amendment; Code of Conduct on Safety and Security of Radioactive Sources;
— Categorization of nuclear material and radioactive sources;

— Consequences from theft or sabotage related to nuclear material, sources and facilities;
— Misuse of nuclear facilities or equipment;
— Certification of the sources;
— IAEA Catalogue of sealed sources.

NS16a.2. Application of fundamental principles of physical protection to nuclear material and other radioactive material and facilities

— Roles and responsibility of international, national, local authorities and operators;
— Legislative and regulatory framework to govern physical protection;
— Competent authorities;
— State threat evaluation;
— Physical protection requirements;
— Graded approach;
— Consequence analysis;
— Quality assurance;
— Emergency plan.

NS16a.3. Characteristics of nuclear facilities

— Design of typical nuclear facilities;
— Vital areas;
  • Fuel cycle facilities (uranium production, enrichment, fuel fabrication, reactors, reprocessing, spent fuel and waste storage);
  • Research reactor facilities;
  • Other facilities.

NS16a.4. Radioactive material and sources use and storage

— Containers for radioactive material and sources;
— Construction of typical storages for radioactive material and sources;
— Construction of typical radiation facilities (medical, industrial and agricultural).

NS16a.5. Application of physical protection approaches and methods for nuclear and other radioactive material and facilities

- Specifics of PPS for nuclear facilities and facilities with radioactive material;
- Target identification;
- Threats and vulnerability assessment in relation to nuclear and other radioactive material and facilities;
- Implementation of security measures;
  - Security grouping;
  - Security objectives and measures;
  - Administrative measures;
    - Periodic accounting and inventory taking;
    - Access control;
    - Emergency response plan;
    - Security plan;
    - Information security;
    - Timely response;
    - Specific technical measures;
    - Practical application of security measures for nuclear and other radioactive material and facilities.

NS16a.6. Establishing national infrastructure for security of nuclear and other radioactive material and facilities

- Creation of security awareness;
- Reviewing legislative authorities;
- Building regulatory capacity;
- Developing regulatory framework;
- Establishing graded security levels;
- Specification of security level application to nuclear material and facilities;
- Selection of regulatory approach.

E. Practical exercises for NS16a

NS16a.1–NS16a.5. Comprehensive project: Design and evaluation of physical protection of a nuclear or radiological facility.

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS16a

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, Vienna (1996).

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Dangerous Quantities of Radioactive Material (D-Values), EPR-D-VALUES 2006, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Design of Spent Fuel Storage Facilities, Safety Series No. 116, IAEA, Vienna (1994).

INTERNATIONAL ATOMIC ENERGY AGENCY, Design of Spent Fuel Storage Facilities, Safety Series No. 116, IAEA, Vienna (1994).

INTERNATIONAL ATOMIC ENERGY AGENCY, Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage, IAEA Nuclear Security Series No. 4, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, IAEA-TECDOC-1092, Vienna (1999).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Manual for First Responders to a Radiological Emergency, EPR-First Responders, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev. 4 (Corrected), IAEA, Vienna (1999).

A. Course title

NS16(b). Physical protection systems for radioactive material and sources

B. Course objectives

Upon completion of this course, students will be able to define the specifics of physical protection measures and national regulations for security of radioactive material and sources. They will be able to design and evaluate a physical protection system for such facilities.

C. Short description

The course includes all important aspects of the process of physical protection system design specific for radioactive material and sources. A significant part of the course (up to 50% of course time) is devoted to a comprehensive project. The objective of the comprehensive project, which is included in the practical exercise of this course, is to synthesize the material from NS7, NS8 and NS17.

D. Main modules

NS16b.1. Introduction to physical protection of radioactive sources

— Code of Conduct on Safety and Security of Radioactive Sources;
— Categorization of radioactive sources;
— Certification of the sources;
— IAEA Catalogue of Sealed Sources and Devices;
— Loss of control and malicious use of radioactive material and sources;
— Consequences from theft or sabotage related to radioactive material and sources.

NS16b.2. Application of fundamental principles of physical protection specific to radioactive material and sources

— Roles and responsibility of international, national, local authorities and operators;
— Legislative and regulatory framework to govern physical protection;
— Competent authorities;
— State threat evaluation;
— Physical protection requirements;

— Graded approach;
— Consequences analysis;
— Quality assurance;
— Emergency plan.

NS16b.3. Radioactive material and sources use and storage

— Containers used for radioactive material and sources;
— Construction of typical storages for radioactive material and sources;
— Construction of typical radiation facilities (medical, industrial and agricultural).

NS16b.4. Application of physical protection approaches and methods for radioactive material and sources

— Specifics of PPS for radioactive sources;
— Target identification for facilities containing radioactive material and sources;
— Threats and vulnerability assessment in relation to radioactive material and sources;
— Implementation of security measures;
  - Security grouping;
  - Security objectives and measures;
  - Administrative measures;
    - Periodic inventory control;
    - Access control;
    - Emergency response plan;
    - Security plan;
    - Information security;
    - Timely response;
  - Specific technical measures;
  - Examples of practical application of security measures for radioactive material and sources.

NS16b.5. Establishing national infrastructure for security of radioactive material and sources

— Creating security awareness;
— Reviewing legislative authorities;
— Building regulatory capacity;
— Developing regulatory framework;

— Establishing graded security levels;
— Specification of security level application to radioactive sources;
— Selection of regulatory approach.

E. Practical exercises for NS16b

NS16b.1–NS16b.4. Comprehensive project: Design and evaluation of physical protection of a facility containing radioactive material or sources.

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS16b

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, INTERNATIONAL ATOMIC ENERGY AGENCY, INTERNATIONAL LABOUR ORGANIZATION, OECD NUCLEAR ENERGY AGENCY, PAN AMERICAN HEALTH ORGANIZATION, WORLD HEALTH ORGANIZATION, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources, Safety Series No. 115, Vienna (1996).

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Dangerous Quantities of Radioactive Material (D-Values), EPR-D-VALUES 2006, IAEA, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Design of Spent Fuel Storage Facilities, Safety Series No. 116, IAEA, Vienna (1994).

INTERNATIONAL ATOMIC ENERGY AGENCY, Engineering Safety Aspects of the Protection of Nuclear Power Plants against Sabotage, IAEA Nuclear Security Series No. 4, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Generic Procedures for Monitoring in a Nuclear or Radiological Emergency, IAEA-TECDOC-1092, Vienna (1999).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

Nuclear Security — Measures to Protect against Nuclear Terrorism, Amendment to the Convention on the Physical Protection of Nuclear Material, Report by the Director General, GOV/INF/2005/10-GC(49)/INF/6, IAEA, Vienna (2005).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev.4 (Corrected), IAEA, Vienna (1999).

A. Course title

NS17. Import/export and transit control mechanism and regime

B. Course objectives

Upon the successful completion of this course, the students will be able to discriminate and apply the legal, procedural and administrative measures used for practical implementation of import and export control.

C. Short description

The course will provide a comprehensive knowledge of import/export control measures, legal aspects and documentation required for nuclear security specialists. Special attention will be paid to import/export of nuclear and other radioactive material and nuclear related equipment. Examples outside the nuclear and radioactive material field may be considered.

D. Main modules

NS17.1. Proliferation of nuclear weapon and export controls

— Early indications of proliferation activities;
— Interdicting and delay of proliferation;
— Terrorist organizations and export control.

