

State Atomic Energy Corporation (ROSATOM)
Central Institute for Continuing Education and Training (CICE&T)
International Training Center

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SYLLABUS

Training Course

**«Security and physical protection of NPPs
and the relationship with safety and safeguards»**

Compiled by

Signature

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Obninsk
2010

Generals

Training course title	Security and physical protection of NPPs and the relationship with safety and safeguards
Final objective:	Participants are expected to achieve a good understanding of physical protection at NPP
Course duration:	100 hours
Attendees education background:	MS in mechanical engineering, energy science, environmental science
Type of training :	Qualification upgrade
Date:	2010
Form of training :	At the beginning of the course acceptance test is performed. Basic form of the course is combination of lectures and seminars given by experts and executives from industry, national research laboratories and universities. The course is finalized with the examinations (final test). Judging by the results of final examination the state-proved certificate of qualification upgrade is awarded.
Training course tools:	LCD –projector, deliveries in the form of printed slides, whiteboard, markers
Language	English
Venue and accommodation	The course will be given on the premises of the Central Institute for Continuing Education&Training
Responsible organizer:	Central Institute for Continuing Education& Training 249031, 21, Kurchatova str, Obninsk, Kaluga, Russian Federation
Attendance fee	TBD
Contact person	Prof. V.Artisyuk. +7 (915)896-94-84, artisyuk@scicet.ru

Blocs and topics of the training course

№	Blocks and topics	Total, hours	including	
			lectures	hands-on sessions
1	2	3	4	5
1	Basic principles of nuclear fuel cycle from nuclear physics to waste management and protection against unauthorized proliferation	10	8	2
To achieve a good understanding of nuclear fuel cycle and waste management from the view point of material properties related to non-proliferation				
2	Effect of radiation, safety and radiation protection	10	10	
To achieve a good understanding of radiation effects, radioecological safety, environmental monitoring, international and Russian standards				
3	National and International Safeguards and Accounting Standards	10	10	
To achieve a good understanding of standards from the view point of safety, security and safeguards.				
4	Threat assessment	6	6	
To achieve a good understanding of basic concepts and relationships between protection features and threat				
5	Physical protection systems design and evaluation	11	5	6
To achieve a good understanding of infrastructure and procedures for detection and response to incidents involving nuclear and other radioactive materials				
6	Physical protection technologies and equipment	14	6	8
To achieve a good understanding of technology and equipment for detection and response to incidents involving nuclear and other radioactive materials				
7	Radioactive waste management	10	10	
To achieve a good understanding of spent fuel and nuclear waste treatment				
8	Measurement methods in material control and accounting system	10	8	2
To achieve a good understanding of principles and applications of non-destructive methods				

9	Use of non-destructive and destructive analysis methods for MC&A	8	8	
To achieve a good understanding of principles and applications of non-destructive methods				
10	Statistical analysis of inventory difference in MC&A	10	8	2
To achieve a good understanding of advanced methods in accounting nuclear materials				
11	Examination (final test)	1		1
	Total	100	79	21

1. Basic principles of nuclear fuel cycle from nuclear physics to waste management and protection against unauthorized proliferation(10 hours)

1.1 Core and fuel assembly Vyalitsin V.V., GIDROPRESS (2 hours)

Description of the core of the high-power VVER reactor (VVER-1000, VVER-1200) and its major components. Design of fuel assembly and its key components. Bundle of control and protection system absorbing rods and absorber elements. Estimation and experimental justification of fuel element serviceability and safety. Fuel cycles used at NPPs with VVER. Experience of fuel elements operation at Russian NPPs and prospects for introduction of upgraded fuel.

1.2 Equipment for handling NPP fuel Chernishov V.N., GIDROPRESS (1 hour)

Handling with fuel from its arrival at NPP to loading of the spent nuclear fuel to container for shipment from NPP. Mechanical equipment used for fuel storage and transportation.

1.3 Current status of the nuclear fuel cycle (NFC): mining, enrichment, fabrication, interim storage, disposal. S.A. Subbotin, RRC “Kurchatov Institute” (7 hours)

Regional aspects. Assessment of uranium resources. Environmental problems and long-term issues of radiation safety associated with uranium mining. Possible ways of development of processing stages of the NFC. Prospects for improving different stages of the NFC. Effectiveness of fuel use, neutron potential in nuclear power systems, functions of nuclide logistics. Issues of transportation of nuclear fuel, interregional exchanges. International nuclear fuel centers. Different aspects of establishing NFC and INPRO, GNEP and G-IV requirements to NFC

2. Effects of radiation, safety and radiation protection (8 hours)

Cherkashin V.A., Cnentral Institute for Continuing Education&Training (8 hours)

Interaction of radiation and biological tissue. Role of radicals in causing damage. Biological paradox. Dynamics of dose limits. Radiation sources at reactors. Activation, corrosion and fission products. Dosimetry characteristics of radiation sources.

