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NUCLEAR SECURITY IN NUCLEAR ENERGY NEWCOMER COUNTRIES

Despite renewed doubts about the benefits of nuclear energy in the wake of the accident at the Fukushima NPP in Japan, a large number of countries have recently launched nuclear energy programs or announced plans to do so in the near future. The list of the *nuclear newcomers* includes such states as Bangladesh, Belarus, Kazakhstan, Turkey, the United Arab Emirates, Vietnam, and several others. These states vary greatly in terms of their technological development, financial capabilities, and existing experience in managing nuclear material and facilities. All of these factors have an impact on the nuclear newcomers' ability to provide adequate levels of nuclear safety and security.

Nuclear security is one of the key elements of a successful nuclear energy program. According to the IAEA, the definition of nuclear security includes prevention, detection, and effective response to theft, sabotage, unauthorized access, unlawful transfer, and other malicious acts involving nuclear material and other radioactive substances, as well as nuclear facilities and nuclear material storage sites.

Given the existing range and severity of threats, the provision of nuclear security must be regarded by the nuclear newcomer states as one of the key obligations that follow from the acquisition of nuclear facilities and material. Key nuclear security measures include nuclear material protection, control, and accounting (MPC&A).

Physical protection¹ of nuclear material consists of a range of technical and organizational measures implemented at nuclear facilities, as well as coordination between nuclear operators, law-enforcement agencies, security services, and other agencies involved in nuclear material management.

Nuclear material accounting is defined as determining the quantity of that material, as well as the compilation, registration, and maintenance of nuclear accounting and reporting documents. Nuclear material control is defined as controlling the presence and any movements of nuclear material, including control of access to nuclear material, equipment and information, monitoring nuclear material, and inspecting authorized placement and transfer of nuclear material.²

The key sources of MPC&A expertise required by the nuclear newcomer countries include IAEA recommendations and assistance provided by the suppliers of nuclear facilities, material, technologies and equipment. These countries can also make use of the existing international mechanisms of assessing the state of MPC&A systems and providing feedback and recommendations on how these systems can be improved.

This article focuses on the existing international requirements for MPC&A and provides a list of measures that can be implemented by the nuclear newcomer countries at the national level in order to achieve an adequate level of nuclear security.



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THE INTERNATIONAL NUCLEAR SECURITY REGIME

The international obligation to undertake adequate MPC&A measures was established by UN Security Council Resolution 1540, which was adopted in 2004. That obligation includes adequate national controls over nuclear weapons and related materials in order to prevent their proliferation. Under the terms of Article 3 of the Resolution, member states have an obligation to develop and implement adequate and effective measures to ensure physical protection, control, and accounting of nuclear material.

Fundamental nuclear security requirements are established by the Convention on the Protection of Nuclear Material. In accordance with amendments to the convention, each state party shall establish, implement and maintain an appropriate physical protection regime applicable to nuclear material and nuclear facilities, with the aims of protecting against theft of nuclear material in use, storage and transport; ensuring the implementation of rapid and comprehensive measures to locate and recover missing or stolen nuclear material; protecting nuclear material and nuclear facilities against sabotage; and mitigating or minimizing the radiological consequences of sabotage. To achieve these goals, state parties must establish and maintain a legislative and regulatory framework to govern physical protection, establish or designate a competent authority or authorities responsible for the implementation of the legislative and regulatory framework; and take other appropriate measures necessary for the physical protection of nuclear material and nuclear facilities.

It is worth mentioning that the initial text of the convention adopted in 1980 covers only nuclear material during international transportation. The amendments adopted in 2005 increase the scope of the convention to include all nuclear material and nuclear facilities used domestically by the member states. These amendments, however, have yet to enter into force because not enough member states have ratified them to date.

As far as nuclear material control and accounting is concerned, there is no international document in this area similar to the Convention on physical protection. Some requirements for material accounting and control are established in the safeguards agreements signed between the IAEA and the NPT member states in accordance with Article 3 of the Treaty. Under Article 7 of the model safeguards agreement, state parties are required to implement and maintain a system of control and accounting for all nuclear material placed under safeguards. Article 32 of a model safeguards agreement also contains fundamental requirements for a national material control and accounting system.

