SMALL MODULAR REACTOR: APPROACHES TO PHYSICAL PROTECTION PROVISION

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SMRs are newer generation reactors designed to generate electric power up to 300 MW, whose components and systems can be shop fabricated and then transported as modules to the sites for installation as demand arises.

There is increasing interest in small modular reactors (SMRs) and their applications. Many SMRs are envisioned for niche electricity or energy markets where large reactors would not be viable.

SMRs could fulfil the need of flexible power generation for a wider range of users and applications, including replacing aging fossil power plants, providing cogeneration for developing countries with small electricity grids, remote and off grid areas, and enabling hybrid nuclear/renewables energy systems.

Currently there are more than 50 SMR designs under development for different application.

According to IAEA document ADVANCES IN SMALL MODULAR REACTOR TECHNOLOGY DEVELOPMENTS there are three groups of SMR:

- land based
- marine based

other/mobile (only project).

Despite a small amount of nuclear material used in small modular reactors, it surely needs the organization of the relevant measures of physical protection provision. Let the author briefly analize the applicability of approaches to physical protection organization, which are described in the IAEA documents of PNS series, for each SMR type.

Onshore small module reactors: Russian specialists argue that the approaches to organizing physical protection of nuclear materials, which are given in the IAEA document NSS-13, are fully and completely applicable to this type of reactors. There is no fundamental difference from the organization of physical protection of reactors with the power of up to 300 MW and over 300 MW. The essential parameter is the category of nuclear material, on the basis of which, pursuant to NSS-13, a particular set of physical protection measures needs to be applied.

Offshore small module reactors etc.:

this type of reactors requires consideration of their life cycle, which includes the following basic stages:

1) platform construction;
2) power unit (unfuelled reactor) installation;
3) transportation to the deployment site;
4) fuel loading;
5) operation.

It should be noted that stages 3 and 4 may be swapped around.

For the context of physical protection, transportable SMR concepts (Transportable and/or Floating Nuclear Power Plants (TNPPs and FNPPs respectively)) are not "traditional" nuclear facilities but are considered nuclear facilities when stationary.

If the fuel is loaded prior to the unit transportation to the operation site, its physical protection must be provided in accordance with NSS-13 and also at the operation site.

During the transportation process (either as a part of the unit of separately from in), the physical protection of nuclear materials must be provided in accordance with the Security of Nuclear Material in Transport; NSS26-G.

Practical Experience: PP of FPU "Akademik Lomonosov"

- PPS of FPU is designed based on the fundamental principals that are applied for all nuclear facilities:
  - based on the threats analysis;
  - potential consequences of malicious acts.
- PPS of FPU is designed to take into account:
  - Location of the facility and nuclear material;

- Category II nuclear materials(uranium enriched to 10% 235U but less than 20% 235U; 10 kg or more);
- FPU whole life cycle:
  - platform construction;
  - installation of the power unit (reactor without fuel);
  - fuel loading;
  - transportation to the site;
  - operation;
  - decommissioning.

Based on the analysis, the results of which were announced, and in order to strictly comply with the requirements of international documents, the IAEA recommendation and Russian Federation legislation, the fuel for FPU was loaded in the one of Rosatom organizations, which has the license by the Russian regulatory authority, and where the physical protection was organized. At the same time, precise attention is paid to ensure the physical protection of the operation site of FPU:

- graded approach was implemented (4.5, 5.6 NSS 13);
- contingency plans were developed (4.19 NSS 13);
- response forces were fully prepared to conduct necessary response actions (4.20 NSS 13);
- access control regime was organized (4.24-4.28, 5.22-5.25 NSS 13).

From August 25 to September 14 2019, the transportation of FPU with two KLT-40S reactor systems from Murmansk to Pevek was successfully completed. The transportation was carried out with loaded fuel and with the crew on board. The physical protection and cooperation with competent authorities and response forces were organized.

In order to provide security during the transportation, set of documents was developed. These documents are necessary pursuant to Russian legislation and their content is consistent with the following documents:

- transport security plan (6.22 NSS 13);
- the contingency plans (6.22 NSS 13);
- written instruction for personnel (6.27 NSS 13).

The experience of the FPU transportation will be used by Russian Federation in international practice.

The methodology of design and evaluation of physical protection systems and measures are similar for each type of SMR. Each State and reactor type has its own threats in the area of nuclear security, but the methodology for developing physical protection measures, contingency plans and/or situations requiring emergency response remains the same.

Assuming that SMRs follow recommendations for a nuclear facility when operating and nuclear security guidance for nuclear materials during transportation, we can conclude that the current IAEA nuclear security documents are applicable to SMRs.

According to our experience, no changes in objectives and principles of PP system design and functioning in legislation were made. Some minor updates were introduced in existing regulatory requirements for PP of vessels (ships) with nuclear power installation to reflect few specific features of application of general PP requirements for floating nuclear power plant.

Experience in implementing nuclear security in SMRs may lead to modifications to guidance in the future. Therefore, Member States should continue collaboration in technical exchanges regarding design and evaluation for the physical protection of SMRs and IAEA Should extend this experience to develop specific guidance on SMRs if needed in the future.

REFERENCES

[1] ADVANCES IN SMALL MODULAR REACTOR TECHNOLOGY DEVELOPMENTS, IAEA.