Safety and security measures during transportation of dangerous goods class 7 (radioactive materials), taking into account the requirements of ADR

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Abstract: *Providing a VVER-1000 type NPP with the required amount of Fresh Nuclear Fuel (FNF) for any Nuclear Reactor System (NRS) energy campaign is of primary importance and is an element of the security of supply and the reliable operation of a NPP. According to the definitions in the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), FNF is dangerous cargo because it contains substances that are permitted for road transportation only under certain conditions. The transportation of FNF on Bulgaria's roads is carried out in strict compliance with the requirements of ADR.*

KEYWORDS: *NUCLEAR FACILITIES, PROTECTION OF NUCLEAR INSTALLATIONS, FRESH NUCLEAR FUEL (FNF), INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR)*

1. Introduction

The fundamental goal of capacity building is to enhance the abilities of relevant stakeholders to assess, establish and implement elements of a nuclear security regime.

The infrastructure needed for capacity building includes, among many other things, educational and training institutes with personnel competent in nuclear security, technical support centres, nuclear security laboratories and equipment, and the means to produce appropriate course materials.

In addressing how to build the capacity to establish, implement and sustain a nuclear security regime, it is necessary to look at the essential elements that should be in place and the underlying functions that make a security programme effective. The Nuclear Security Fundamentals [1] set out different essential elements of a nuclear security regime.

Capacity building programmes need to be tailored to the national infrastructure and resources that are available, but also to address these important and essential elements.

Taking into account importance of the problem, the European Agreement on the international transportation of dangerous goods by road ADR [2, 3] was adopted in Geneva on 30 September 1957 under the auspices of the United Nations Economic Commission for Europe and came into effect on 29 January 1968.

It was subsequently and repeatedly amended and supplemented. Currently, the ADR structure is aligned with the UN Recommendations on the Transport of Dangerous Goods, the International Maritime Dangerous Goods Code (IMDG Code) and the Regulation concerning the International Carriage of Dangerous Goods by Rail (RID).

2. Organizational and technical safety measures when transporting radioactive materials.

2.1. Purpose

The purpose of the ADR agreement is to ensure the protection of people, property and the environment from the effects of radiation when transporting dangerous goods of Class 7 (containing radioactive substances).

This protection is achieved by:

- sealing the radioactive contents;

- control of external radiation levels;

- prevention of a state of criticality;

- prevention of damage caused by thermal effects.

The transportation of radioactive material must be carried out in accordance with a radiation protection program, which consists of systematic prescriptions aimed at due compliance with radiation protection measures.

The nature and extent of the measures provided for in the program must be related to the degree and likelihood of radiation exposure. The following requirements form an integral part of the program:

- radiation doses must be below the permissible limit;

- when monitoring people or workplaces, appropriate documentation must be kept;

- workers must undergo appropriate radiation protection training.

2.2. Transportation of dangerous goods

Any enterprise whose activities involve the transportation of dangerous goods by road or related activities of packing, loading, filling or unloading of dangerous goods, must appoint one or more dangerous goods transportation safety consultant whose task is to help prevent the risks, inherent in these activities, to the public, to the various types of property or to the environment.

The safety consultant's duties more specifically are as follows:

- to monitor the compliance with the requirements governing the transportation of dangerous goods;

- to consult the enterprise on the transportation of dangerous goods;

- to submit to the management of the enterprise or to the local public authority an annual report on the enterprise's activities involving the transportation of dangerous goods;

- to monitor the procedures for compliance with the requirements concerning the identification of the transported dangerous goods;

- to monitor the enterprise's practice, when purchasing new vehicles, of taking into account the special requirements for transporting dangerous goods;

- to monitor the procedures for the inspection of equipment used for the transportation, loading and unloading of dangerous goods;

- to monitor the availability of appropriate and responsible training of the employees and the workers in the enterprise and the keeping of records of this training;

- to implement emergency procedures in the event of an accident and/or incident;

