
Physical Protection, Accountancy and Control Systems Vulnerability Assessments

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Abstract: The so-called "Security Studies" constitute one of the major tools for evaluating the provisions implemented at facilities to protect and control nuclear material (NM) against unauthorized removal. Operators use security studies to demonstrate that they are complying with objectives set by the Competent Authority to counter internal or external acts aimed at unauthorized removal of nuclear material. The paper presents the context of security studies carried out in France.

1. INTRODUCTION

The national control system set up in France is designed in such a way that physical protection, control and accountancy of nuclear material complement each other and form a coherent whole. It is placed under the Authority of the Minister for the Industry as represented by the High Civil Servant for defence of this ministry (Competent Authority).

The French regulatory system lays down a performance-based approach rather than a compliance-based approach. It is oriented towards the detection and prevention of any loss, theft or diversion of nuclear material usable for the fabrication of a nuclear explosive device.

Emphasis has to be laid on the fact that prime responsibility for the security of nuclear material rests with the operator, holder of the relevant licence. To do so, the operator has to take all the necessary measures to guarantee the protection, control and accountancy of his nuclear material. In other words, he must define the principles of his protection, control and accounting systems and then put them into practice. He must also devise the procedures necessary for the satisfactory functioning of the various equipment of the systems. In particular, he exercises his responsibility over the maintenance of the equipment, periodic tests for checking its satisfactory functioning and the achievement of the required performance, the definition of operating procedures, the training of personnel, the execution of periodic exercises, etc... Moreover, the operator has to prove that his arrangements satisfy the objectives specified by the authority. Consequently, he has to produce various files and notably vulnerability assessments also known as security studies.

The measures taken by the operator could be analysed in the frame of a "defence in depth" approach. This concept of defence in depth is organised around prevention, management of the event and mitigation as regards the unauthorized removal of nuclear material. It takes the form of several lines of defence including both administrative aspects (such as procedures, instructions, sanctions, access control rules, confidentiality rules, ...) and technical aspects (multiple barriers fitted with detectors and delaying devices). Provisions taken in the field of material control and accountancy constitute one line of defence and provisions taken in the field of physical protection constitute an other one.

2. REGULATORY ASPECTS

The French Competent Authority requires, by ministerial instruction, that specific studies, known as security studies, be carried out to assess the effectiveness of the security arrangements taken for the most sensitive types of nuclear material. These studies can be divided into two types depending on their scope. The first covers the physical protection area and the second, the nuclear material control and accountancy area.

The security studies cover storages and facilities in which nuclear material are kept, produced or processed. They are used to assess the effectiveness and reliability of the control and protection provisions made to prevent internal or external action aimed at the theft of a significant quantity of nuclear material, and if necessary, to deal with such an event. They are focused on plutonium and high enriched uranium (HEU), stored in amounts higher than 2 and 5 kg respectively (these are the thresholds for Category 1).

On a practical point of view the process involves the following regulatory steps :

- A study is performed by the operator concerned who is responsible for the security of nuclear material held in his installations,
- The study and its conclusions are assessed by the Institut de Radioprotection et de Sûreté Nucléaire (IRSN) acting as technical support to the Competent Authority (SIEN : Control of nuclear material, Ministry of Industry),
- The security study and its conclusions are submitted to the Competent Authority for approval.

After examination and on the basis of the assessment report produced by IRSN, the Competent Authority confirms by letter whether or not an authorization can be granted for holding, transferring and using nuclear material in the concerned facility. If need be, he can ask the operator to modify the existing arrangements or to make new ones, the implementation of which can then be verified during an inspection.

Of course security studies have to be carried out in compliance with the corresponding confidentiality rules. In addition, such studies have to be regularly updated, notably if significant modifications are made in the material control and accountancy or physical protection systems.

It is important that security studies are available in the facilities for competent personnel, as it gives the rationale behind control and protection of nuclear material. In particular, it could be used, in a performance-based approach, to support analysis reports or to illustrate that the required level of security has been reached.

Security studies have begun, in France, for more than fifteen years. Up to now more than fifty security studies are available in the field of physical protection and most of them have been revised at least once.