NS17.2. Import/export national regulatory infrastructure and regulations

— Implementation of national law and regulations;
— Additional protocol and national export control requirements;
— Reporting system;
— Training.

NS17.3. Import/export legal instruments

— NPT and export/import control;
— Zangger Committee;
— Trigger list;
— Nuclear Suppliers Group (NSG);
— Multilateral export control;

— Additional protocol reporting requirements;
— Code of conduct.

NS17.4. Methodology for practical implementation

— Important nuclear weapon proliferation technologies, equipment and material;
— Dual use equipment;
— Nuclear proliferation practice, illicit nuclear trade;
— Export/import control practice.

NS17.5. Nuclear and radioactive material international trade

— Nuclear and radioactive material as objects of international trade;
— Transportation in international trade;
— Export/import packing and labelling;
— Nuclear and radioactive material tariff classification codes;
— Nuclear and radioactive material characteristics subject to customs verification.

NS17.6. Exporting/importing and transit of nuclear and radioactive material: Procedures and documentation

— Legal framework and regulations;
— Non-tariff restrictions and licences;
— Export/import documentation;
— Transit documentation;
— Customs clearance and customs inspection;
— Risks associated with transit countries;
— Differences in national export control systems;
— Relationship between the international and the national export control system;
— Gaps at the interface of the two systems.

E. Practical exercises for NS17

NS17.4. Case study: Import of dual use equipment for clandestine enrichment purposes.

NS17.5. Demonstration of typical import/export and transit documentation.

NS17.6. Case study: Check for correctness a set of documentation and labelling for import of nuclear related equipment.

F. Laboratory work

No laboratory work is foreseen for this course.

G. Suggested reading for NS17

Communication Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment and Technology, INFCIRC254/Rev. 6/Part 2 and Rev. 7/Part 1, IAEA, Vienna (2005).

Communication Received from Members Regarding the Export of Nuclear Material and of Certain Categories of Equipment and other Material, INFCIRC/209/Rev. 1, IAEA, Vienna (1990).

Customs Convention on Containers, United Nations/International Maritime Organization, Brussels (1972).

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Guidance on the Import and Export of Radioactive Sources, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security in the Transport of Radioactive Material, IAEA Nuclear Security Series No. 9, IAEA, Vienna (2008).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, UNIVERSAL POSTAL UNION WORLD CUSTOMS ORGANIZATION, Monitoring of Radioactive Material in International Mail Transported by Public Postal Operators, IAEA Nuclear Security Series No. 3, Vienna (2006).

International Convention on Mutual Assistance in Customs Matters (Johannesburg Convention), World Customs Organization, Brussels (2003).

International Convention on the Simplification and Harmonization of Customs Procedures, World Customs Organization, Kyoto (1973, as amended 1993).

A. Course title

NS18. Nuclear security at major public events

B. Course objectives

Upon the successful completion of this course, students will be able to design a comprehensive nuclear security system for major public events.

C. Short description

The course is based on the IAEA Guidelines for Nuclear Security at Major Public Events. The course will emphasize the practical issues of a comprehensive nuclear security system for major public events, including threat analysis, prevention, detection and response activities, and the general principles for the development of an action plan.

D. Main modules

NS18.1. Design of comprehensive nuclear security system for major public events

— Threat analysis;
— Prevention activities;
— Detection activities;
— Response activities;
— General principles for the development of an action plan;
— Management of resources and information security.

NS18.2. Threat analysis

— Evaluation of threat;
— Vulnerability assessment;
— Security measures for radioactive sources;
— IAEA Illicit Trafficking Database.

NS18.3. Prevention measures

— Physical protection of critical radiation sources;
— Role of the State in creating an effective physical protection system;
— Border monitoring;

— Nuclear security preparation for a State hosting a major public event;
— Awareness and training.

NS18.4. Detection measures

— Selection of venues and other strategic locations for detection systems;
— Detection approach and equipment deployment strategies;
— Detection instruments;
  • Types of detection instrumentation;
  • Detection instruments at strategic locations;
  • Pre-event radiological surveys and background mapping;
  • Early detection systems outside strategic locations;
— Acceptance testing;
— Equipment calibration and maintenance;
— Training.

NS18.5. Response measures

— Elements of response;
— Organizational structure for response;
  • Role of the response organization;
  • Required infrastructure for the response organization;
— Response to an alarm;
  • Alarm response procedures for strategic locations and other important points;
  • Search procedures;
  • Mobile expert support team (MEST) and reach-back to experts;
— Response strategies and arrangements;
  • Required infrastructure for responding to a radiological emergency;
  • Assessing the State's radiation emergency response capabilities;
  • Event-specific emergency response plan for nuclear security;
  • Preparedness;
— Consequence management;
  • Assessment, rescue, recovery and restoration;
  • Medical issues;
  • Public information;
  • Recovery and return nuclear and other radioactive material under regulatory control;
— Collection and preservation of evidence and prosecution;
— Training and awareness.

E. Practical exercises for NS18

NS18.1–NS18.5. Case study: Example command and control structure for a major sports event.

NS18.1–NS18.5. Action plan: Study of an example.

NS18.1–NS18.2. Case study: Design basis threat for a major sports event.

NS18.5. Presentation of a generic alarm response scheme for a major public event.

F. Laboratory work

NS18.4–NS18.5 Radiation alarm verification in a crowd.

G. Suggested reading for NS18

INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA Safety Standards Series No. RS-G-1.9, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Code of Conduct on the Safety and Security of Radioactive Sources, IAEA/CODEOC/2001, IAEA, Vienna (2001).

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and Other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Development, Use and Maintenance of the Design Basis Threat, IAEA Nuclear Security Series No. 10, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Measures at the XV Pan American Games: Rio de Janeiro 2007, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standards Series No. TS-R-1, 9th edn, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

INTERNATIONAL ATOMIC ENERGY AGENCY, Technical and Functional Specifications for Border Monitoring Equipment, IAEA Nuclear Security Series No. 1, Vienna (2006).

The Physical Protection of Nuclear Material and Nuclear Facilities, INFCIRC/225/Rev. 4 (Corrected), IAEA, Vienna (1999).

A. Course title

NS19. Nuclear forensics and attributions

B. Course objectives

Upon the successful completion of this course, students will be able to contrast nuclear forensic techniques and to describe relevant tools and procedures. They will be provided with consolidated training for responding to incidents involving the interdiction of nuclear and other radioactive material when nuclear forensic investigations are required.

C. Short description

The focus of this advanced course on nuclear forensics will be on a detailed description of analytical tools for nuclear forensics and nuclear forensic analysis. In addition, the course will emphasize the sampling and distribution methods in a nuclear forensics laboratory. Considerable time will be spent on interpretation of findings in nuclear forensics and data quality methods aiming to enhance confidence in driven conclusions.

D. Main modules

NS19.1. Physical basis for nuclear forensic science

— Nuclear and other radioactive material;
— Nuclear material and criticality;
— Effects of production and treatment of nuclear and other radioactive material on specific signatures (physical, chemical and isotopic signatures);
  - Separation and enrichment of uranium;
  - Nuclear reactors and the production of plutonium;
  - Nuclear fuel cycle operations;
  - Principles of nuclear and radiological explosive devices;
  - Nuclear applications in medicine, industry and research.

