# French lessons learnt regarding

# interfaces between security and

# safety and safeguards, for smrs

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**Abstract**

The French nuclear regulatory framework comprises three distinct areas: Safety, Security and Safeguards, each of which is overseen by different regulatory bodies.

The coordination among these authorities is crucial, with regular meetings held to facilitate information exchange.

The paper will present the current experience with this coordination between the Nuclear Security Authority and the other two authorities.

Among other things, it will address the following issues:

- Major safety enhancements incorporated in the design of these SMRs may not be relevant to nuclear security;

- As a consequence, synergies between safety and security for SMRs could have limited potential compared to normal reactors, as malicious attacks could have the potential to destroy a more important part of the reactor at once;

- The cost of nuclear security could be proportionately higher and perhaps similar to the cost of safety, whereas for historical reactors it is often significantly lower.

## INTRODUCTION

For the first time, nuclear power was included in the final agreement of COP28 as a potential solution for combating global warming. Many project leaders are exploring the potential of nuclear power due to its enhanced safety performance and ability to close the fuel cycle, which makes it a valuable asset. Small modular reactors (SMRs) represent high-stakes projects offering flexibility, modularity and small size.

In its project ”France 2030”, the French government has acknowledged that nuclear power presents significant challenges for research and development, which are directly linked to the government's objectives. To support innovation, the French government has earmarked 1 billion euros of public funds for investment in the 'France 2030' initiative. The objective is to facilitate the development of innovative nuclear reactors and the emergence of new players in the market. The government has reaffirmed its support for new concepts of innovative nuclear reactors, in the fields of nuclear fission or fusion.

In light of this, numerous French project leaders have responded to the call for projects under the 'France 2030' initiative and have obtained subsidies. There are approximately twelve project leaders in France, each at different stages of their respective projects. All of these nuclear start-ups are currently in the design stage, with the goal of having their first reactor operational by 2026 or in the 2030s. Some of these companies have set a goal of providing hundreds of reactors before 2050. Given the challenges of implementing 'security by design', it is crucial that the Nuclear Security Authority provides support to these start-ups from the outset.

This will help to raise their awareness of nuclear security issues and enable them to better understand the concept of “security by design”.

In order to proceed with their reactor projects, project developers must obtain approval from several authorities: for the security, safety, and safeguards aspects of their projects. The 3S (safety, security, safeguards) present a number of complex issues. The 3S approach is a crucial element of success for these project leaders. However, there are numerous interfaces between these three areas, which can impede the success of the project.

How can designers ensure that all three S (safety, security, and safeguards) are properly coordinated and taken into account at the early stage of the design?

## Safety, security, safeguards (3S)

In France, different authorities oversee nuclear matters: the French Nuclear Security Authority, the French Nuclear Safety Authority, and the EURATOM Technical Committee. These bodies address safety, security, and safeguards issues for nuclear sites. Unlike the Nuclear Safety Authority that is responsible for control, the Nuclear Security Authority is in charge of issuing regulations, authorisations and carrying out inspections.

The table below gives an overview of the French organisation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Laws | Regulatory body | Control body | Inspections |
| Safety | Environment Code | Ministry of Ecological Transition and Territorial Cohesion | French Nuclear Safety Authority (ASN) | Safety inspections by ASN |
| Security | Defence Code | Ministry of Ecological Transition and Territorial Cohesion / Department of Nuclear security (DSN) | Ministry of Ecological Transition and Territorial Cohesion / Department of Nuclear Security (DSN) | Security inspections by DSN |
| Safeguards | Euratom Treaty + IAEA commitments + international agreements | Prime Minister Office | Euratom Technical Committee (CTE) | Safeguards inspections by Euratom and the IAEA |

*Table 1: French regulatory framework overview*

In practice, large companies operate the current installations, and both operators and authorities have extensive experience of working together. Nuclear sites were constructed several decades ago, and new facilities, such as the Flamanville EPR reactor, are constructed on these premises. The concept of ”security by design” is implemented to a limited extent due to the existing security framework. The basis for this approach is the French nuclear DBT, which is classified information under the national defence security.

The French Nuclear Security Authority faces challenges with SMR projects due to a lack of practical knowledge of nuclear security among designers and the confidential nature of the DBT. As a result, the French Nuclear Security Authority has developed a guidance [1], to assist the designers in understanding nuclear security.

Initially, many SMR/AMR designers lack a comprehensive understanding of the French regulation pertaining to nuclear security. It is often the case that the focus is mainly on safety, which can result in an underestimation of the importance of security and safeguards. It is, however, essential to consider all three aspects (safety, security and safeguards) as early as possible.

In fact, incorporating 3S considerations from the design stage onwards will significantly reduce future project development costs.

However, it is essential that designers ensure their measures comply with all three regulations and avoid any conflicts between them. While there may be positive synergies among these three regulations, there are also risks of incompatibility.

