Modernization of physical protection educational laboratories in the National Research Nuclear University MEPhI

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Abstract. Non-proliferation of nuclear materials includes, in addition to accounting and control, the Physical Protection (PP) of one. The paper considers the experience by MEPhI in application the practical educational in the area of PP technical systems. The following aspects are discussed in the paper: specific features graduate program in nuclear security area; overview of the practical course curricula in the special laboratory.

1. Background

MEPhI has the 20-year experience in developing and implementing the educational programs of different graduate levels in the area of Nuclear Security. There are the Master of Science Graduate Program and Engineer Degree Program. To train high level specialists is needed laboratory with modern equipment. Joint efforts undertaken by the RF State corporation Rosatom, US Department of Energy, and MEPhI have resulted in creating the MS Graduate Program (MGP) in Nuclear material (NM) Physical Protection, Control and Accountability at MEPhI Department “Theoretical and Experimental Physics of Nuclear Reactors” in 1997. The educational program takes two academic years and has been developed for training those, who have already completed technical education at the level of Engineer or Bachelor of Sciences in the associated directions. The graduates receive the MS degree in Physics. In 2001 further joint efforts was started the Engineer Degree Program (EDP) “Security and Non-Proliferation of Nuclear Materials”. This educational program takes 5,5 academic years. Under the EDP the students have an opportunity to have a specialized training in the following two directions: nuclear materials (NM) control and accountability and physical protection of nuclear objects and materials.

2. The main direction of PP training

The graduates from the areas of nuclear security and NM physical protection shall:

- Know all the regulatory requirements to PP systems of nuclear objects, methodology for PPS development and upgrading, have a clear notion about a variety of PP engineering and technical tools;
- Have a capability to prepare the technical requirements on PP systems creating or upgrading, have a capability to estimate the proposed decisions, organize and conduct the works on PPS creating or upgrading;

- Have a capability to apply the methodologies for assessment of PP systems effectiveness.

Currently, these areas are covered by the following main disciplines:

- Fundamentals of nuclear materials physical protection, control and accountability.[1]
- Methods of vulnerability analysis and optimization of PP systems.[2]
- Equipment and devices of physical protection systems.[3]

The training course “Fundamentals of NM physical protection, control and accountability” is the first course of the direction that contains introduction into the specialty. The training course “Methods of vulnerability analysis and optimization of PP systems” covers the methodologies and basic principles used in PPS designing, creating and effectiveness assessment.

The course “Equipment and devices of physical protection systems” contains deep knowledge the engineering and technical tools, which are the mostly used in PP of nuclear objects, and specific features in their applications.

In present time, PP training laboratories, created in 2003, consist of separate training places, in which the following laboratory works are carried out:

- Interior sensors for physical protection systems;
- Access control and management system;
- Video-surveillance systems;
- Data acquisition and processing systems.

Also students learn the simplest methods of integration of separate PP subsystems, such as "dry contacts" (relay). For example – start of camera work by a signal from the sensor alarm. Such methods were widely used in real PP systems at nuclear facilities at the beginning of the millennium.

3. Modernization of PP training laboratories

Over the past decade, new equipment and methods have been established on nuclear facilities PP system. For instance, integration of subsystems based on Ethernet technologies is used overall, web-cameras are widely applied, biometric and video analysis technologies have been developed. These changes force us to improve the educational process. Therefore, MEPhI is able to update laboratory equipment under financial support from the US Department of Energy in 2016.

The new laboratory complex will be based on several workstations. Every workstation deals with its own PP subsystems (access control, alarm sensors, video cams). All subsystems are connected with each other by network.

The educational process in the PP laboratory training includes the following PP components:

- detection systems and tools for physical protection of rooms, buildings and perimeters, methodologies and specific features in their applications;
- access control systems and tools: identification tools, control and management systems, devices of biometrical identification, executive means, methods and technologies for creation of the distributed access control networks;
- main components of video-surveillance system: camera-system, tools for transmission of video-pictures, commuters, recorders, methods and technologies for creation of the distributed video-surveillance networks, remote monitoring system;
- methods and technologies for creation of the integrated security systems: alarm systems through radio-channels and telephone lines, the integrated PP including systems for protection and situation assessment at lengthy perimeters;
- fire alarm systems.

Fire alarm system is not formally PP subsystem, but uses similar principles of operation. Moreover, fire systems are equipped at all the nuclear and other dangerous facilities.

Figure 1 shows the flowchart of interaction access control and alarm subsystems.

