Non-proliferation and security: synergy and differences

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Summary
Operators of nuclear facilities put in place both physical and organisational means to meet in a comprehensive way the requirements associated with Nuclear Non-Proliferation, Safety and Security. The common aim is to protect man and the environment from ionising radiation. The approaches for meeting these requirements have real similarities, but also differences which need to be respected in order to develop an appropriate synergy for obtaining the best possible level of safety, security and non-proliferation. This article aims to show the provisions that have been taken with regard to non-proliferation, security and safety which complement and reinforce each other.

Introduction
The aim of peaceful and safe use of nuclear energy in the world has led the international community to develop a legal framework in the four main fields of safety, security, non-proliferation and civil responsibility in case of nuclear accident. The main texts which govern the peaceful and safe use of nuclear energy are, for each field:

- Non-proliferation: INFCIRC/153 concerning the structure and content of the agreements to be concluded between the Agency and States under the framework of the Treaty on the Non-Proliferation of Nuclear Weapons, and INFCIRC/540 concerning Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards;

These international texts have become national obligations and form a set of constraints which operators of nuclear facilities must take into account in order to obtain the licences required for their activity.

Although with regard to non-proliferation, the commitments appertain to the States, it is actually the operator who has responsibility for nuclear material accountancy, and it therefore bears first responsibility for safety and security.

From the nuclear operator's perspective, the constraints relating to nuclear safety and security as well as non-proliferation should all be taken into account during design of the facility, during its operation and during its dismantling. This convergence of the three Ss (Safety, Security and
Safeguards) has been the subject of several exchanges over the last few years, especially at IAEA where the requirements resulting from these texts are discussed. Although there are synergies between Safety, Security and Safeguards, these three components of peaceful and safe use of nuclear energy should not be mixed up.

From the concept of 3 Ss to that of 4 Ss

Before examining the synergies and differences between these three fields, it should be pointed out that nuclear Security has two different aims: the security of nuclear material (protection against theft and misappropriation) and sabotage of the facilities (protection against release of radioactive products) containing it. This paper will discuss four separate fields:

- Safety,
- Sabotage,
- Security of nuclear material,
- Non-proliferation.

An initial analysis of these four fields shows that:

- The initiator of the dreaded event is the State for proliferation, the individual (or group of individuals) for nuclear material security and sabotage and human and equipment failures as well as natural hazards for safety;
- The event we wish to protect ourselves against is the development of nuclear weapons for non-proliferation, the use of an improvised nuclear device for nuclear material security and the release of radioactive substances for sabotage and safety of facilities;
- The targets to be protected are nuclear material for non-proliferation and nuclear material security, and safety functions for sabotage and safety;
- The four fields share, in twos, common protection provisions. Non-proliferation and nuclear material security share nuclear material accountancy and confinement and surveillance systems. Nuclear material security and sabotage share the function of physical protection of the facility. Sabotage and safety have common approaches of redundancy and physical separation of safety functions.

All these points are summarised in the following table:

<table>
<thead>
<tr>
<th>Safeguards NPT</th>
<th>Security NM security</th>
<th>Sabotage</th>
<th>Safety</th>
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</thead>
<tbody>
<tr>
<td>Initiator</td>
<td>State</td>
<td>Individual</td>
<td>Human or equipment failures, natural hazards</td>
</tr>
<tr>
<td>Dreaded events</td>
<td>Nuclear weapon</td>
<td>Improvised nuclear device</td>
<td>Radioactive releases</td>
</tr>
<tr>
<td>Targets</td>
<td>Nuclear material</td>
<td>Nuclear material</td>
<td>Safety functions</td>
</tr>
<tr>
<td>Some main features</td>
<td>Accountancy C/S</td>
<td>Accountancy C/S</td>
<td>Redundancy physical separation of safety related equipments</td>
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<td></td>
<td>Physical protection</td>
<td>Physical protection</td>
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</tbody>
</table>

This table shows that, in twos, the four fields have common points but these are limited to particular points and cannot be confused.
**Common methodologies**

**Similar organisational principles**

Nuclear operators are the first to be responsible for the safety and security of their facilities and this responsibility cannot, under any circumstances, be delegated. This first responsibility rests on the same fact for both safety and security, namely that the operator, better than anyone, can identify the risks associated with its activities, detect deviations from requirements concerning safety, security (sabotage and nuclear material security) and non-proliferation and remedy them. In this context, operators:

- devise, implement and maintain the technical provisions that enable appropriate levels of safety and security to be reached, while in particular meeting regulatory requirements;
- implement a quality system in the fields of safety and security, in particular ensuring a first level of control;
- ensure the competence of their staff in particular by appropriate training;
- inform the competent authorities of events that could endanger the safety or security of their facilities or nuclear material.

