MANAGEMENT OF NUCLEAR SAFETY AND SECURITY SYNERGY

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ABSTRACT

After “9/11” terrorist attack in New-York, more attention paid by the international community to prevent and to combat the nuclear and radiological terrorism. In this context, features of the Design Basis Threat (DBT) for nuclear installations, especial for Nuclear Power Plants (NPP) were revised. Also, after Fukushima NPP accident, a set of detailed analyses were performed to assess the NPPs behavior under severe accidents conditions induced by external events like strong earthquakes and flooding (tsunami waves), beyond safety design basis. Recently was revealed by the IAEA DG that “a nuclear power plant became the target of a disruptive cyber-attack two to three years ago, and there is a serious threat of militant attacks on such plants”. Other relevant threats on general public is represented by smuggles of radioactive materials which could be used to build a radioactive dispersion devices (RDD), so-called "dirty bomb". The paper provides an analysis of the nuclear safety and security synergy in the light of maximization of the nuclear installations protection efficiency, including cyber-attack threats. Based on the lessons learned of the above presented events, the paper is underlining the main conclusions derived from un appropriate management of nuclear safety and security interfaces.

1. Introduction

The terrorist attacks in the USA, on September 11, 2001 surprised by the extent of the consequences and by the unconventional way in which the terrorist groups acted. The events in New York and Washington D.C. imposed a wide re-evaluation of the actions plans in order to prevent and fight against nuclear and radiological terrorism from designated national authorities and international organizations. The means of fighting against terrorist actions based on the use of nuclear weapons of mass destruction or highly radioactive materials spread by classic means (dirty bombs) were analyzed in depth. All these analyses were developed starting, for the first time, from the assumption of the suicidal terrorist who handles highly radioactive materials, considered to be self-protected until September 11, 2001.

The following definitions of nuclear safety and security are described by the IAEA Safety Glossary [1], as follows:

- *Nuclear safety:* “The achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards.”;
- *Nuclear security:* “The prevention and detection of, and response to, theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities.”

Based on the dictionary definitions [2], the nuclear safety/security synergy can be defined as the interaction of nuclear safety and nuclear security specific elements that when combined produce a total effect that is greater than the sum of the individual elements effects.

Both nuclear safety and nuclear security have a common objective, mainly to protect people and environment from potential radiological hazards generated by the nuclear and radiological installations.

2. International context

Last year investigations related to the terrorist attacks in Belgium shows the terrorist interests for nuclear installations but also several cyber-attacks were launched on NPPs. According to ICSR's latest estimate, the number of foreigners that have joined Sunni militant organizations in the Syria/Iraq conflict continues to rise. The total now exceeds 20,000 – of which nearly a fifth were residents or nationals of Western European countries [3]. Fig. 1 provides an estimation of foreign fighter total in Syria/Iraq, by Western European countries.

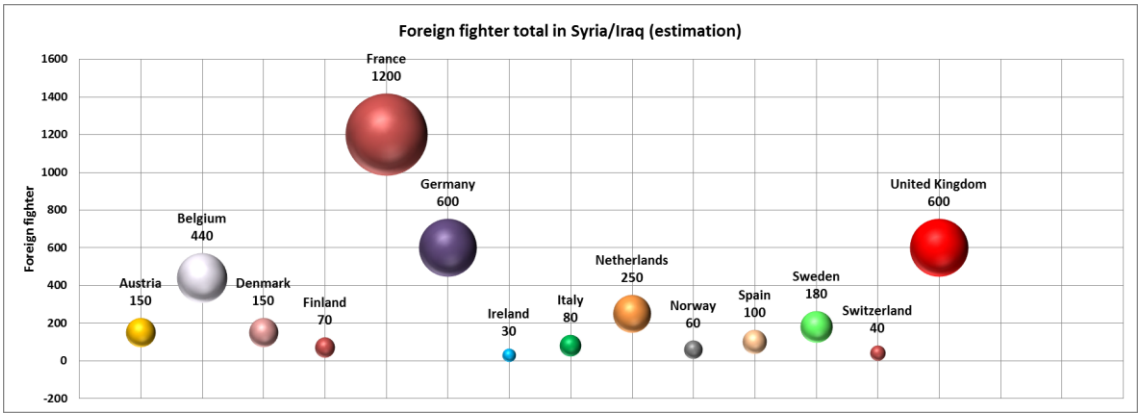

Fig. 1 Foreign fighter total in Syria/Iraq (estimation) [3]

In this context, it's clear that the risks of increasing threats on nuclear installations are already in place. This is the reasons why more attention is needed to be paid for using as much as possible the synergy between the nuclear safety and nuclear security.