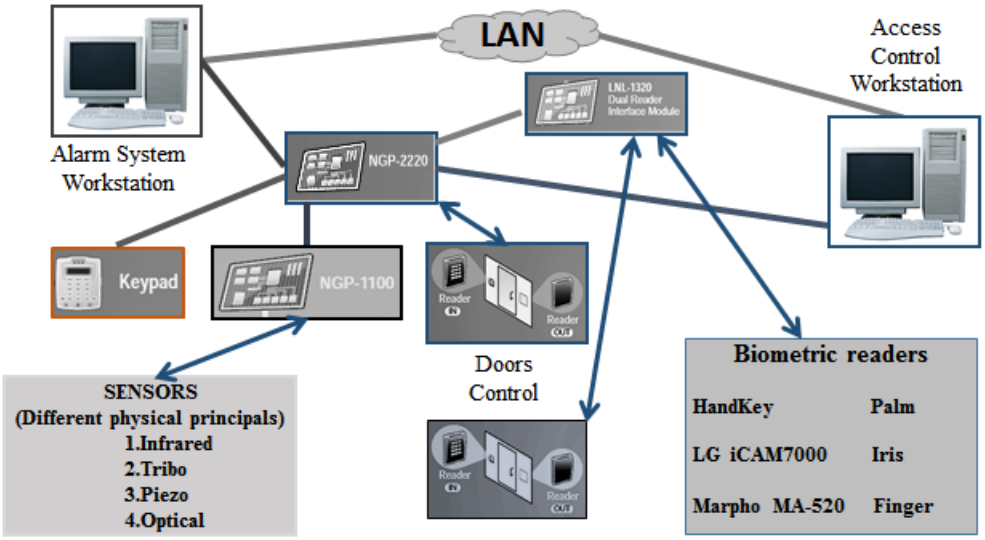

Figure 1. The Access Control and Alarm System laboratory facilities scheme.
Lines show the LAN (Local Area Network) connection.
Arrows show information transfer under firmware protocols, the interface is provided by intelligent NGP controllers family.

Video surveillance is one of the most complex PP subsystems. Figure 2 shows the flowchart of designing video parts for laboratories.

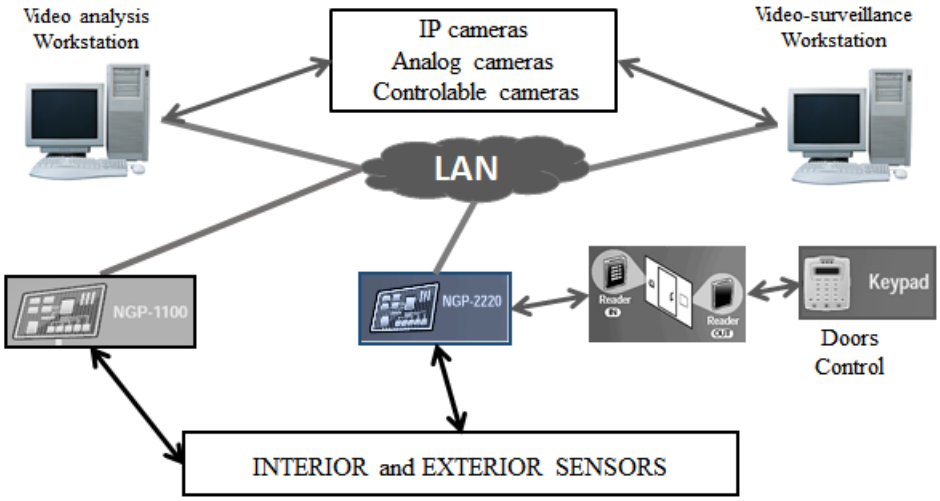

Figure 2. Laboratory video facilities scheme.
Designations correspond to the previous figure. As a signal source to be used for above ten cameras.

During training, students consistently study separately all subsystems and, principles of operation of each equipment element. However, since all the parts are integrated with a common manager server, learning tasks can be more complex. It is possible to organize complicated scenarios of interaction of subsystems. Possible options for such modeling scenarios are listed below.

a) The sensor detects intrusion into the protected area. Video system receives an alarm signal, selects the appropriate camera and displays the picture on the operator workplace. Simultaneously, the picture

is transmitted to the video analysis work station. After analysis, the characteristic can be given, is the event false or not.
b) The employee enters an area which is protected by sensors. Access control system checks whether the entry is authorized or not. If access is denied, the sensors are switched off. Otherwise, there is an alarm and other actions perform, such as blocking doors and locks.
The modeling of those and similar tasks allows students to successfully take on the challenges of real objects.

4. Conclusion

For the modernization of the training PP laboratories the modern equipment has been selected. Characteristics of equipment correspond to same devices used at nuclear sites. It should be noted that the PPS training and research laboratories were structured as a “sand-box”, i.e. the students can create and simulate various PP system structures within the limited frames of available laboratorial equipment. These capabilities are of special importance in the course of the training research works, pre-diploma internship works, preparation of the graduate qualification works or preparation of the MS thesis. New equipment is going to be installed in the PP laboratories for the Fall-2016 semester, and currently activity on creation and development of new laboratorial practical works is underway.

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