NS19.2. Radioanalytical chemistry principles and practices

— Dissolution of solids;
— Carriers and tracers in inorganic analysis;
— Relevant chemical and physical properties;
— Techniques for forensic signatures;

— Collateral forensic indicators;
— Radionuclide separation and purification;
— Standard methods in radioanalytical chemistry.

NS19.3. Incident response

— Securing the incident site;
— On-site measurements;
— Collection of traditional forensic evidence;
— Collection of evidence in radiological incidents;
  - Interdicted radiological material in transit;
  - Range of potential RDD material and their legitimate uses;
  - Radiologically contaminated traditional trace and bulk evidence in a radiological dispersal event;
  - Processing the scene of a nuclear yield event;
  - Sample handling.

NS19.4. Nuclear forensic laboratory sampling and distribution

— Nuclear forensic laboratory;
— Forensic management team;
— Sampling in the nuclear forensics laboratory.

NS19.5. Nuclear forensic analysis

— Characterization goals;
— Presentation of available analytical tools for nuclear forensics;
  - Type of information provided;
  - Typical detection limit;
  - Spatial resolution.
— Sequence of analysis techniques and methods;
  - Radiological (estimated total activity, dose rate (α, β, γ, n), surface contamination);
  - Physical (visual inspection, radiography, photography, weight, dimensions, optical microscopy, density);
  - Traditional forensic (fingerprints, fibres);
  - Isotope analysis (γ spectroscopy, α spectroscopy);
  - Mass spectrometry;
  - Elemental/chemical analysis;
  - Particle analysis;
  - Other techniques.

NS19.6. Nuclear forensic interpretation

- — Nuclear dating methods and forensic signatures;
  - Empirical approach through the systematic analysis of nuclear and radioactive material;
  - Modelling based on the chemistry and physics of nuclear processes;
  - Nuclear dating and interpretation of signatures;
- — Cooperation with other nuclear forensics laboratories;
  - List of nuclear forensics laboratories;
- — Knowledge bases of nuclear processes;
  - Archived material;
  - Open literature;
  - Closed literature;
  - National and international databases;
- — Iterative nuclear forensics process;
  - Sampling;
  - Categorization;
  - Hypothesis building (case knowledge bases, archived material, other experts);
  - Analysis (radioactive material and traditional forensics);
  - Interpretation/exclusion;
  - Conclusion.

NS19.7. Confidence in conclusions

- — Analytical data quality objectives control;
- — Precision and accuracy;
- — Sensitivity;
- — Reporting of results;
- — Source and route attribution;
  - The mission of nuclear attribution;
  - Law enforcement and intelligence community roles;
  - Nuclear forensic signatures and attribution process.

E. Practical exercises for NS19

Proposal for a series of exercises related to the interdiction of material in a container:

NS19.3. Sampling of interdicted material, taken from the surface of an interdicted container.

NS19.5. Instrument selection for analysis of sample.

NS19.6. Data interpretation (including use of databases) of the results of analysis.

NS19.7. Conclusions of the analysis.

F. Laboratory work

NS19.1–NS19.4. Use of various analytical tools to determine the source of radioactive material and its method of production.

G. Suggested reading for NS19

INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA Safety Standards Series No. RS-G-1.9, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and Other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Identification of Radioactive Sources and Devices, IAEA Nuclear Security Series No. 5, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Forensics Support, IAEA Nuclear Security Series No. 2, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

A. Course title

NS20. Infrastructure and procedures for detection and response to incidents involving nuclear or other radioactive material out of regulatory control

B. Course objectives

Upon completion of the course, students will be able to establish a national infrastructure, including a national response plan, and procedures for response to incidents involving nuclear or other radioactive material.

C. Short description

The course addresses issues related to the national infrastructure for response to criminal or unauthorized acts. It will cover the legal framework necessary to establish such infrastructure and activities for developing a national response plan, including steps for receiving international assistance to augment response capability and develop training programmes. It will also provide the methodology for developing and using efficient and effective response procedures.

D. Main modules

NS20.1. Roles, responsibilities and arrangements

- Creation of an organizational structure;
  - Radiological response organization;
  - Roles and responsibilities of agencies involved;
  - Duties and responsibilities of key personnel;
  - Preparing a budget and obtain funding;
- Competencies of institutions/agencies involved;
  - Local expertise for verification of alarms and expert support operations;
  - National notification point and emergency response centre;
  - Emergency medical response services;
  - Criminal investigation/crime scene forensics;
  - Communication services;
  - Public health and environmental contamination services;
  - Public information/media communications services;
  - Services for the storage and transport of radioactive material;
  - Nuclear forensics services;
- Response plan;

— Readiness;
— Obtaining and using illicit trafficking information;
— Border monitoring to detect illicit trafficking;
— Deployment of equipment at strategic points;
— Mobile expert support team (MEST);
  • Roles and responsibilities;
  • Organization;
  • Role of radiological assessor;
  • Equipment;
  • Communications;
  • Training;
— Maintenance and sustainability of the framework.

NS20.2. International assistance to augment response capability

— Assessing needs, capabilities and desirability of requesting international teams;
— Developing coordinated plan to integrate international assistance into national plans;
— Developing training programme and material for integration;
— Coordinating international assets.

NS20.3. Response procedures

— Concept of operations;
— Scale of response;
— Response initiation;
— Response operations;
— Incident command;
— Investigation and gathering of evidence;
— Transport arrangements for radioactive material;
— Media awareness;
— Training in procedures;
— Tabletop exercises to validate procedures;
— Provisions for revision of procedures.

NS20.4. Developing training programme

— Identify personnel to be trained;
— Prioritize training needs;
— Develop training programme and material.

E. Practical exercises to NS20

NS20.1. Examining the country's response plan (local, national).
NS20.2. Requesting international assistance — Case study.
NS20.4. Developing response procedures on hypothetical cases.

F. Laboratory work

No laboratory work is required for this course.

G. Suggested reading for NS20

INTERNATIONAL ATOMIC ENERGY AGENCY, Categorization of Radioactive Sources, IAEA Safety Standards Series No. RS-G-1.9, IAEA, Vienna (2005).

INTERNATIONAL ATOMIC ENERGY AGENCY, Combating Illicit Trafficking in Nuclear and other Radioactive Material, IAEA Nuclear Security Series No. 6, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Identification of Radioactive Sources and Devices, IAEA Nuclear Security Series No. 5, IAEA, Vienna (2007).

INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Forensics Support, IAEA Nuclear Security Series No. 2, Vienna (2006).

INTERNATIONAL ATOMIC ENERGY AGENCY, Security of Radioactive Sources, IAEA Nuclear Security Series No. 11, IAEA, Vienna (2009).

A. Course title

NS21. Cooperation of stakeholders at the national and international levels

B. Course objectives

Upon completion of this course, students will be able to define various national and international stakeholders in nuclear security. Emphasis will be placed on developing skills to build and maintain collaborative partnerships across organizational boundaries and the ability to interact effectively with internal and external counterparts.