3. Nuclear Safety/Security Synergy Maximization

The initiating events which can affect the level of nuclear safety and/or nuclear security are due to human errors and/or equipment failures, the internal and/or external hazards or an event induced by malicious actions. The risks for nuclear installations, workers, population and environment are evaluated with various types of safety analyses and also with the assessment of internal and external threats possible to occur.

During the assessment process, beginning with Design Base Accident (DBA) and Design Base Threat (DBT), the maximization of the synergy between safety and security would be obtained by correlated technical and administrative measures, as like as, design concepts and criteria, operating principles, emergency response, use of a graded approach [6].

The reasons for a joint safety and security requirements analyses are to determine the potential hazard of the facility. The power and source term, fuel design and handling, amount and enrichment of fissile materials, existence of high pressure or high energy piping, quality of means of confinement, siting and proximity to population are used in graded approach.

Fig. 2 shows main steps in assessing the synergy between nuclear safety and nuclear security.

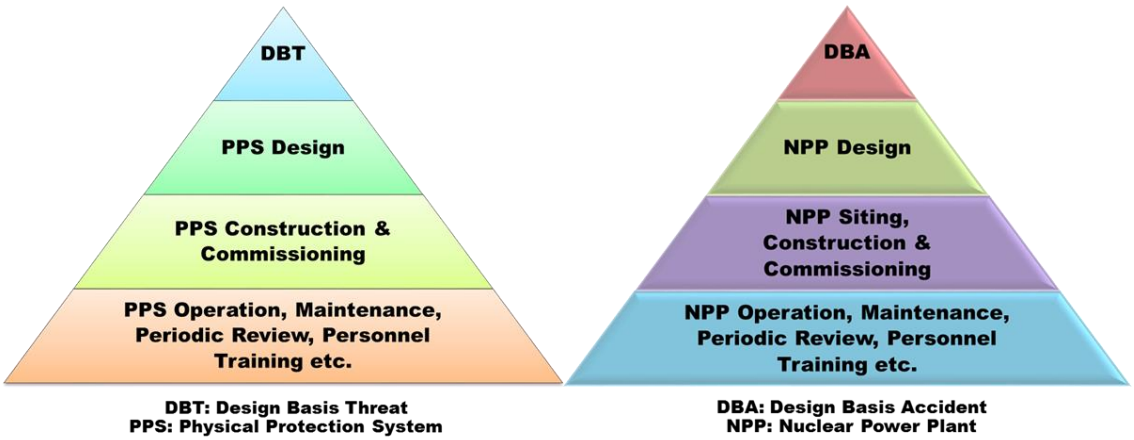

Fig. 2. Main steps in assessing the synergy between nuclear safety and nuclear security.

4. Prevention of nuclear terrorism

The basic principles that show the adoption of the measures of prevention and fight against nuclear terrorism may be listed as follows:

- Full compliance with the provisions of international treaties, conventions and agreements regarding the non-proliferation of weapons of mass destruction;
- Ensuring an appropriate legislative framework and a national infrastructure suited for safe execution of nuclear activities, both for the control authorities and the operators of nuclear facilities;
- Use of nuclear energy for peaceful purposes;
- Transparency in carrying out nuclear activities;
- High-level implementation of nuclear and radioprotection security standards;
- Thorough implementation of the measures of prevention and fight against nuclear and radiological terrorism;
- The actions of export/import in the nuclear fields must be maintained under a strict control;
- Sustained activities for the prevention and fight against illicit traffic of nuclear and radioactive materials; and
- Wide international cooperation in the nuclear field.

At the national level, a number of actions are recommended by Nuclear Security Summits, as follows:

- *Evaluation of system efficiency:* evaluation of the physical protection of nuclear facilities;
- *Evaluation of operating security:* review of the security of nuclear facilities during operation;
- *Transport:* evaluation of the physical protection of the nuclear materials during transport and/or of the transport systems;
- *Evaluation of the design and protection of nuclear facilities:* evaluation of the designs of nuclear facilities from the point of view of their solidness and resistance to acts of extreme violence;
- *Border detection:* evaluation of the needs regarding the equipment for border monitoring and support for the IAEA member states in financing, purchasing and installing such equipment. In the support of such activity, guides will be drawn up in order to define and identify the appropriate equipment which may be used by the states to detect and

respond to the illicit border traffic. The efforts to improve the detection technology will be accelerated by coordinating the necessary activities of research and development.