Dosimetry characteristics of radiation sources. Changes in radionuclide composition of contaminants as a function of time of reactor operation and spent fuel cooling. Deterministic and stochastic effects of exposure to small doses. Impact of accumulated dose on long-term consequences of exposure. Acceptable risk. Relationship of linear energy transfer and dose rate and health effects.

Principles for assessing effects of ionizing radiation on living organism. Radiation sickness. Lethal doses. Health effects at small radiation doses for humans

Regulatory documents related to human exposure. History of evolution of regulation principles. Transition from the concept of critical organ to the effective dose concept. Main principles of requirements of ICRP, NRB-99 and OSPORB-99.

Laws and regulations on nuclear power. Requirements related to licensing. Legal framework for the activity of oversight authority (Rostekhnadzor, Gossanepidnadzor, MVD, Civil Defense and Ministry of Emergency) and mode of their interaction in ensuring radiation safety

Justification for dose limits for personnel and members of the public based on acceptable risk

3. National and International Safeguards and Accounting Standards (8 hours)

Pshakin G.M., Institute of Physics and Power Engineering (10 hours)

Introduction: Short historical overview of International Safeguards

Basic IAEA documents on Safeguards –Statute, INFCIRC – 66 and 66/Rev2., NPT, INFCIRC – 153, INFCIRC – 540 ETC.

National Safeguards – legal framework, structure, implementation

Nuclear Materials counting – goals, objectives, technologies

Nuclear Materials Control - goals, objectives, technologies

Physical Protection - goals, objectives, technologies

Export Control – national and international goals; international agreements; national legal framework.**MC&A Standards** – computerization, data transfer, NDA and DA measurements systems, quality control, reference materials, material balance, reporting

4. Assessment of design-basis threats of nuclear material theft at the plant and requirements to characteristics of subsystems of material control and accounting system (6 hours)

Regoushevsky V.I., Institute of Physics and Power Engineering (6 hours)

Goals and objectives of material control and accounting system (MC&A) Information in MC&A system. Requirements to source information. Information needs for material balance. Goals and types of inventory taking. Inventory difference. Initial inventory taking. Anomalies in MC&A

Role of measurements in material control and accounting system. Selection of measuring methods and tools based on a design-basis threat list. Use of seals and stamping devices. Confirmatory measurements to confirm that design-basis threats are not realized.

Procedure in case of detection of anomalies in MC&A.

Actions in case of detection of anomalies in MC&A. Requirements of OPUK.

Special report – report on conditions and causes of anomaly

5. Physical protection systems design and evaluation (11 hours)

Zubkov Dmitry “Interdepartmental training center”

6.1 Fundamentals of PPS design

Strategies for PPS design. Determining the intent of malevolent actions. PPS design and evaluation outline (DEPO). Defining the requirements to PPS. Facility characterization. Implementation of PPS functions. Characteristics of effective physical protection system. **(lecture-3 hours)**.

Analysis of PPS for a hypothetical nuclear facility. Determining the requirements to PPS. Development of the PPS concept for a nuclear facility (protected area perimeter, personnel and vehicle entry points, perimeter crossing engineering communications). **(practice-5 hours)**.

6.2 Evaluation of effectiveness of PPS

Concept of design basis threat. Vulnerability analysis and PPS effectiveness assessment. Methods of their conduct and application of results. **(lecture – 2 hours)** .

Identifying the nature of threats and those who may implement them based on suggested situation scenarios. **(practice – 1 hour)**.

6. Physical protection technologies and equipment (14 hours)

Zubkov Dmitry “Interdepartmental training center”

7.1 Perimeter detection instrumentation

Role of detection instrumentation in the facility physical protection. General requirements to perimeter detection instrumentation. Creating barriers on the borders of protected areas. Operating principles of exterior sensors, their merits and shortcomings. **(lecture – 2 hours)**

Demonstrating options of configuring detection systems along the perimeter, integration of engineering capabilities and instrumentation of physical protection systems. Demonstration of operation of detection sensors using different detection principles. **(practice – 3 hours)**

7.2 Interior intrusion detection equipment at nuclear facility

Classification of detection equipment. Operational principles and technical characteristics of detection instrumentation. Purpose, structure, composition and recommendations as to the use of detection systems in buildings and rooms. **(lecture – 1 hour)**

Features of using detection equipment indoors. Zones of detection equipment coverage and causes of misses. Causes of false alarms of detection equipment. Possibility of bypassing (cheating) detection equipment. **(practice – 1 hour)**