C. Short description

This course will provide an overview of cooperation efforts among various national agencies and international coordination in case of nuclear/radiological incidents. Considerable time will be devoted to focusing on cooperation with other competent organizations as the hallmark of nuclear security efforts, especially in cases of combined CBRN incidents or when a dirty bomb is involved. Furthermore, it will be emphasized that nuclear security is and should remain a national responsibility and that some countries still lack the programmes and the resources to respond properly to the threat of nuclear/radiological terrorism. This course will cover international cooperation essential to help countries to strengthen their national capacities and to build regional and global networks for combating transnational threats.

D. Main modules

NS21.1. Interagency cooperation and coordination

- Roles and strategies of nuclear/radiological regulator and radiation response organization;
- Law enforcement, fire department, hazmat and emergency medical services management;
- Techniques for promoting interagency understanding;
- Capabilities of and interaction among emergency management responders;
- Interagency planning and response processes required for the effective handling of the event.

NS21.2. Cooperation with other competent organizations in case of combined CBRN incidents

— Joint operations in CBRN environments;
— Difference between chemical, biological, radiological or nuclear events;
— Personal safety considerations;
— Indicators of chemical event;
— Indicators of biological event;
— Indicators of radiological and nuclear event.

NS21.3. Cooperation with other competent organizations in case of incidents involving radiological dispersal devices

— Explosives and conventional ordnance;
— The role of bomb squad;
— Mass casualty events;
— Related safety and health topics;
— Interagency cooperation in protection of first responders, health care workers, clean-up workers and others;
— Organizations and authorities involved in RDD response;
— Command and management.

NS21.4. International coordination

— The IAEA;
— World Customs Organization (WCO);
— Interpol;
— OECD/Nuclear Energy Agency (OECD/NEA), Regional Cooperation Agreement;
— Forum for Nuclear Cooperation in Asia (FNCA);
— Relevant United Nations organizations.

E. Practical exercises for NS21

NS21.1–NS21.4. Case study: Organization of international cooperation for a large scale international exercise on response to a nuclear emergency.

F. Laboratory work

No laboratory work is required for this course.

G. Suggested reading for NS21

INTERNATIONAL ATOMIC ENERGY AGENCY, Joint Radiation Emergency Management Plan of the International Organizations, EPR-JPLAN, IAEA, Vienna (2006).

Measures to Strengthen International Cooperation in Nuclear, Radiation and Transport Safety and Waste Management, GC(49)/RES/9, IAEA, Vienna (2005).

Nuclear Security — Measures to Protect Against Nuclear Terrorism, Progress Report and Nuclear Security Plan for 2006–2009, GC(49)/17, IAEA (2005).

Nuclear Security — Progress on Measures to Protect against Nuclear Terrorism, GOV/INF/2002/11-GC(46)/14, IAEA (2002).

A. Course title

NS22. IT/cyber security

B. Course objectives

Upon the successful completion of this course, students will be able to explain and give examples of IT and cyber security and use computer and communication security measures. They will be able to apply different intrusion detection methods and establish network management practice.

C. Short description

The course will provide theoretical and practical knowledge of IT and cyber security and security methods for computer, network and electronic communication. Intensive practical exercises will support the theoretical lectures.

D. Main modules

NS22.1. Computer security and access control

— Prevention;
— Physical security;
— Computer operating systems;
— Access control principles;
— Remote maintenance.

NS22.2. Authentication and cryptography

— Authentication methods;
— Practical application.

NS22.3. Computer security architecture

— Threats and vulnerabilities to computing infrastructure;
— Consequence analysis;
— Security levels, multilevel security;
— Security zones.

NS22.4. Network security

— Network devices;
— Network service;
— Expected threats;
— Viruses, worms, Trojan horses;
— Firewalls;
— VPNs;
— Secure LAN;
— E-mail communication.

NS22.5. Intrusion detection and information recovery

— Common intrusion methods;
— Network attacks;
— Intrusion detection;
— Responses to intrusion;
— Computer forensics;
— Recovery plan.

NS22.6. Network management practice

— Automated vulnerability detection;
— Scanning techniques and approaches;
— Countermeasures against network threats.

E. Practical exercises for NS22

NS22.1–22.3. Case study: Security arrangements for a health physicist computerized system at a hospital.
NS22.1–22.4. Case study: Security of nuclear power plant computerized system.
NS22.1. Practical exercise in access control and in encryption.
NS22.5. Practice in detection of computer attacks.
NS22.5. Practice in computer forensics.
NS22.6. Practice in scanning techniques.

F. Laboratory work

No laboratory work is foreseen for this course.

Appendix II

RECOMMENDED COURSES FOR A CERTIFICATE PROGRAMME IN NUCLEAR SECURITY

Appendix II contains the core courses (Section II.1) and additional courses (Section II.2) for the certificate programme in nuclear security. Details on the main modules of the modified courses recommended for the certificate programme are provided below. The objectives of the courses remain the same as in the MSc programme.

II.1. CORE COURSES

A. Course title

NS.M1. Introduction to nuclear security

B. Main modules

NS.M1.1 Adversaries (non-State actors)

— Conventional adversary acts and past nuclear threats;
— Attributes and characteristics of potential adversaries.

NS.M1.2. Adversary organizations

— Goals, tactics and methods;
— Capabilities, technologies, funding.

NS.M1.3. Counterterrorism

NS.M1.4. CBRN

— CBRN weapon;
— Four main nuclear and radiological concerns;
— Clandestine proliferation of nuclear and radiological weapon.

NS.M1.5. Basic elements of nuclear security and their interrelations

— Prevention;
— Detection;
— Response.

NS.M1.6. Planning of nuclear security at the State level

— State authorities related to nuclear security;
— State nuclear related infrastructure;
— State threat assessment;
— State nuclear security measures;
— State nuclear security plan.

NS.M1.7. Planning of nuclear security at the facility level

— Safety and security overlap;
— Physical protection systems;
— Nuclear material accounting and radioactive material inventory control;
— Contingency plans and drills.

NS.M1.8. Introduction to detection of, and response to, unauthorized acts involving nuclear and other radioactive material out of regulatory control

— Illicit trafficking and the Illicit Trafficking Database (ITDB);
— Need for detection infrastructure, response arrangements and preparedness;
— Basic elements of response measures;
— Role and responsibilities of the responsible organizations.

NS.M1.9. Information security

— Classification of information;
— Security policies and procedures
— Computer security;
— Information access techniques and control;
— Security zones.

NS.M1.10. Security culture: Concept and model

— Establishment of attitudes and beliefs in an organization;
— Formal working methods to produce good outcomes;
— Organizational and professional culture;
— Model for nuclear security culture for various types of organizations, radioactive material and uses.

NS.M1.11. Interrelation of nuclear security, safety and safeguards

— Goals and objectives;
— Synergies of nuclear security, safety and safeguards.

NS.M1.12. Nuclear non-proliferation regime

— Treaty on the Non-Proliferation of Nuclear Weapons;
— State system of accounting for and control of nuclear material (SSAC);
— International safeguards.

A. Course title

NS.M2. International and national legal framework for nuclear security

B. Main modules

NS.M2.1. Role of law in implementing nuclear security

NS.M2.2. History and role of international organizations and programmes related to nuclear security and the United Nations Global Counter Terrorism Strategy

— The United Nations Security Council (UNSC);
— The IAEA;
— United Nations Office on Drugs and Crime (UNODC).