To go ahead preliminary security studies in the field of material control and accountancy have been performed by operators of two different types of facilities, the results of which are very encouraging. A more detailed security study was carried out for a nuclear manufacturing facility. It shows the relevance of the performance-based approach. At the same time a security study in the field of physical protection was carried out for the same facility. This work underlined the complementarity between these two types of studies.

3. HOW TO STEAL NUCLEAR MATERIAL

The potential unauthorized removal of nuclear material usually may take place in two stages. The first stage involves the sequence leading to handling of the nuclear material. It occurs inside the physical barriers of a facility and may include action involving the documents corresponding to material control and accounting systems. At this stage it is possible to limit the risk of unauthorized removal of nuclear material by means of detection capabilities of the material control and accounting systems. The second stage is more specific to theft and involves removing the nuclear material out of the physical barriers of a facility in which they are being held, notably by affecting the physical protection system.

4. SECURITY STUDIES

The philosophy of these studies is based on a postulated unauthorized removal of nuclear material and the study of the behaviour of the systems implemented to control and protect nuclear material in a facility. This postulated removal is laid down with reference to the design basis threat specified by the competent authority for the purpose of these studies. Both internal and external threats are taken in account. The external threat is more specific of the security studies in the field of physical protection.

- Steal of small quantities of nuclear material without being discovered by one or more employee who usually have access to the nuclear material,
- Steal of a significant quantity of nuclear material all at once by one or more employee who may or may not have access to the nuclear material,
- Steal of a significant quantity of nuclear material by outsiders. Two assumptions are considered (1) a small team of attackers with limited resources, (2) a larger team of attackers with more sophisticated resources.

The operators have to study, from a quantity and time lapse point of view, the ability of the installed systems to detect unauthorized removal, as well as the possibility of tampering with the systems to mask unlawful operations. They have also to analyse the sequences during which nuclear material are accessed, removed from their containment and further removed from the facility in which they are stored. At each stage in the process, the probability of detection and the time taken to carry out the above actions have to be estimated. Of course, these two types of studies complement each other.

With more than fifty security studies in the field of physical protection, France has a large experience. Some of these studies have underlined the need to upgrade the physical protection system of particular facilities or nuclear sites. It was also underlined that the physical protection system could not be efficient enough to preclude the theft of small quantities of nuclear material. For this reason a new type of security study based on a control and accountancy approach has been developed. Up to now three security studies, already performed, underline the relevance of this approach. A fourth one is under preparation.

4.1 In the field of physical protection

In the field of physical protection, security studies are based on an analysis of all the possible paths leading to nuclear material in compliance with the design basis threat. This may involve crossing zones or outwitting detection devices and overcoming obstacles implemented by operators at the facility for physical protection purposes. By following the paths mentioned above, the probability of undetected persons (or nuclear material) as they progress in the facility is evaluated. The moment at which this probability is sufficiently low as to be able to assume that the unauthorized removal has been detected, is determined. Then the time elapsing between positive detection of the action performed by the adversaries and the removal of the nuclear material from the facility is estimated. Critical paths are taken as being those along which nuclear material can be removed from the facility in the shortest time after detection. Special care is taken when analysing these paths.

A security study is performed for each facility housing sensitive nuclear material located on a nuclear site. In addition, for complex sites a specific security study is carried out for the whole of the site. The objective of this study is to evaluate the effectiveness and the consistency of the provisions taken at the site level to protect nuclear material. This site security study complements each facility security study, and focus on the physical protection of the central alarm station and the interaction between the inside and/or outside response forces. The site security study describes the actions of response forces since the detection of an alarm till the forces are in position to interrupt the adversary attack. The efficiency of this action is based on a quick location of the adversaries and the time required to deploy the response forces which has to be as short as possible. In this matter, the fences surrounding the site could be considered as a significant device to stop the adversaries and allow the recovery of the nuclear material

The time required by the response forces (inside response forces and/or outside response forces) to counter each type of threat according to the scenarios previously identified are analysed namely :

- the procedures applied by the local security forces in the event of an alarm and the times and the means associated with these procedures,

- the resources available to the security forces,
- the physical protection and security of the means used to alert the authorities.