7.3 Access control and delay systems (ACDS)

Purpose and goals of ACDS. Composition of ACDS. Main functions of ACDS. Rules for equipping different entry points with ACDS. Requirements to inspection equipment tools. **(lecture – 1 hour)**

Demonstration of ACDS capabilities and operation at different entry points (personnel and vehicle entry points of different zones) **(practice – 1 hour)**

7.4 Electro-optical surveillance systems (EOSS)

Intended use of EOSS and situation assessment. EOSS composition. EOSS main functions. EOSS operational modes. Resolution levels of EOSS elements. Requirements to EOSS equipment . **(lecture – 1 hour).**

Demonstrating features of configuration and operation of analogue and combined EOSS systems of different manufacturers . **(practice-1 hour).**

7.5 Data collection and processing systems (DCPS)

Main functions of DCPS. Classification of DCPS. Features of contemporary DCPS. Criteria for selecting DCPS. DCPS deployment and operation . **(lecture-1 hour)**

Demonstrating operation and design features of contemporary DCPS. **(practice-2 hours)**

7. Radioactive waste management

Vasilyeva A.N., Institute of Physics and Power Engineering – 10 hours

Introduction: Liquid, solid and gaseous radioactive waste (RW). Sources and characterization of radioactive waste. Classification of radioactive waste

Regulatory framework of radioactive waste management. Radiation safety standards. Key sanitary rules for ensuring radiation safety. Sanitary rule for radioactive waste management.

Experience of radioactive waste management in different countries. Main directions in science and technology. Methods for radioactive waste conditioning: compaction, remelting, biological oxidation methods, bituminization, vitrification incorporation into ceramics and mineral-like matrix. Main lines of activities of the nuclear center Studsvik (Sweden). Methods of high-level waste and SNF in selected countries.

Safe storage and disposal of radioactive waste. Requirements to site of radioactive waste storage and disposal sites. Characteristics of engineered barriers.

Problems of old radioactive waste storages built in the 50-s of the last century. Assessment of migration of man-made radionuclides beyond subsurface storages. Environmental monitoring on the territory of storages and in the vicinity. Methods to assess radiation and toxic effects of radioactive waste storages on ecosystem components and human health

8. Measurement methods in material control and accounting system (10 hours)

Regoushevsky V.I., Institute of Physics and Power Engineering (10 hours)

Use of measurement methods for MC&A

Confirmatory measurements of characteristics of nuclear materials in the course of physical inventory taking. Specific features of application of methods and accuracy indicators. Accountability and confirmatory measurements. Training of personnel .

Documentation, instrumentation and methodological support to measurements

Measurement program, measurement control program. Characteristics of nuclear materials to be measured. Methods to perform measurements. Tools for measurement. Standard samples. Comparison of methods of non-destructive and destructive analysis

9. Use of non-destructive and destructive analysis methods for MC&A.

Filippov V.V., Institute of Physics and Power Engineering (10 hours)

Brief review of destructive and non-destructive methods.

Specifics of gamma technique application (high resolution Ge technique and low resolution NaI scintillation technique).

Specifics of neutron technique

- Total neutron counting for nuclear material mass measurement;
- Neutron coincidence technique for mass measurement- active and passive methods;
- Neutron spectra analysis (neutron resonance transmission method)

Practical case 1: express analysis of isotopic composition of nuclear materials with gamma technique (based on analysis of gamma spectra)

Practical case 2: express analysis of neutron transmission spectra in selected samples to make isotopic identification.

10. Statistical analysis of inventory difference in MC&A

Karpenko A.Ya., Central Institute for Continuing Education&Training (10 hours)

Introduction: The issue of non-proliferation of nuclear weapons (nuclear materials), IAEA safeguards.

Role of nuclear material control and accounting. Terminology and concepts.

Principles for nuclear material control and accounting. Materials to be accounted in the state system of nuclear material control and accounting. Categories of nuclear materials. Accountability items and material in bulk form. Material balance area. Key measurement points. Physical inventory taking of nuclear materials. Nuclear material balance. Calculation of inventory difference. Anomaly criteria in nuclear material control and accounting. Specific features of nuclear material control and accounting at NPP.

Methods of mathematical statistics in nuclear material control and accounting. Statement of the problem for discrepancy in shipper and receiver data, accountability and confirmatory measurements. Examples of solutions. Selected statistical control of accountability items. Statement of problem and examples of solution

Statistical analysis of inventory difference in nuclear material control and accounting

Statement of problem of inventory difference analysis. Methods for calculating ID variance, Regulatory documents to calculate IR discrepancy boundaries. Examples of statistical analysis of IR.

Practical sessions. Selection of MBA. Calculation of ID. Discrepancy in shipper and receiver data. Statistical samples. Calculation of ID variance, detecting anomaly in nuclear material control and accounting.