NS.M2.3. International legal framework for nuclear security

Selected binding international instruments

— Convention on the Physical Protection of Nuclear Material, 1980 (CPPNM) and its Amendment, 2005;
— International Convention for the Suppression of Acts of Nuclear Terrorism (UNGA Resolution 59/290) (2005);
— United Nations Security Council Resolution 1373 (2001), Threats to international peace and security caused by terrorist acts;
— United Nations Security Council Resolution 1540 (2004), Non-proliferation of weapons of mass destruction;
— Treaty on the Non-Proliferation of Nuclear Weapons (NPT);
— Regional nuclear-weapon-free zone treaties;
— Safeguards agreements and Model Additional Protocol;
— Other relevant instruments.

Selected non-binding international instruments

— Code of Conduct on the Safety and Security of Radioactive Sources (INFCIRC/663);
— Guidance on the Import and Export of Radioactive Sources (INFCIRC/663);

— The Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Rev.4/corrected);
— Other relevant instruments.

NS.M2.4. National legal framework

— National laws relevant for nuclear security;
— National security organizations;
— Regulatory framework;
— Private security organizations;
— Transport and export/import control;
— Emergency response;
— Intelligence gathering and analysis.

NS.M2.5. Criminal justice aspects

— Basic principles of criminal law;
— Criminal offences;
— Criminal jurisdiction;
— Criminal law enforcement;
— Mechanisms and tools for international cooperation.

C. Practical exercises for NS.M2

NS.M2.3. Case study: Required nuclear security at a nuclear research reactor (depends on infrastructure of the State) based on international legal instruments.

A. Course title

NS.M3. Nuclear energy, nuclear fuel cycle and nuclear applications

B. Main modules

NS.M3.1. Nuclear energy

— Fission and fusion reactions, neutron cross-sections; chain reaction, critical mass; fission products;
— Nuclear fuel, moderators, coolants;
— Design and types of nuclear reactors;
— Fuel burnup, transuranium elements production.

NS.M3.2. Nuclear fuel cycle

— Uranium mining, conversion;
— Uranium enrichment;
— Fuel fabrication;
— Nuclear power plants;
— Spent fuel handling and reprocessing;
— Radioactive waste treatment.

NS.M3.3. Non-power application of nuclear technologies

— Radioisotope production;
— Nuclear technologies in industry, medicine, agriculture, etc.;
— Nuclear research.

A. Course title

NS.M4. Methods and instruments for nuclear and other radioactive material measurements

B. Main modules

NS.M4.1. Counting statistics

— Precision and accuracy;
— Biased errors and random errors;
— Limits of detectability.

NS.M4.2. Radiation detectors

— Ionization chambers;
— Proportional counters;
— Geiger-Mueller counter;
— Scintillation detectors;
— Semiconductor detectors.

NS.M4.3. Neutron detection

— Neutron reaction, neutron moderation;
— Neutron detectors;
— Neutron sources, pulse neutron sources.

NS.M4.4. Detection of charged particles

— Electron detection;
— Alpha particle detection.

NS.M4.5. Other methods

— Gamma spectroscopy, isotope identification;
— Activation analysis;
— Destructive analysis.

C. Practical exercises for NS.M4

NS.M4.1. Demonstration of radiation detectors.

D. Laboratory work

NS.M4.1–NS.M4.2. Measurements of alpha, beta, gamma and neutron sources.

NS.M4.1–4.4. Practice in use of different radiation detectors and detection systems.

A. Course title

NS.M5. Effect of radiation, safety and radiation protection

B. Main modules

NS.M5.1. Quantities and measurements

— Quantities and units;
— Dosimetric calculations and measurements.

NS.M5.2. Biological effects of ionizing radiation

— Effects of radiation at the molecular and cellular level;
— Deterministic effects;
— Stochastic effects.

NS.M5.3. Principles of radiation protection

— Conceptual framework;
— Development of safety culture.

NS.M5.4. Assessment of external and internal exposures

— Assessment of occupational exposure due to external sources of radiation;
— Assessment of occupational exposure due to intakes of radionucludes.

NS.M5.5. Protection against occupational exposure

— Organization and management;
— Methods of protection and safe use of radiation sources;
— Individual and workplace monitoring;
— Health surveillance;
— Potential exposures;
— Protection against occupational exposure.

NS.M5.6. Intervention in situations of emergency exposure

— Types of events;
— Basic concepts of emergency response.

C. Practical exercises for NS.M5

NS.M5.1. Demonstration of different types of dosimeters.
NS.M5.6. Monitoring a workplace for external radiation.

D. Laboratory work

NS.M5.1. Determination of background level of radiation; measurement of alpha and beta radiation level for alpha and beta emitter samples.

A. Course title

NS.M6. Threat assessment

B. Main modules

NS.M6.1. Threat assessment

— Definition of threats;
— List of threat characteristics;
— Sources and analysis of threat related information;
— External threats;
— Internal threats;
— Review of actual, planned and possible threat actions;
— Analysis of threat related data.

NS.M6.2. Design basis threat (DBT)

— International recommendations for DBT;
— Roles and responsibilities;
— Screening of output of threat assessment (TA);
— Translating specific threats in TA to generic adversary attributes and characteristics;
— Modifying generic adversary attributes and characteristics based on policy concerns;
— Assigning which attributes and characteristics are part of DBT and which are excluded;
— Addressing other remaining credible threat attributes and characteristics that are not included in final DBT;
— DBT and another alternative threat based approach;
— Implementing DBT;
— Maintaining DBT.

NS.M6.3. Threat informed security: Role of threat analysis in developing adequate security measures

— Relationship between protection features and the threat;
— Graded protection;
— DBT approach versus alternatives.

C. Practical exercises for NS.M6

NSM6.1–6.3. Case study: Threat assessment and DBT development for a facility (nuclear or radiological facility).

D. Laboratory work

No laboratory work is foreseen for this course.

A. Course title

NS.M7. Physical protection systems design and evaluation

B. Main modules

NS.M7.1. Fundamental principles of physical protection

— Roles and responsibility of international, national, local authorities and operators;
— State threat evaluation;
— Physical protection requirements, graded approach;
— Concept of several layers and methods, defence in depth, balanced protection, no single point failures, redundant equipment;
— Quality assurance;
— Emergency plan;
— Confidentiality.

NS.M7.2. Determination of PPS requirements

— Consequences analysis;
— Facility characterization;
— Target identification;
— Threat definition, assessment and DBT;
— PPS effectiveness;
— Approaches to defining security measures.

NS.M7.3. Design of the physical protection system

— Physical protection plan;
— PPS functions;
— Design of PPS.

NS.M7.4. Response and communication

— Response forces;
— Communication;
— Neutralization.

NS.M7.5. Vulnerability assessment

— Risk assessment;
— Evaluation analysis;
— System effectiveness;
— Use of evaluation results.

NS.M7.6. PPS operation

— Performance tests;
— Contingency plan;
— Operating principles of PPS;
— Physical protection inspections at nuclear facilities.

C. Practical exercises for NS.M7

NS.M7.5. Case study: Design of a physical protection system for a hypothetical facility.

NS.M7.7. Case study: Evaluation of the physical protection system of a facility.

A. Course title

NS.M8. Physical protection technologies and equipment

B. Main modules

NS.M8.1. Function of physical protection system

— Deterrence;
— Detection;
— Assessment;
— Delay;
— Response.

NS.M8.2. Intrusion detection

— Performance characteristics;
— Sensor classification.