- to investigate and, if necessary, to report any serious accident, incident or serious violation documented during the transportation, loading or unloading of dangerous goods;

- to take appropriate measures to prevent the recurrence of accidents, incidents or serious infringements;

- to comply with the regulatory provisions and special requirements for the transportation of dangerous goods when selecting and using subcontractors or third parties;

- to check that all employees and workers involved in the transportation, loading and unloading of dangerous goods have detailed working instructions;

- to introduce measures to increase the knowledge on the risks inherent in the transportation, loading and unloading of dangerous goods;

- to introduce procedures for checking that vehicles carry the safety documentation and equipment which must accompany transport shipments and that these documents comply with the regulatory requirements;

- to monitor is the availability of a security program (plan).

2.3. Technical measures for transportation of Fresh Nuclear Fuel (FNF).

The delivery of fresh nuclear fuel (FNF) for the VVER- 1000 type Nuclear Reactor System (NRS) is usually carried out using transport packaging containers (TPK) of the TK-C5-B type.

According to the TPK certificate, the package identification is RUS/3014/IF-96 and the UN classification cargo designation is UN number UN 3324 Low Specific Activity Radioactive Material Group 2 (LSA-II), fissile.

The materials that are defined as Low Specific Activity ones (LSA-II) must meet the following condition:

- when the activity is distributed throughout the substance, the calculated average specific activity must not exceed 10^{-4} A_2/g according to item 2.2.7.2.3.1.2. of ADR, where the permissible value of A_2 for neutron emitting nuclides is up to 9 x 10^{-5} TBq, according to table. 2.2.7.2.2.2. of ADR - Basic radionuclide values for unknown radionuclides or mixtures.

- according to [4, 5], the approximately determined activity A of a fresh heat releasing cartridge with 4.4% enriched U^{235} is 0.5Ki, which means that the specific activity a[Bq/g] is a = A/m = 18.5GBq /500kg = 0.037GBq/kg = 37Bq/g, where the mass of the radioactive substance (here nuclear fuel) m is approximately 500kg.

On the other hand, the permissible value of the specific activity is aperm = $9*10^{-5}$TBq*10^{-4} = $9*10^{-9}$TBq=9KBq/g.

Therefore, aperm>a (9KBq/g>37Bq/g).

This means that the considered radioactive material Fresh Nuclear Fuel (FNF) can be transported safely using the proposed transport packaging in accordance with the requirements of ADR.

3. Measures to ensure transportation security

3.1. Security program (plan).

Carriers, freight forwarders and other participants in the transportation of high-risk dangerous goods (including radioactive material) are required to adopt and effectively implement security-related plans that cover at least the following elements:

- specific assignment of security-related responsibilities to persons equipped with knowledge and qualifications and having the necessary powers;

- recording and reporting of the relevant dangerous goods;

- assessment of the current operations and the resulting security risks, including stoppages and instances of the dangerous goods remaining in the transport vehicles due to the conditions of the transportation and/or the specific road conditions;

- a clear presentation of the measures to be taken to reduce security risks;

- effective and up-to-date procedures for reporting and countering threats, security breaches and other incidents;

- procedures for evaluating and verifying security plan, as well as the procedures for periodical reviews and updating of the programs;

- measures to ensure the physical protection of the transportation information contained in the security plan;

- measures to guarantee that access to the shipping information contained in the security plan is allowed only to persons who need that information.

For the purpose of exchanging information on possible threats, the carriers, consignors and consignees should cooperate with each other and be prepared to implement appropriate security measures and to respond to security threats.

3.2. Road transportation safety measures.

Prior to the road transportation of the radioactive material, it is necessary to carry out the following:

- all critical points must be determined ;

- the local traffic police must be notified about the transport transit time;

- the vehicles must move in a column signaled in accordance with the Road Traffic Regulations and observing the maximum speed set by the Nuclear Regulation Agency (NRA) for the specific transport and route;

- traffic police posts must be placed at all intersections to block the movement of vehicles, people and animals along the column route;

- the column must be headed by a traffic police vehicle;

- at a distance of 1 km in front of the column, a pilot car must move ahead to explore the road and notify the column in good time of any obstacle;

-the transport vehicles must be escorted by NPP Departmental Security vehicles and a specialized vehicle equipped as necessary to measure and control the radiation situation;

-the drivers of the column vehicles must receive instructions on the specific features of the route and the critical points and must know the regulations for communication with each other, with the NPP Departmental Security and with the traffic police authorities.