- *Databases with illicit traffic incidents*: improvement of the database program in order to provide much more comprehensive and efficient knowledge regarding nuclear security (including activities related to nuclear terrorism) and better cooperation and information follow-up mechanisms.
- *Improvement of the state response to captured materials*: organizing exercises in the IAEA member states in order to test the coordination and response to simulated, but credible situations involving captured materials. Specific recommendations of improvement may be made for each country, based on the results.

Defense-in-depth model for nuclear security and cyber security in the nuclear context [5], should be described as follows:

- Legislation;
- Regulatory Framework;
- Licensing Process (see Fig. 3);
- Integrated Management Manual (Quality Assurance Program);
- Training & Qualification;
- Good Operating & Maintenance Practices;
- Intrusion Detection Systems;
- Approved Procedures;
- Security Systems; and
- Physical Barriers.

5. International Adopted Strategies

The international strategies for preventing and combating the nuclear terrorism and radiological terrorism were discussed and adopted during the Nuclear Security Summits, in Washington (2010), Soul (2012), Hague (2014) and Washington (2016).

It is known that the fields in which the international community may effectively contribute include establishing and applying the international norms and standards, the exchange of information within international forums, the identification of deficiencies, the proposal of strategies to eliminate the deficiencies identified and coordinating the bilateral and international support.

The protection of nuclear materials against thefts and sabotage, fight against the illicit traffic of nuclear and radioactive materials are priorities included in the action plans combined at a national and international level. An example in this respective is the Global Threat Reduction Initiative (GRTI), launched by the US and to which the Russian Federation and other states adhered. In this context, an important role is represented by the program of return to the Russian Federation of the highly enriched nuclear fuel from the nuclear research reactors delivered by the former USSR to some countries of the world, Russian Research Reactor Fuel Return (RRRFR) Program. Romania took part in this program and transported to the Russian Federation all the enriched nuclear fuel from the research reactor VVR-S of the Nuclear Physics and Engineering Institute – “Horia Hulubei” (IFIN-HH). The transport was made by air, which represented a world premiere.

Fig. 4 shows the partners in the RRRFR project for Romania. Also, the highly enriched nuclear fuel from the TRIGA research reactor in Piteşti was returned to the US, and the reactor core was converted for use of the low enriched fuel. The actions undertaken for the two nuclear research reactors, which were financed by the US, eliminated the risk of use of the highly enriched nuclear fuel from Romania for possible terrorist actions.

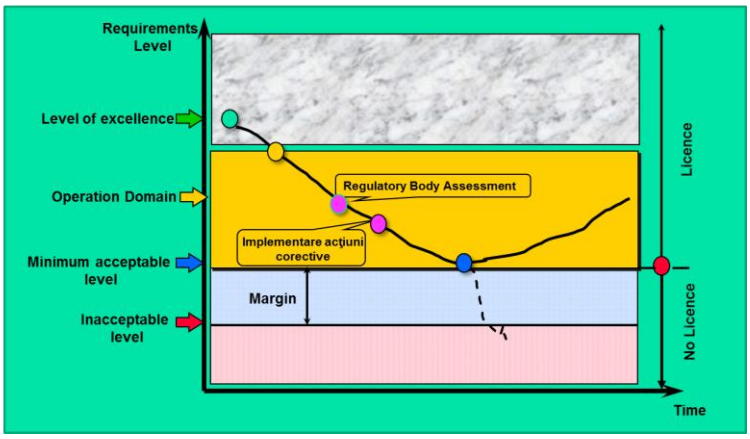

Fig. 3 Licensing process - principles

Fig. 4. RRRFR Project for Romania – Partners [8], [9], [10].

6. Conclusions

Taking into the consideration the lessons learned after the Fukushima NPP nuclear accident, terrorist intensions to attack NPP and recent cyber attacks on NPP, a number of initiative at international lever are necessary to be continued beyond Design Basis Accident (DBA), beyond Design Basis Threat (DBT), Design Basis Cyber Attack (DBCyA) similarly to the action taken for investigations of test stress after Fukushima accident. In order to maximize the synergy between the nuclear safety and security, a number of actions should be taken beginning with the nuclear projects, as follows:

- The safety/security synergy should be consider from the design stage of nuclear installations;

- Full security measures on site should be in place before commissioning phase of nuclear installations; and

- Cyber Security specific measures should be implemented in correlations with nuclear safety and nuclear security measures.

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