Detailed recommendations on physical protection of nuclear materials and facilities that ensure compliance with compulsory requirements of the Convention on Physical Protection of Nuclear Material are provided in various IAEA documents, including:

Nuclear Security Series Publications No 20: Objective and Essential Elements of a State's Nuclear Security Regime (*Fundamentals*). This document is for use by politicians, legislators, government agencies and other state institutions and officials to aid them in establishing, implementing, and maintaining long-term effectiveness and sustainability of a national nuclear security regime. The document draws on the provisions of many international agreements that define the legislative and regulatory framework in the area of nuclear security, as well as the experience of IAEA members in establishing and maintaining their own national nuclear security regimes.

NSS 13: INFCIRC/225/Revision 5, Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (*Recommendations*). This document contains a list of *recommended* requirements that are necessary to

achieve the goals and implement the measures outlined in the Fundamentals. Over the years, this document has become the standard of key requirements that must be reflected in the national legislation and regulation of IAEA members. Many experts believe that the requirements outlined in the Recommendations are insufficient — but they are the only ones at the moment to which all parties can agree.

There are also several other IAEA documents that provide recommendations on specific elements of nuclear material protection systems.

Another useful publication that contains detailed requirements in this area is **Nuclear Material Accounting Handbook, IAEA Services Series #15**. It provides recommendations on implementing national control and accounting systems.

These documents establish basic criteria for assessing the state of national MPC&A systems, including protection systems at individual nuclear facilities.

NUCLEAR SECURITY REQUIREMENTS

IAEA recommendations have been used to formulate the following requirements to national MPC&A systems for the nuclear newcomer countries, including measures implemented at the national level and measures to be taken by each individual facility that works with nuclear material.³

Requirements to national MPC&A systems

Physical protection, control and accounting of nuclear material must be compulsory for any activities that involve nuclear material and the operation of nuclear facilities.⁴ National legislation must define MPC&A as a compulsory requirement for any activities that involve nuclear material and for the operation of nuclear facilities. It must list nuclear materials and special non-nuclear materials — including their type, form, and threshold quantities — that are subject to control and accounting, as well as material and facilities that require physical protection. The list of material and facilities subject to physical protection, control and accounting must comply with IAEA recommendations.

National laws and regulations **must make operators responsible for control and accounting of nuclear material and nuclear facilities.** They must set out mechanisms of ascertaining the operator's ability to provide physical protection, control and accounting for nuclear material. Activities that involve nuclear material and facilities must be suspended if the operator is unable to provide adequate protection, control and accounting (licensing, inspection, and penalties).

Laws and regulations **must establish responsibility for ensuring physical protection, control and accounting of nuclear material at the national level,** including responsibility of government agencies, their remit, and coordination.⁵ National legislation must establish responsibility of various agencies for ensuring physical protection, control and accounting of nuclear material. Laws and regulations must define agencies that are directly responsible for managing and coordinating activities in the areas of physical protection, control and accounting of nuclear material, and that act as the competent authorities in these matters at the international level. Laws and regulations must also define agencies that do not have direct responsibilities related to nuclear material management, but whose work is important to ensure nuclear security, such as law-enforcement agencies, agencies providing armed security guards, and agencies



involved in emergency response. Laws and regulations must define the remit of these agencies with regard to nuclear security issues and the procedure of their cooperation in discharging these functions.

Laws and regulations **must designate a regulatory authority** that is functionally, organizationally, and financially independent of the agencies and organizations that govern nuclear material management, manage nuclear material, or provide services related to nuclear security, such as designing physical protection systems for nuclear material and facilities. The remit of the regulatory authority must include establishing compulsory requirements and verification of compliance with these requirements at the licensing stage and during operation, as well as applying penalties for any violations.⁶

A legislative and regulatory framework for MPC&A must be put in place.⁷

The existing national legislative and regulatory framework must ensure the development of laws and regulations that establish requirements for physical protection, control and accounting of nuclear material. The existing system must make it possible to identify gaps in the legislative and regulatory framework and to develop new and/or review the existing laws and regulations. Fundamental laws and regulations must be put in place to regulate physical protection, control and accounting of nuclear material. The established requirements must be made available to any organization whose work requires physical protection, control and accounting measures, or which provides relevant services. A system of advisory documents must be put in place (guidelines, standards, recommendations, etc) to help nuclear operators comply with compulsory requirements.

There **must be penalties, including criminal penalties**, for violating MPC&A requirements and for unauthorized action with regard to nuclear material and facilities.⁸ National laws must stipulate penalties, including criminal ones, for violating MPC&A requirements and for unauthorized action involving nuclear material or facilities. These penalties must be in line with the relevant international agreements in this area (Convention on the Protection of Nuclear Material, International Convention for the Suppression of Acts of Nuclear Terrorism). The existing national law-enforcement system must ensure that perpetrators are identified and brought to justice.