NS.M8.3. Sensors

— Perimeter sensor systems;
— Boundary penetration sensors;
— Other sensors;
— Integration of physical protection system.

NS.M8.4. Alarm systems

— Alarm communication and display;
— Alarm assessment systems.

NS.M8.5. Access control

— System design;
— Access control systems;
— Personal identity verification;
— Contraband detection.

NS.M8.6. Access delay

— Passive/fixed barriers;
— Active/dispensable barriers;
— System configuration.

NS.M8.7. Response force equipment

— Performance measures;
— Communication equipment;
— Other equipment.

C. Practical exercises for NS.M8

NS.M8.2–8.3. Case study: Selection of internal and external sensors for a research reactor.

D. Laboratory work

NS.M8.2. Familiarization with interior and external sensors.
NS.M8.3. Review of video images; alarm assessment.

A. Course title

NS.M9. Security of nuclear and other radioactive material in transport

B. Main modules

NS.M9.1. Objectives of transport security

— Aspects of transport security;
— Types of threats and possible consequences;
— Guidance on security in transport.

NS.M9.2. International and national requirements and guidance

— International legal instruments for nuclear and other radioactive material;
— State responsibilities;
— Cooperation with other States and the IAEA;
— Physical protection of nuclear material;
— Transport of dangerous goods;
— Transport of radioactive material and sources.

NS.M9.3. Transport regulations

— IAEA transport security guidelines for radioactive material;
— Transport indexes and security levels;
— Safety of radioactive material transport;
— Activity thresholds for radioactive packages;
— Package preparation;
— Licensing;
— International transport container database.

NS.M9.4. Security of nuclear material during transport

— Customs information database;
— State and operator's responsibilities;
— General security principles for security regime development;
— Security provisions;
— International shipment;
— Transport security plan;
— Transport security technologies.

C. Practical exercises for NS.M9

NS.M9.4. Tabletop exercise: Identification of security measures and preparation of transport security plan for transportation of irradiated HEU fuel assemblies from the storage facility.

A. Course title

NS.M10. Detection of criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control

B. Main modules

NS.M10.1. Introduction to detection alarm

— Types of alarm;
— Types and purpose of detection instrumentation.

NS.M10.2. Implementation strategy for the deployment of radiation detection equipment at:

— Land borders, seaports, airports;
— International mail;
— Internal strategic locations;
— Other locations of importance.

NS.M10.3. Illicit trafficking in nuclear and other radioactive material

— Basics on illicit trafficking and orphan sources;
— Innocent alarms;
— Control of legal transport;
— Need for detection infrastructure within a country, including intelligence resources and State level trafficking information;
— Effective mechanisms and detection systems to prevent illicit trafficking in nuclear and other radioactive material.

NS.M10.4. Radiation searches and surveys

— Transport documents, transport category and transport index;
— Equipment for radiation searches and surveys;
— General search preparation (pedestrians, packages, cargo, vehicles).

NS.M10.5. Detection response and verification of alarms

— Basic principles for responding to a radiation instrument alarm;
— Procedures for response to instrument alarms;
— Detection response.

C. Practical exercises for NS.M10

NS.M10.2. Demonstration of deployment and operation of radiation detection equipment at land borders, seaports, airports and other locations of importance.

NS.M10.3. Tabletop exercise on verification of shipping documents.

NS.M10.5. Operation of hand-held devices to locate and identify hidden sources.

D. Laboratory work

NS.M10.1. Familiarization with portal radiation monitors.

NS.M10.1. Familiarization with hand-held radiation detection equipment.

A. Course title

NS.M11. Interdiction of, and response to, criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control

B. Main modules

NS.M11.1. Introduction

— Regulations and response organizations;
— National response plan;
— Crime scene operations;
— International requirements.

NS.M11.2. Interdiction of criminal or unauthorized acts involving nuclear and other radioactive material out of regulatory control

— Interdiction at the facility level, borders, transport;
— Interdiction in other cases when 'unknown' radioactive material is involved.

NS.M11.3. Application of detection and personal protective equipment during interdiction

— Measurement of ambient gamma, surface contamination, air contamination;
— Isotope identification;
— Personal protective equipment.

NS.M11.4. Site characterization

NS.M11.5. Response management

— Priorities;
— Radiological versus conventional response;
— Response organization.

NS.M11.6. Emergency procedures

— Emergency response plan;
— Rescue/response action.

NS.M11.7. Prosecution

NS.M11.8. Consequence management

— Threat analysis and neutralization of RDDs;
— Risk factors and vulnerabilities;
— Emergency management;
— Strategies for consequence managements;
— Managements of mass casualties.

C. Practical exercises for NS.M11

NS.M11.3. Personal protective equipment exercise.

NS.M11.5.–M10.6. Tabletop exercise on incident response management and emergency procedures.

A. Course title

NS.M12. Crime scenes investigation and forensic techniques

B. Main modules

NS.M12.1. Introduction to traditional forensics

— Overview of available tools, techniques and methods;
— Traditional forensics evidence.

NS.M12.2. Introduction to nuclear forensics and nuclear forensic interpretation

— Goals in nuclear forensics;
— Tracing the route of the material from diversion to interdiction.

NS.M12.3. International cooperation

— Nuclear smuggling international technical working group nuclear forensics laboratories;
— Nuclear forensic data banks that catalogue nuclear processes for use in nuclear interpretation.

NS.M12.4. Principles of incident response

— Securing the incident site;
— On-site analysis;
— Collection of traditional forensic and radioactive evidence.

NS.M12.5. Nuclear forensics plan of action

— On-site action plan;
— Involvement of the national legal authority;
— Case treatment by the national courts.

C. Practical exercises for NS.M12

— NS.M12.1. Examples of traditional forensic evidence;
— NS.M12.2. Examples of a statement of nuclear forensics work.

D. Laboratory work

NS.M12.2. Determination of the source of radioactive material and its method of production.

II.2. ADDITIONAL COURSES

A. Course title

NS.M13. Nuclear material accountancy and inventory control of other radioactive material

B. Main modules

NS.M13.1. Role and functions of the national safeguards authority

NS.M13.2. The national nuclear material accountancy system

— Nuclear material accountancy and radioactive sources control;
— SSAC information system;
— State level accountancy system.

NS.M13.3. Nuclear material accountancy at the facilities

— Type of facilities, LOFs, nuclear related sites;
— Facility accounting system, facility records;
— Book inventory, physical inventory, material balance area;
— Closing the NM accounting balance.

NS.M13.4. National inspections and physical inventory taking

— National interim inspections and PIT;
— Book auditing, nuclear material inventory and flow verification;
— MUF, NM production, shipper/receiver difference, NM loss and gain;
— Material balance evaluation;
— Cumulative MUF.

NS.M13.5. International safeguards

— Safeguards agreements, comprehensive safeguards, integrated safeguards;
— Subsidiary arrangement, DIQ, facility attachment;
— State reports and declarations.

NS.M13.6. Safeguards evaluations

— Traditional safeguards criteria;
— State evaluation;
— Remote monitoring and satellite imagery;
— Safeguards conclusion, annual implementation report.

NS.M13.7. IAEA verification activities

— Facility and State level safeguards approaches;
— Safeguards inspections;
— Safeguards measures;
— Design information verification;
— Complementary access.