Finally potential upgrades are proposed by the operator to deal with the potential weak points identified by the security study, such as :

- delay devices could be increased by strengthening the physical barriers notably along the critical paths,
- new points of detection could be placed upstream to make delay more efficient for the response forces,
- physical protection of the nuclear material, its containment and the means of surveillance used could be strengthened,
- intrusion detection methods and personal checks could be improved,
- procedures followed in the event of alarms, resources of the inside response forces and how they are protected and, more particularly, the ways of alerting if necessary the outside response force could be updated,
- resources of the outside response forces, if applicable, could be redefined.

4.2 In the field of material control and accountancy

In the field of material control and accountancy, when unauthorized removal or dysfunction occurs, a discrepancy appears between the physical reality of nuclear material and the way in which it is represented in the material control and accountancy systems. This discrepancy remains latent until detected. Consideration is given to the scenario between creation of the discrepancy and its detection. It should be noted that possible detection of the discrepancy by the physical protection system is not covered by such studies, since this type of detection gives no information on either the effectiveness or the reliability of the material control and accountancy systems.

In other words, an assumption is made that such a discrepancy exists in compliance with a set of threats. Then, the purpose of the security study is to analyse the way in which the discrepancy is revealed in connection with a discovery threshold amount, if any. The duration of all possible scenarios is calculated and the possibilities of failure of the detection are taken into account in the study.

A critical scenario is defined as one which leads to discrepancies involving substantial amounts of material or for which the time periods before detection are long. Special care is taken when analysing these scenarios. The time elapsed before detection could be long if one or more point of control are bypassed or if nuclear material have been replaced by dummy material. Of course possible diversion of nuclear material held in waste or in scrap material need to be carefully studied notably if such material are without control for a long time. Careful examination is also necessary for scenarios in which detection depends on the presence of two persons (two person rule criterion) or depends on organizations not directly concerned by measures taken by the operators to protect and control nuclear material (safety or radioprotection requirements for example).

Events which have enabled the discovery of the latent discrepancy are examined by studying the associated functions. A verification is made of the pertinence of the function for each of the situations or states that can arise in the facility (maintenance or emergency situations for example). A verification is also made to establish that the function in question is effectively a material control and accountancy matter. If not, and if detection strongly depends on this item, it will probably have to be integrated in the material control and accountancy systems. Thus the radioactivity detection system could produce alarms in case of unauthorized removal of nuclear material, but these alarms, which have to be taken into account by the staff in charge of radiological matters, could not be taken into account by the staff dealing with protection of nuclear material if there is no provision to do that.

Moreover if the function's reliability is deemed not sufficient, it should be disregarded as a detection capability. As an example the two person rule could be not sufficient enough according to the cases to detect unauthorized removal of nuclear material.

For critical scenarios, a sensitivity analysis is performed to determine whether a quantity of material less than that considered for the purpose of the security study would have resulted in the same detection, possibly with a different time period. Care is, of course, taken to evaluate the quantity of material below which detection would probably not have taken place. The sensitivity analysis makes it possible to determine the threshold of

detection of the discrepancy. This threshold may vary according to the nature of the measures performed (for example measure of weight, volume, concentration, radiation). The adjustment of the equipment used to make measures and its associated procedures have to be considered.

Possible improvements of the material control and accountancy systems are examined using the above approach when needed. Potential upgrades have to be proposed by the operator to deal with the potential weaknesses identified by the study. For example possible improvements could include :

- measures related to control (choice of measurement points, physical inventory methodology, etc.),
- accountancy procedures,
- comparison of the actual situation of the nuclear material held in the facility with its representation in the material control and accountancy systems,
- independence between the material control system and the accountancy system,
- organization of the work of the staff in the different phases of the lifetime of the installation.

5. CONCLUSION

Vulnerability assessments in the fields of physical protection and of control and accountancy are complementary. They allow for an accurate knowledge and performance of both systems to protect and control nuclear materials against loss, theft or diversion.