Nuclear material and facilities must be categorized in order to establish graded requirements for their protection, control and accounting systems depending on their attraction as targets for unauthorized action and the gravity of the consequences of such action.⁹

States **must put in place a system of response to unauthorized action involving nuclear material and facilities**, including measures by law-enforcement agencies to find and retrieve nuclear material, as well as to mitigate and neutralize the consequences of unauthorized action involving nuclear material and nuclear weapons. A government must designate agencies responsible for emergency response, their remit, and coordination procedures.¹⁰

A country **must have a national register of nuclear material** that contains information about all nuclear material on national territory that is subject to accounting requirements, regardless of its form of ownership. A country must also have a reporting system and requirements for the data these reports must contain, and for how regularly they must be submitted to the national register by the operators. The national reporting system must be compatible with the reporting requirements contained in the safeguards agreement with the IAEA.¹¹

Non-nuclear weapon states **must place all their materials under IAEA safeguards.**¹² The application of comprehensive safeguards in accordance with INFCIRC/153 is

regarded as the minimum acceptable standard, while the application of the Additional Protocol in accordance with INFCIRC/540 is regarded as best practice.

A country **must participate in and comply with the requirements of all the international security regimes** that pertain to nuclear security, including the Convention on Physical Protection of Nuclear Material, UNSC Resolution 1540, and the International Convention for the Suppression of Acts of Nuclear Terrorism. In particular, a country must submit a national report under UNSC Resolution 1540.

Requirements to the operator

National regulations **must establish requirements for threat assessment** (vulnerability analysis). The results of vulnerability analyses must be used to specify requirements for the physical protection system of each individual nuclear facility. Regulations must specify minimum requirements for the frequency of regular vulnerability analyses; they must also specify the cases when a vulnerability analysis must be conducted immediately, regardless of when the previous analysis was conducted.¹³

National regulations **must specify requirements for assessing the effectiveness of physical protection systems**. If the assessment determines that the system is not sufficiently effective, remedial measures must be taken; their sufficiency must be confirmed by an ad hoc effectiveness assessment.¹⁴

Long-term sustainability of physical protection, control and accounting systems must be ensured.¹⁵ An operator must implement measures to ensure long-term sustainability of MPC&A systems. These measures must include the following:

- Organizing and planning MPC&A activities, including designating departments, officials, and coordination procedures necessary to perform MPC&A activities;
- Developing procedures and instructions for MPC&A measures;
- Personnel management and training;
- Repair, maintenance, and validation of MPC&A equipment;
- Evaluating the costs of operating MPC&A systems;
- Checking the performance and analyzing the state of MPC&A systems;
- Managing the configuration of MPC&A systems.

Regulations **must instruct operators to designate material balance areas at nuclear facilities for control and accounting purposes**, and establish requirements for material balance areas.¹⁶

Regulations **must require measurement-based accounting of nuclear material**. They must also specify requirements for measuring systems, including the precision of measurements made for material accounting purposes.¹⁷

Regulations **must specify requirements for assessing any discrepancies between the shipper and recipient during the transfer of nuclear material between organizations**, as well as the procedure for resolving the differences if those differences are above a certain threshold of discrepancy that may suggest a loss of nuclear material.¹⁸

Regulations **must establish requirements for taking a physical inventory of nuclear material**. There must be specific requirements for the frequency of taking an inventory depending on the category of nuclear material at the facility, and for situations that



require an ad hoc inventory to be taken without waiting for the next regular one. Regulations must contain specific requirements for organizing and conducting inventory-taking operations and for steps that must be taken when the discrepancy obtained during inventory taking is over a certain threshold that may suggest a loss of nuclear material.¹⁹

Regulations **must contain requirements for the procedure of assessing unmeasured technological losses and accumulations of nuclear material** in technological equipment.²⁰

Regulations **must require each nuclear facility to maintain a system of accounting and reporting** documents that shows the inventory quantity of nuclear material for each material balance area and any changes in the inventory quantity, including inbound and outbound material for each material balance area. Regulations must also specify requirements for the form and frequency of reports submitted by each nuclear facility to the national register of nuclear material so that the facility reports enable the state to fulfill its obligations under the safeguards agreement with the IAEA.²¹