The State ensures that the responsibilities of each (operators, authorities, etc.) are clearly defined. However, protection in respect of malevolent acts requires a different position and broader and more direct involvement of the State in both security and safety.

**Similar design principles**

**Graded approach**

This approach is one of the fundamental principles used in the design of a facility. It consists of evaluating the issues for man and the environment in terms of potential consequences of accidents or malevolent acts, in order to ensure commensurate provisions for preventing and limiting the consequences.

**In-depth defence**

In-depth defence is also a general principle used in design. Many different provisions, whether physical or organisational, are put in place in a balanced way to prevent the risk of malevolent aggression or natural hazard and the risk of accident.

<table>
<thead>
<tr>
<th>Operational states</th>
<th>Accidental conditions</th>
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<tbody>
<tr>
<td>Normal operation</td>
<td>Anticipated operational occurrences</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Accident management</td>
<td></td>
</tr>
</tbody>
</table>

**Emergency/contingency plans**

**Redundancy and physical separation**
Moreover, certain design principles relating to safety significantly increase the efficiency of the protection of a facility against malevolent acts. Thus safety measures make wide use of the “single failure criterion”. This criterion dictates that a facility should be designed to be able to ensure certain functions even if a system or equipment involving these functions has failed or is unavailable. Thanks mainly to the application of this criterion, aggressors must reach several targets in the facility in order to provoke an accident situation. Similarly, the aggressor’s actions may be hindered by the implementation of rules of diversification and physical or geographical separation, used for safety in the design of a facility. These technical measures reduce the relative sensitivity of each equipment and the impact of sabotage perpetrated by persons with limited means or time to carry out their actions.

Similar operating principles

The main principles governing the operation of nuclear facilities and equipment and transport systems are identical with regard to safety and security.

The same requirement for daily monitoring

The operator must have full and permanent knowledge of the facility, and of both systems involved in safety and those involved in security, with strict monitoring of equipment availability, the modifications and developments affecting the installation, temporary palliative measures, etc. The availability of safety and security systems is ensured by periodical checks and preventive maintenance. If necessary, compensatory measures are taken if unavailability is discovered. These operating measures, aimed at checking the conformity and availability of the facility, help limit the risk of malevolent acts by the surreptitious deterioration of the safety level of the facility.

The same need to process experience feedback

The events which constitute equipment failures, irregularities identified, human errors and attempted sabotage are recorded and processed so as to avoid their recurrence. However, it may be a delicate matter to identify precisely the malevolent origin of an event. At all events, each incident is analysed by the operator whether it is linked to safety or security, with appropriate analysis of possible aspects relating to human factors. The lessons learnt from incidents occurring in the facility or in other similar facilities make it possible to improve safety or protection against malevolent acts. There must be periodical feedback of operating experience in the two fields of safety and security.

Safety and security cultures

A fundamental point is the need to develop both a safety culture and a security culture. They are based on very similar principles (specific commitment of each operator’s Manager, promotion of these cultures, training and awareness, etc.). Both are manifested in three main fields. The first concerns the policy implemented by the State. The second consists of the organisation put in place by the various operators. The third concerns the attitude of staff.

The two cultures should not be set against each other, and one should not take precedence over the other. It is not conceivable to fuse these two cultures into one, but they must co-exist and reinforce and enhance each other. Any complementary aspects of safety and security, and their underlying cultures, must be researched and developed.

It should be noted that the need to develop the principles of a non-proliferation culture has not arisen yet.
What are the common provisions?