NS.M13.8. Control of other radioactive material

— Inspections at radioisotope production laboratories;
— Control of radioactive sources.

C. Practical exercises for NS.M13

NS.M13.3. Practical exercise to design the nuclear accountancy and control system at a nuclear reactor with associated isotope production hot cell laboratory (MBAs, control of NM production and loss, receipt of target NM, shipment of NM and radioactive sources, frequency of national inspections, PIT).

NS.M13.4. Practical exercise to evaluate PIT results at a bulk facility and prepare a material balance report for the State authorities, including calculated values of MUF, CuMUF, SRD, nuclear loss and production.

A. Course title

NS.M14. Vulnerability assessment of physical protection systems

B. Main modules

NS.M14.1. System analysis

— Fault and event trees;
— Expert opinion;
— Data reliability.

NS.M14.2. Risk management

— Risk definitions, acceptable risk;
— Methods of quantitative risk assessment;
— Elements of risk management.

NS.M14.3. Risk management in physical protection

— Estimating security risk;
— Risk reduction strategies;
— Cost effectiveness and acceptable risk;
— Impact of risk management decisions.

NS.M14.4. Evaluation and optimization of physical protection system

— Adversary path; scenario and path analysis;
— Probabilistic and graph-analytical methods in evaluation of physical protection systems;
— Insider and reliability analysis;
— System effectiveness evaluation;
— Optimization methods in evaluation of systems effectiveness;
— Uncertainties in evaluations;
— Decision making under risk and uncertainties, managing security risk.

C. Practical exercises for NS.M14

NS.M14.3. Case study: Risk assessment, evaluation of effectiveness and optimization of physical protection system of a large research reactor.

NS.M14.4. Case study: Optimization of the physical protection system of a research reactor or a fuel cycle facility.

A. Course title

NS.M15. Risk assessment and management of State nuclear security measures

B. Main modules

NS.M15.1. Analysis of the State nuclear related infrastructure and nuclear security measures

NS.M15.2. Analysis of adversary activities in the State and possible nuclear adversary characteristics (State threat assessment)

NS.M15.3. Evaluation of resistance of State nuclear activities and infrastructure to adversary

- Quantitative evaluation of technical difficulties in completion of each adversary's scenario;
- Qualitative estimation of possible adversary's capability in the State to complete each adversary's scenario.

NS.M15.4. Risk assessment of State nuclear activities and infrastructure, and effectiveness of State security measures

- Mathematical methods for quantitative nuclear and radiological risk assessments in the State;
- Quantitative risk assessment for each of the adversary's threats in the State.

NS.M15.5. Optimization of State nuclear security measures

- Mathematical method for optimization of the State security measures;
- Optimization of the State security measures;
- Effectiveness of the State security measures;
- State action plan for implementation of the State security measures;
- Responsibilities of State organizations;
- Design of the State action plan and distribution of the responsibilities;
- Analysis of detected inconsistencies and undeclared nuclear related activities as indicators of possible adversary activities in the State;
- Possible inconsistencies and undeclared nuclear activities;
- Analysis of detected nuclear inconsistencies and undeclared activities;
- Possible follow-up actions to improve State nuclear security measures.

C. Practical exercises for NS.M15

NS.M15.1. Case study: Evaluation of a State nuclear related infrastructure and possible nuclear security measures.

NS.M15.2. Case study: Analysis and optimization of the State security measures for a State (according to State infrastructure and State nuclear activities).

A. Course title

NS.M16(a). Physical protection systems for nuclear and other radioactive material, sources and facilities

B. Main modules

NS.M16a.1. Introduction to physical protection of nuclear and other radioactive material and facilities

— Categorization of nuclear material and radioactive sources;
— Misuse of nuclear facilities or equipment;
— IAEA Catalogue of sealed sources.

NS.M16a.2. Application of fundamental principles of physical protection to nuclear material and other radioactive material and facilities

— Roles and responsibility of international, national, local authorities and operators;
— Physical protection requirements.

NS.M16a.3. Characteristics of nuclear facilities

— Design of typical nuclear facilities;
— Vital areas.

NS.M16a.4. Radioactive material and sources use and storage

NS.M16a.5. Application of physical protection approaches and methods for nuclear and other radioactive material and facilities

— Specifics of PPS for nuclear facilities and facilities with radioactive material;
— Target identification;
— Threats and vulnerability assessment of nuclear and other radioactive material and facilities;
— Implementation of security measures.

NS.M16a.6. Establishing national infrastructure for security of nuclear and other radioactive material and facilities

— Creation of security awareness;
— Reviewing legislative authorities;
— Building regulatory capacity;
— Developing regulatory framework;
— Establishing graded security levels;
— Specification of security level application to nuclear material and facilities;
— Selection of regulatory approach.

C. Practical exercises for NS.M16(a)

NS.M16a.1–NS.M16a.5. Comprehensive project: Design and evaluation of physical protection of a nuclear or radiological facility.

A. Course title

NS.M16(b). Physical protection systems for radioactive material and sources

B. Main modules

NS.M16b.1. Introduction to physical protection of radioactive sources

— Categorization of radioactive sources;
— Certification of the sources;
— IAEA catalogue of sealed sources.

NS.M16b.2. Application of fundamental principles of physical protection specific to radioactive material and sources

— Roles and responsibility of international, national, local authorities and operators;
— Physical protection requirements.

NS.M16b.3. Radioactive material and sources, use and storage

NS.M16b.4. Application of physical protection approaches and methods for radioactive material and sources

— Specifics of PPS for radioactive sources;
— Target identification for facilities containing radioactive material and sources;
— Threats and vulnerability assessment in relation to radioactive material and sources;
— Implementation of security measures.

NS.M16b.5. Establishing national infrastructure for security of radioactive material and sources

— Creation of security awareness;
— Reviewing legislative authorities;
— Building regulatory capacity;
— Developing regulatory framework;
— Establishing graded security levels;
— Specification of security level application to radioactive sources;
— Selection of regulatory approach.

C. Practical exercises for NS.M16b

NS.M16b.1–NS.M16b.4. Comprehensive project: Design and evaluation of physical protection of a facility containing radioactive material or sources.

A. Course title

NS.M17. Import/export and transit control mechanism and regime

B. Main modules

NS.M17.1. Proliferation of CBRN and export controls

NS.M17.2. Import/export international regulations

— NPT and export/import control;
— Export/import control organizations.

NS.M17.3. Methodology for practical implementation

— Important nuclear weapon proliferation technologies, equipment and material;
— Dual use equipment;
— Export/import control practice.

NS.M17.4. Import/export national regulatory infrastructure and regulations

— Implementation of national law and regulations;
— Additional protocol and national export control requirements.

NS.M17.5. Nuclear and radioactive material international trade

— Export/import packing and labelling;
— Nuclear and radioactive material tariff classification codes;
— Nuclear and radioactive material characteristics subject to customs verification.

NS.M17.6. Exporting/importing and transit of nuclear and radioactive material: procedures and documentation

— Legal framework and regulations;
— Non-tariff restrictions and licences;
— Export/import and transit documentation;
— Customs clearance and customs inspection.

C. Practical exercises for NS.M17

NS.M17.6. Demonstration of typical import/export and transit documentation.