Regulations **must specify requirements for physical protection, control and accounting of nuclear material and nuclear facilities depending on their category.** In particular, regulations must specify requirements for physical protection of Categories I, II and III nuclear material, including design solutions, physical barriers, technical means, and organizational measures. Regulations must establish requirements for the frequency of taking a physical inventory and using access control systems depending on the category of nuclear material.²²

Regulations **must contain a requirement that nuclear material and facilities must be protected by armed security guards.** Regulations must also contain requirements for the organization of armed security and its interaction with the nuclear facility and external emergency response forces in ordinary circumstances and emergency situations.²³

Regulations **must contain requirements for physical protection of nuclear material during transportation** at or above the minimum requirements recommended by the IAEA. In particular, there must be a requirement to conduct vulnerability analysis and effectiveness evaluation, and to provide armed security guards during the transportation of top-category nuclear material. Regulations must contain requirements for coordination between the shipper, recipient, and the authorized national agencies involved in providing physical protection during transportation.²⁴

Regulations **must contain a requirement for operators to conduct self-assessment of the state of their MPC&A systems** to assess their performance and compliance with regulatory requirements. When shortcomings are identified, remedial measures must be taken and their implementation must be monitored. This self-assessment must be performed in addition to inspections conducted by the regulatory authorities. Its purpose is not to identify violations or mete out penalties, but to maintain a constant and ongoing process of improvement.²⁵

PROVIDING ASSISTANCE TO IMPROVE NUCLEAR SECURITY IN THE NUCLEAR EXPORTS FRAMEWORK

The main, and in most cases the only source of nuclear material and technologies, which the nuclear newcomer countries require to develop their nuclear programs, is technologically advanced nuclear exporters who already have a wealth of nuclear expertise.

This opens up valuable opportunities to improve the state of nuclear security in the nuclear newcomer states.

In accordance with Nuclear Export Guidelines (INFCIRC/254/Rev.12), nuclear material and technology can be exported only on the condition that nuclear security measures are taken to prevent unauthorized use and application of nuclear material. These nuclear security measures must comply with IAEA recommendations stipulated in INFCIRC/225. Another necessary precondition for exports is that the importer country must have enacted a safeguards agreement with the IAEA that requires all source and special fissile material used in the current and future peaceful programs of the importer state to be placed under safeguards. This creates the framework for establishing a national system of nuclear material control and accounting.

The requirements contained in the Nuclear Export Guidelines are reflected in the national legislation of the exporter states. Russia, for example, has a government-approved regulation *Provisions on exports and imports of nuclear material, equipment, special non-nuclear material, and related technology*. These provisions stipulate that exports can be authorized only if the importer state has provided assurances of application of IAEA safeguards and if nuclear security measures in the importer state meet the minimum recommended requirements of the IAEA.

In addition to the obligations required of the recipient states by the exporter states in accordance with the Nuclear Export Guidelines, some exporter states also include measures to facilitate compliance with MPC&A requirements by the importer state in the extended package of services supplied along with the core set of technologies, equipment, and nuclear material. The provision of such support is part of the terms of all the agreements on peaceful nuclear energy cooperation Russia has signed with other countries.

A case in point is Russian cooperation with Turkey. In addition to building the nuclear power plant in Akkuyu, Russia is also providing support to Turkey in creating its national MPC&A infrastructure. Many of the regulatory documents and licensing requirements for the Akkuyu NPP were transplanted from the Russian regulatory framework. In particular, the following Russian documents have been used:

- *Standards of physical protection of nuclear material, nuclear facilities, and nuclear material storage sites*, approved by Cabinet Resolution No 456 of July 19, 2007;
- Federal norms and standards NP-030-05 *Basic standards of nuclear material control and accounting*;
- Federal norms and standards NP-083-07 *Requirements for physical protection systems for nuclear material, nuclear facilities, and nuclear material storage sites*.

These documents were used during the licensing stage, and the requirements they contain are part of the terms of the license. The nuclear facility must comply with these requirements during its operation.

MECHANISMS OF ASCERTAINING COMPLIANCE WITH MPC&A STANDARDS

The mechanisms of ascertaining compliance with MPC&A standards remain fairly limited. No compulsory checks or inspections are required as far as physical protection is concerned. As for control and accounting, indirect assessments can be made on the



basis of inspections held in the framework of the safeguards agreements between the IAEA and its member states.

The Convention on Physical Protection of Nuclear Material does not include any verification mechanisms. Under the terms of the convention, implementation of physical protection measures is the remit of national legislations and competent authorities of the member states.