Before examining the common provisions, it should be remembered that nuclear material safety is based on three complementary and independent provisions:

- Physical protection: measures for preventing, detecting or delaying any unauthorised or unjustified movement of or access to nuclear material in the areas where it is situated;
- Physical tracking: measures authorising the movements of nuclear material and its control with the aim of detecting any attempted fraud during one of these movements. These measures are based on precise and permanent knowledge of quantity and quality of entries/exits of material to/from the places where it is stored and also knowledge of its location, use, movement and possible processing (continuity of knowledge);
- Accountancy: this is an independent way of controlling the physical tracking. It is based on daily knowledge of the stocks of material held in the mass balance areas and of the material entry/exit movements.

Material security and Non-proliferation

The common provision is nuclear material accountancy and continuity of knowledge.

It should be noted that INFCIRC/225 rev. 5, which lays down recommendations in the field of nuclear material security, does not define the requirements relating to the instructions for putting in place a material accountancy system. This is not satisfactory, but work is in progress to prepare a Security Series guide entitled “Guidance on Nuclear Material Control and Accountancy for Nuclear Security at Facilities”, work in which security and non-proliferation experts are participating.

Material security and sabotage

The joint provision is the physical protection system. Its three components: detection, delay and response, are designed to deal with the two risks, and are based on:

- the two reference threats (theft and sabotage);
- the two types of targets, nuclear material for theft and sensitive equipment for sabotage.

Material security and safety

There are very few common provisions. It may nevertheless be noted that:

- physical monitoring of the security of nuclear material may be seen as good practice for safety, with regard to controlling confinement;
- control of access can help limit accidental exposure to ionising radiations.

On the other hand, use of the nuclear material accountancy system should be excluded from safety provision for managing the risk of criticality, for several reasons:

- risks of criticality may be prevented in five ways: control by neutron poisoning, moderation, equipment geometry, fissile material mass and concentration of fissile material in solution. Only the latter two methods require measurements of nuclear material;
- when there are material measurements, the mass of fissile material is evaluated within the working unit where the risk of criticality must be in control and the accounting balance (material security) is carried out within the material balance area. These two areas are different because they are defined with a view to preventing independent risks;
- If there are common measurement points (mass or concentration), the result of the measurement and the related uncertainty are handled in different and incompatible ways.
**Sabotage and safety**

The level of protection of man and the environment must be the same whether the hazard is voluntary (sabotage) or involuntary or natural (safety). For this, the design, operating rules and emergency plans are evaluated on the same bases for the two situations (robust design, risk limitation, etc.).

The malevolent act of sabotage is an “intelligent” aggression, contrary to natural aggressions or failures taken into account in safety. This involves some specific features:

- The need to manage the confidentiality of sensitive information;
- Greater commitment from the State:
  - In collecting information to evaluate the reference threat and the actual threat;
  - In the response to an aggression on the site (special intervention units, mine clearance, etc.);
  - To screen the persons who need to have access to sensitive activities or information.

**Material security, sabotage and safety**

Operators and public authorities work out emergency/contengency plans to limit the consequences of a theft of nuclear material, and in an accident situation, release of active products and the associated consequences. These plans must cover not only equipment failures and human error, but also malevolent acts. The plans for protecting a facility, in terms of security, are designed to stop malevolent aggressions and secure the premises so that the operators can carry out the actions to limit the consequences. The implementation of protection plans thus precedes the implementation of emergency plans concerning safety, and constitutes a specific line of defence for preventing a malevolent act. It is particularly important that these plans (protection and emergency plans) are drawn up by agreement between the safety and security managers, and that they are complementary and consistent. It is also necessary for intervention to be coordinated. These plans are very similar in terms of methodology (simple activation criteria, clear organisational change, predefined strategies, crisis exit criteria, etc.). An important point to note is that the safety and security plans are not activated independently. In actual fact, the activation criteria should not prejudge the origin of a failure (voluntary or fortuitous) or the final objective of an intrusion. This implies than when one of these criteria is reached, the reflex phases of the two plans must be activated, with discrimination taking place during the reflection phase (removal of doubt).

**Conclusion**

It is important that, in nuclear facilities, the provisions taken to meet requirements relating to safety, security (nuclear material security & sabotage) and Safeguards form a homogenous and consistent whole and so complement and reinforce each other. Considerable work still remains to be done to define and explain the specific features of these four fields (the 4Ss) and how they converge. This aim of convergence will require active participation of experts in the four fields in examining the documents produced, especially by the AIEA. It is a fundamental concept for improving the peaceful and safe use of nuclear energy in the world.