4. Interfaces with nuclear safety

Nuclear security and safety have the common aim of protecting persons, property, society and the environment. Security and safety measures have to be designed and implemented in an integrated manner to develop synergy between these two areas and also in a way that security measures do not compromise safety and safety measures do not compromise security [1].

When building the capacity for nuclear security, there will be direct interfaces with nuclear safety. In addition, there may be interfaces with nuclear safeguards such as in nuclear material accounting and control.

In practical terms, this means that there are likely to be many areas where building the capacity of regulators or operators can follow a common approach. In some cases, basic competences may be the same (e.g. using equipment for detection, and identification of radioactive material). In other cases, the individuals may be the same (e.g. inspectors having responsibilities in both safety and security).

Furthermore, a person with an education and experience in nuclear safety may work in nuclear security or safeguards for some portion of their career.

A major interface where capacity building may overlap is in emergency management. Safety and security will both be major considerations in addressing nuclear or radiological emergencies arising from nuclear security events.

Although preparedness and response for a nuclear security event is different from that for a nuclear or radiological emergency, the response arrangements need to have the capacity to work together seamlessly for the protection of the public and the environment [6].

The capacity to implement a nuclear security regime rests largely in countries laws and regulations, its organizations and the people in those organizations.

Consequently, these also affect, either directly or indirectly, the implementation of safety and material accounting and control, especially at nuclear facilities.

Therefore, the capacity that is developed at the regulatory and facility level should take into consideration how security will be applied and how this interfaces with other programmes such as safety.

For example, if there is a single regulatory body for safety and security, then that regulator might share resources for its rulemaking, inspection and enforcement. These resources represent the capacity of the regulator to perform its duties.

As another example [7], a nuclear facility operator needs to implement all requirements for safety, security and nuclear material accounting.

Therefore, it is most effective and efficient if the management systems, procedures and personnel at the facility are designed to take maximum advantage of shared facilities, equipment and resources and to work together to achieve their respective goals (to the extent possible, taking into consideration the differences between these areas).

4. Conclusions

The transportation of Class 7 dangerous goods on the roads of Europe is a highly responsible activity where compliance with the regulatory requirements of ADR is mandatory.

First and foremost come the technical safety measures, such as the availability of properly selected packaging for the transportation of the specific material, availability of a certificate of intended use and shelf life of the packaging and details of the design algorithm and tests carried out on the packaging during manufacture

Secondly, but no less important, is the existence and the implementation of a program (plan) for security during transportation.

The development of such a program is a specific activity requiring competences in the fields of security management, public order protection, traffic control, and operational combat training and police systems organization.

A professionally prepared security program is a good prerequisite for securing the road transportation of Class 7 materials (according to the requirements of ADR) in normal and emergency situations related to natural disasters, malicious acts or the threat of radioactive (nuclear) terrorism.

Building capacity for nuclear security should be undertaken via a systematic approach that includes provisions for assessment, planning, implementation, documentation, evaluation and feedback.

This approach should be developed as part of a national security policy and implementation strategy. Before initiating the approach, the government should decide which organizations should coordinate the approach at the national level.

Furthermore, each organization with responsibilities should assign a unit to perform the necessary work.

Building the capacity of organizations and people to establish, implement and sustain a nuclear security regime is an essential responsibility of an each country.

Analysis of national nuclear security needs and existing infrastructure should drive the development of capacity building programmes to combat the threat of sabotage or the use of nuclear or other radioactive material for malicious acts, and to prepare effective response measures to nuclear security events.

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