### Safety and security interfaces

In accordance with the French Environment Code and Ministerial Order of 7 February 2012, it is mandatory to include a description of accidents from a malicious origin in the safety study, accompanied by a rationale justifying the adaptation of safety measures and emergency plans to address such accidents. French regulations require that safety measures must be compatible with security regulation.

Furthermore, the ministerial order of 13 April 2023 requires that security measures must be compatible with safety regulation and that synergies must be sought with safety (and radiation protection, health and safety of employees, environment protection and regulations regarding security of critical infrastructure). The security study must be consistent with the safety study.

The French regulation establishes interfaces between safety and security.

Besides, many project developers rely on the safety measures taken as the basis for demonstrating nuclear security. In other words, they consider ensuring security of their reactor by its intrinsic safety. These assertions must be demonstrated and justified in close cooperation between the Nuclear Safety Authority and the Nuclear Security Authority.

The project sponsors are developing innovative reactors with numerous technological innovations and intrinsic safety. The safety demonstration provided by project developers is generally of much use for the identification of targets. Nevertheless, it is often not sufficient for the security demonstration.

For example, effects of explosives on a component or fuel are generally not taken into account in terms of safety, while they are important in terms of security. A solution optimized only from the point of view of safety can be a security disadvantage.

On top of that, numerous design choices have been made by operators to ensure the passive safety of their reactor. However, the loss of passive safety functions can have significant safety consequences and constitute targets of major importance. Indeed, it is not feasible for passive safety systems to be in a non-functional state. Therefore, the loss of this equipment is an unlikely occurrence for the safety authority. As a result, these scenarios are not included in the safety demonstration. Nevertheless, the absence of operation of a passive system, which is considered highly unlikely in safety terms, may be the target of a malicious attack. The occurrence of such an attack is known to be beyond the scope of a probability calculation.

Furthermore, existing high-power nuclear reactors are equipped with backup circuits that enable the control of accident scenarios and the mitigation of their consequences, as exemplified by the safety injection circuit. In the case of large reactors, the operator include safety redundancy in their security demonstration, given that the safety elements are physically distant or protected. This redundancy can make it difficult for a successful act of sabotage to succeed, and thus create a positive safety/security synergy. However, in the case of an SMR, given its size, an act of sabotage inside the SMR enclosure could destroy all the safety equipment at once.

As a consequence, synergies between safety and security for SMRs could have limited potential compared to normal reactors, as malicious attacks could have the potential to destroy a more important part of the reactor at once. However, it is important to note that there are still interesting synergies between safety and security, such as insider threat and cyber security.

Safety design choices can also have security design consequences, such as the choice of the reactor structure and containment. It is crucial to identify all potential synergies between safety and security as early as possible in the project design process. It is therefore essential that authorities work together to share information, which has become increasingly important in light of recent developments. Start-up employees working on safety must collaborate with employees working on security side to identify potential interfaces and design bottlenecks. This will enable them to reconcile safety and security measures.

All security design choices must be made with safety considerations in mind and vice versa. The objective is to eliminate, from the beginning, all potential conflicts.

### Security and safeguard interfaces

One of the unavoidable links between security and safeguards is the nuclear materials accounting and control (NMAC) system. France is subject to EURATOM control. In France, the Institute for Radiological Protection and Nuclear Safety (IRSN), which is the technical support organization (TSO) for the French Nuclear Security Department, French Nuclear Safety Authority and for the EURATOM Technical Committee is responsible for centralised accounting. The data from the centralised accounting is transmitted to EURATOM, to provide information on the presence of nuclear materials, control access to these materials and detect their loss or diversion, while guaranteeing the integrity of these systems and measures.

The NMAC system helps to deter and detect the unauthorised removal of nuclear materials by maintaining an inventory, including information on their location. In France, centralised accounting is used to supply EURATOM, as well as to account for national accounting, which is a regulatory requirement in nuclear security. Consequently, accounting is shared between nuclear security and international safeguards. The design features could result in penalties for accounting managed by the IAEA or by the French Nuclear Security Department. Project developers must therefore consider the requirements of both nuclear security and international safeguards to ensure compliance with all regulations and identify potential improvements to these two requirements.

Furthermore, the reactors proposed by the designers are more compact, smaller and more complex than existing French nuclear power plants, which necessitates additional security considerations. The physical layout and access controls of the facility have a direct impact on both security and safeguards. The IAEA must be able to gain access to the facility, particularly to areas or materials that might otherwise be inaccessible for nuclear security reasons. It will be necessary to make arrangements to enable IAEA to carry out these verifications while reconciling nuclear security measures.

Moreover, the IAEA implements surveillance measures that do not rely on national surveillance systems. The designer must consider the implementation of both national and international monitoring systems from the design stage, ensuring that these systems do not interfere with each other.

These interfaces require significant input from the designers, who must also consider safety.

### Safety, security and safeguards interfaces

In addition to the direct bilateral Safety-Security and Security-Safeguards interfaces, new security-safety and safeguards interfaces have been identified by French authorities.