The most comprehensive and well-regarded mechanism of assessing the state of physical protection of nuclear material and facilities is the International Physical protection Advisory Service (IPPAS) of the IAEA. IPPAS conducts its assessments at the request of any state that wants such an assessment to be made. The assessments are made by a group of experts convened by the IAEA on the basis of source information provided by the state being assessed. The following elements are assessed:

- Physical protection measures at the national level;
- Legislative and regulatory framework;
- Licensing and inspections;
- Coordination with other organizations and departments;
- Implementation of physical protection measures at individual facilities.

The criteria used for the assessments are defined by the Convention on Physical Protection of Nuclear Material, including amendments, and by IAEA guidelines, such as the aforementioned INFCIRC/225/Revision 5 Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities.

A report containing the results of the assessment is a confidential document, but it can be released into the public domain on the initiative of the state being assessed. The results are not used to compile any national rankings. The expert group that conducts the assessment also draws up recommendations and proposals; their implementation may be the subject of another assessment held at a later time.

In terms of the scope and of the results of the assessment, IPPAS is the most effective instrument available that can be used to improve the state of nuclear security. Nevertheless, IPPAS currently also has several drawbacks, some of which significantly reduce its effectiveness. First, its assessments are held on a voluntary basis at the request of the state being assessed, and the state is not mandated to follow its recommendations. Second, IPPAS missions do not cover nuclear material control and accounting issues, which are an important element of nuclear security.

The purpose of the application of safeguards, including inspections held in the Safeguards Agreement framework, is to ascertain that there has been no diversion of nuclear material from peaceful use to nuclear weapons programs. This means that formally, the inspections do not assess the state of the control and accounting systems in the country or at its individual nuclear facilities. Nevertheless, under the terms of Article 7 of a model agreement on safeguards, during inspections the IAEA takes into account the technical effectiveness of the national system. In other words, the effectiveness of nuclear material control and accounting systems is assessed during these inspections after all, albeit indirectly, and a positive report by inspectors demonstrates that the national nuclear material control and accounting system is adequate.

CONCLUSIONS AND RECOMMENDATIONS

Based on all of the above, the following conclusions can be made:

- Given the range and gravity of the existing threats, nuclear security must be regarded by the nuclear newcomer countries as one of the key responsibilities that follow from the acquisition of nuclear material and facilities.
- The main sources of expertise the nuclear newcomer countries require to put in place adequate MPC&A arrangements include IAEA recommendations, assistance from the nuclear exporters, and international mechanisms of assessing the state of MPC&A systems that can be used to receive feedback and recommendations.
- The system of international requirements and recommendations in the area of MPC&A covers the entire range of nuclear security measures. The existing documents stipulate fundamental criteria that can be used to assess the state of national MPC&A systems, as well as systems at individual nuclear facilities.
- The mechanisms of implementing these requirements and recommendations as well as controlling compliance thereof remain insufficient to ensure their uniform implementation in all the potential nuclear newcomer states.
- The mechanisms of nuclear export control provide a valuable opportunity to improve the state of nuclear security in the nuclear newcomer countries. The nuclear export guidelines contain a requirement to make sure that the state of nuclear security in an importer country is at or above the IAEA-recommended level. They also require the application of safeguards, which creates a framework for the development of a national MPC&A system.

The following recommendations can be made to achieve an adequate level of nuclear security in the countries that have recently launched or are about to launch nuclear energy programs:

- The scope of the assessments conducted by the IAEA in the IPPAS framework can be increased to cover nuclear material control and accounting. That would make it possible to produce detailed assessments of the state of national control and accounting systems — something that is not yet happening as part of the implementation of the safeguards agreements — and to provide recommendations to the states being assessed on how to improve these systems.
- Nuclear exporter countries should be encouraged to make the provision of assistance to improve the state of nuclear security in the importer countries part of the agreements and contracts they sign with these countries.
- Nuclear newcomer countries should be encouraged to invite IPPAS missions to conduct extended assessments that would include physical protection as well as material control and accounting issues. The adoption of a national plan of implementing any recommendations made by the IPPAS missions should be one of the elements of the programs to build the national infrastructure required to pursue nuclear energy development in line with IAEA guidelines. 

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- 23 IAEA documents do not contain a recommendation on providing armed security guards at nuclear facilities as a compulsory requirement. Nevertheless, we believe that this is an important requirement and crucial for achieving nuclear security goals.
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