NS.M17.6. Case study: Check the correctness of a set of documentation and of the labelling for import of nuclear related equipment (full set of documents will be provided for the Case study).

A. Course title

NS.M18. Nuclear security at major public events

B. Main modules

NS.M18.1. Design of comprehensive nuclear security system for major public events

— Threat analysis and vulnerability assessment;
— Prevention activities;
— Detection activities;
— Response activities;
— General principles for the development of an action plan.

NS.M18.2. Prevention measures

— Physical protection of critical radiation sources;
— Role of the State in creating an effective physical protection system;
— Border monitoring;
— Nuclear security preparation for a State that hosts a major public event;
— Training;
— Sustainability/maintenance.

NS.M18.3. Detection measures

— Selection of venues and other strategic locations for detection systems;
— Detection approach and equipment deployment strategies;
— Detection instruments;
— Acceptance testing;
— Equipment calibration and maintenance;
— Training.

NS.M18.4. Response measures

— Elements of response;
— Organizational structure for response;
— Response to an alarm;
— Emergency response;
— Consequence management;
— Training and awareness.

C. Practical exercises for NS.M18

NS.M18.1–NS.M18.4. Case study: Example command and control structure for a major event.

NS.M18.1–NS.M18.4. Action plan: Study of an example.

NS.M18.1–NS.M18.2. Case study: Design basis threat for a major sports event.

NS.M18.3 Presentation of a generic alarm response scheme for a major public event.

D. Laboratory work

NS.M18.3–NS.M18.4. Radiation alarm verification in a crowd.

A. Course title

NS.M19. Nuclear forensics and attributions

B. Main modules

NS.M19.1. Physical basis for nuclear forensic science

— Nuclear and other radioactive material;
— Effects of production and treatment of nuclear and other radioactive material on specific signatures (physical, chemical and isotopic signatures).

NS.M19.2. Radioanalytical chemistry principles and practices

— Carriers and tracers in inorganic analysis;
— Relevant chemical and physical properties;
— Techniques for forensic signatures;
— Collateral forensic indicators;
— Radionuclide separation and purification;
— Standard methods in radioanalytical chemistry.

NS.M19.3. Incident response

— Securing the incident site;
— On-site measurements;
— Collection of traditional and radiological forensic evidence.

NS.M19.4. Nuclear forensic laboratory sampling and distribution

— Nuclear forensic laboratory;
— Sampling in the nuclear forensics laboratory.

NS.M19.5. Nuclear forensic analysis

— Characterization goals;
— Presentation of available analytical tools for nuclear forensics;
— Sequence of analysis techniques and methods.

NS.M19.6. Nuclear forensic interpretation

— Nuclear dating methods and forensic signatures;
— Cooperation with other nuclear forensics laboratories;
— Knowledge bases of nuclear processes;
— Iterative nuclear forensics process.

NS.M19.7. Confidence in conclusions

— Analytical data quality objectives control;
— Precision, accuracy, sensitivity;
— Reporting of results.

C. Practical exercises for NS.M19

Proposal for a series of exercises related to the interdiction of material in a container:

NS.M19.3: Sampling of interdicted material and instrument selection for analysis.

NS.M19.6: Data interpretation (including use of databases) of the results of analysis.

NS.M19.7: Conclusions of the analysis.

D. Laboratory work

NS.M19.1–NS.M19.4. Use of various analytical tools to determine the source of radioactive material and its method of production.

A. Course title

NS.M20. Infrastructure and procedures for detection and response to incidents involving nuclear or other radioactive material out of regulatory control

B. Main modules

NS.M20.1. Development, maintenance and interpretation of the portion of a national response plan that is related to incidents involving nuclear and other radioactive material out of regulatory control

— Creation of organizational structure;
— Competencies of institutions/agencies involved;
— Development of a design basis threat and vulnerability assessment;
— Obtaining and using illicit trafficking information;
— Concept of operations;
— Physical protection of nuclear and radiological facilities;
— Border monitoring to detect illicit trafficking;
— Deployment of equipment;
— Mobile expert support team (MEST);
— Maintenance and revision of the national response plan.

NS.M20.2. International assistance to augment response capability

— Assessment of needs, capabilities and desirability of requesting international teams;
— Developing necessary international agreements;
— Developing coordinated plan to integrate international assistance into national plans;
— Developing training programme and material for integration;
— Coordinating international assets.

NS.M20.3. Developing training programme

NS.M20.4. Response procedures

— Response initiation and operation, scale of response;
— Mitigation of health hazards;
— Incident investigation and gathering of evidence;
— Media awareness;

— Tabletop exercises to validate procedures;
— Provisions for revision of procedures.

C. Practical exercises for NS.M20

NS.M20.1. Examine the country's response plan.
NS.M20.2. Requesting international assistance — Case study.
NS.M20.4. Develop response procedures on hypothetical cases.

A. Course title

NS.M21. Cooperation of stakeholders at the national and international levels

B. Main modules

NS.M21.1. Interagency cooperation and coordination

— Roles and strategies of nuclear/radiological regulator and radiation response organization;
— Law enforcement, fire department, hazmat and emergency medical services management;
— Techniques for promoting interagency understanding;
— Capabilities of and interaction among emergency management responders;
— Interagency planning.

NS.M21.2. Cooperation with other competent organizations in case of combined CBRN incidents

— Joint operations in CBRN environments;
— Difference between chemical, biological, radiological or nuclear events;
— Personal safety considerations;
— Indicators of CBRN events.

NS.M21.3. Cooperation with other competent organizations in case of incidents involving RDDs

— Explosives and conventional ordnance;
— The role of bomb squad;
— Mass casualty events, related safety and health topics;
— Interagency cooperation in protection of first responders, health care workers, cleanup workers and others;
— Organizations and authorities involved in RDD response;
— Command and management.

NS.M21.4. International coordination

— International Atomic Energy Agency (IAEA);
— United Nations Scientific Committee of the Effects of Atomic Radiation (UNSCEAR);
— International Commission on Radiological Protection (ICRP) ;

— OECD/NEA Regional Cooperation Agreement;
— Forum for Nuclear Cooperation in Asia (FNCA) ;
— Organization of international cooperation in case of major radiological/nuclear emergencies.

C. Practical exercises for NS.M21

NS.M21.1–NS.M21.4. Case study: International cooperation for a large scale nuclear emergency response exercise.

ABBREVIATIONS

CBRN	chemical, biological, radiological and nuclear
CPPNM	Convention on the Physical Protection of Nuclear Material
DBT	design basis threat
DIQ	design information questionnaire
GNEP	Global Nuclear Energy Partnership
HEU	high enriched uranium
ICAO	International Civil Aviation Organization
ICR	inventory change report
IMO	International Maritime Organization
IND	improvised nuclear device
ITDB	Illicit Trafficking Data Base
LOF	location outside facility
MSc	Master of Science
MBR	material balance report
MEST	mobile expert support team
MUF	material unaccounted for
NM	nuclear material
NSD	neutron search device

PIL	physical inventory listing
PIT	physical inventory taking
PPS	physical protection system
PRD	personal radiation detectors
RDD	radiological dispersal device
RED	radiation exposure device
RID	radionuclide identification device
RPM	radiation portal monitor
TA	threat assessment
UNECE	United Nations Economic Commission for Europe
UNGA	United Nations General Assembly
WNTI	World Nuclear Transport Institute

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