One of the key points raised by the French authorities is the need to ensure the reliability, quality and security of information for all remote data transmission planned in the three areas and for other purposes, notably operations. Indeed, many project developers have expressed a desire to conduct remote operation and monitoring of their reactors.

Furthermore, there are other potential synergies between the three areas in terms of structural design. For instance, the same barrier can play several roles, in terms of safety, security or safeguards. In addition, internal procedures in the event of an accident or emergency must also take account of all three S to ensure compliance with regulations.

Please refer to the fig.1. below for an illustration of some of the interfaces.

Intrinsic safety/security

Information on nuclear materials

Materials accounting and control

Personnel security

Design

Information

Computer / cyber security

**Safeguards**

**Security**

**Safety**

*FIG.1. Illustration of some of interfaces between Safety, Security and Safeguards*

### Cooperation between French Authorities

To assist SMR designers in keeping pace with existing operators, the French Nuclear Security Authority developed a tailored approach. The Nuclear Security Authority cooperates with other nuclear authorities, such as Safety and Safeguards, and services of the ministries responsible for supporting SMRs to ensure that a start-up would be aware of all the interfaces.

The Nuclear Safety Authority and the Nuclear Security Authority have launched regular bilateral exchanges of information, as it was already done between the Nuclear Security Authority and the CTE.

The Nuclear Safety Authority invites the Nuclear Security Authority to participate in seminars with project developers. These ongoing and fluid exchanges facilitate the identification and examination of various interfaces between safety and security domains.

Safety experts possess more experience in anticipating hazards or issues that may arise during reactor start-up or operation, in particular for “first of a kind” reactors, whereas security experts might not consider these aspects. Engaging in safety discussions provides a better understanding of various security issues at all levels, taking into account the expertise of safety professionals. This involvement allows for the consideration of impacts on both safety and security. Through these meetings, the DSN has identified new security challenges. For instance, significant security issues could arise if core unloading should occur unexpectedly. Additionally, questions have been raised about the on-site storage of assemblies or waste.

Moreover, these exchanges keep the Nuclear Security Department updated and enhance their understanding of reactor operations, enabling the identification of potential attack scenarios.

Nevertheless, it also provides insight regarding potential malicious acts into the knowledge levels of safety experts, which can be problematic. The start-up culture can be an obstacle to counter internal threats.

Similarly, the interfaces between security and international safeguards are addressed through regular exchanges between the two authorities. A number of emails and meetings are held to discuss with the various designers and on their projects.

What's more, a new method of exchange has emerged with the advent of SMRs: 3S meetings. Meetings between the three authorities have been organised to discuss with the designers and share the various advances and blocking points of each authority. The Nuclear Security Authority has noted the importance of these meetings, which have proved to be highly relevant and informative.

### Are the 3Ss enough?

The French Nuclear Security Authority (DSN) has reinforced the 3S approach for addressing SMRs. However, SMRs have led to greater cooperation between stakeholders at ministerial level. .

Indeed, the issue of SMRs is an inter-offices matter that extends beyond the 3S. In France, national energy policy must consider all issues, especially security. French energy policy needs to determine the different types of nuclear energy use required, financial aspects, employment areas, locations where energy is needed, available electricity networks, security capacities in various territories, and public acceptance. It is essential to understand security within the context of national energy policy.

Security must be understood at the highest level by decision-makers, including those not directly involved.

Information sharing between stakeholders is therefore of great importance. The Nuclear Security Authority has encountered significant questions about the level of information shared and the need to know. Should reference threats be shared? The Design Basis Threat (DBT) involves defining acceptable risk levels for nuclear material security. This information is crucial for the decision-makers shaping French energy policy, as the DBT could influence their decisions on SMR deployment.

Today, these information-sharing questions are being discussed, weighing the pros and cons. The French Nuclear Security Authority organizes biannual meetings with all government offices concerned with SMRs, including authorities responsible for energy policy. This type of meeting is new for the Nuclear Security Authority, which operates independently of French energy policy. However, these meetings are essential to ensure security issues are considered at the highest level, both in the development of French energy policy and in the general organization of the French response in case of an attack.

## CONCLUSION and perspectives

SMRs introduce a new approach to working that differs significantly from traditional methods. There is a need for enhanced coordination and integration of the three S, both among designers and authorities, and even more.

The Nuclear Security Authority has restructured its organisation to facilitate closer cooperation with other authorities. Regular meetings have been scheduled, and there will be constant communication with designers to encourage them to consult with other authorities on specific matters as their project processes.

As designers make more concrete progress with their projects, there is a possibility that closer coordination and cross-instructions will emerge.

As a result, coordination between the various stakeholders is a key issue to the development and deployment of SMRs.

References

[1] French Nuclear Security Department, Nuclear security – Guide on French Regulations for Small Modular Nuclear Reactor Designers, April 2024