

Assessing Tracking Systems for High-risk Radiological Sources

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Abstract

The European Commission has entrusted the IRSN with a study to identify and analyse organisational and technological solutions for the tracking of high-activity sealed radioactive sources in order to improve their security aspects against malevolent acts. This study concerns the security of radioactive sources in a facility or during transportation activities.

In order to define and assess a tracking solution, the functional requirements that must be met by a tracking system have been defined. These are defined on the basis of the general security functions (detection, response) but also on the potential radiological consequences in case of a malevolent act. These last ones are mainly characterized by the activity and the accessibility of the source. The paper will address how technical and organizational measures can be set depending on the activity and the accessibility of the radioactive source during transport.

A list of data on commercial off-the-shelf (COTS) technologies has been established as well as practices implemented by few operators. The functional requirements relating to these various practices or technologies are analysed, along with details of their advantages and disadvantages.

Finally, guidance on further actions on the security of high-activity sealed radioactive sources with tracking systems is proposed.

The place of tracking in radioactive source security

The European Commission has entrusted the IRSN with a study contract to identify and analyse administrative and technological solutions for the tracking of high-activity sealed radioactive sources (HASS) in order to improve their security aspects, and to examine the operational feasibility of deployment from these solutions. In this study, the term "tracking" covers technical and organisational measures that are used to provide information on the location of a radioactive source at a given time, in real time or otherwise.

Tracking solution functional requirements

In order to define and assess a tracking solution, the functional requirements must be defined, adopting a graded approach in order to do so. The consequence level of each source must therefore be identified; this is mainly characterised by its activity and its accessibility (ease of access), which depends on the technical and organisational measures. These functional requirements must be defined on the basis of the general security functions: deterrence, detection, delay and response.

These functional requirements must be met by one or more elementary measures that make up the tracking solution, such as a physical tracking system based on bar codes or RFID tags, a GPS system, an emergency beacon, positioning via mobile telephony Cell ID, etc. Tracking solutions are proposed for sources that are located in a facility, in storage or on a site, and in transport.

List of available tracking practices and technologies

A list of data on commercial off-the-shelf technologies and the practices and technologies implemented by operators has been established. The functional requirements relating to these various practices or technologies are identified, along with details of their advantages and disadvantages.

The practices relating to organisational measures vary in complexity, ranging from a simple visual inspection upon receiving a source to a sophisticated physical tracking system for sources. Their effectiveness greatly depends on the company's robustness in terms of its security culture, physical protection and training, the structure of its chain of responsibility (including for subcontracting), quality assurance, etc. Although setting up a robust organisational measure does not, in principle, create any noticeable issues for a medium-sized or large enterprise, it may be more difficult for small businesses, for which it is difficult to envisage separating the appropriate roles at the staff level, providing the employees with specialised training, etc.

The following points should be remembered regarding technical measures:

- There is currently no commercial off-the-shelf electronic technology for remotely localising the sources themselves in real time, given the level of radiation and the dimensional constraints resulting from the sources' small size. The basic tracking measure will therefore be placed on the source-holder, such as the device, the transport package or the vehicle in the case of transport.
- The commercial off-the-shelf technologies are, in general, not tested under all of the sources' operating conditions, such as the device's or the package's level of irradiation, the temperature or the environment (dust, vibrations, etc.). This will result in qualification programmes being defined and performed for an elementary tracking measure as soon as it is to be used in high-risk sealed radioactive sources.
- The implementation of elementary tracking measures could result in the design of some source packaging being revised, or even another application for its approval.

In the case of sources located in a facility, the commercial off-the-shelf real-time geolocation technologies for locating the device containing the source are complicated to implement, particularly if one wishes to detect that the device is no longer in the expected place. Because these measures generally use radio waves that do not pass through walls or buildings.

- In the case of sources in transport, the real-time geolocation of packages equipped with a GPS system does not always work inside a vehicle. Similarly, potential interference with other operating systems must also be taken into account, for example in the case of air transport. On the other hand, vehicle geolocation is technically feasible and is already deployed by some carriers of high-risk radioactive sources in order to improve the logistics, safety and security of their transport.
- By combining geolocation (GPS) and identification (RFID tag) technologies with various sensors (radioactivity or opening sensor, etc.), a package in a vehicle can be tracked in real time and its theft or diversion detected. The feasibility of such a tracking solution is accepted. Nevertheless, no commercial off-the-shelf system capable of adapting to the wide variety of currently-known packages and source use environments has been found.

Some elements of detailed information could not be obtained in this study: although the cost of a basic tracking measure such as a GPS tag can be assessed, for example, it is more difficult to assess the cost of setting up organisational tracking measures. In addition, a company's organisation and existing operation may be affected if new measures with additional constraints are implemented. On the other hand, it may improve source logistics management, as the use of an identification technology such as bar codes or RFID tags, both of which are widely

deployed in many fields, improves the traceability of source movements while also facilitating their management (maintenance, replacement, etc.). In addition, these technologies simplify the preparation of the mandatory regulatory tracking documents relating to the possession of radioactive sources and may be useful in the field of radiation protection by reducing the amount of exposure resulting from the performing of inventories and various checks. These identification and tracking technologies are also used to locate a source in interval mode by knowing the last geographical position at which the source's position was checked.

Tracking measure security analysis

In general, the threats to be taken into account when defining a security system are defined by the State. They are often confidential, and therefore not public. In addition, there are inconsistencies in the approach adopted by different countries regarding the security of high-risk radioactive sources. That is why it was not possible to study the tracking measures' security aspects on the basis of the threats involved. Nevertheless, we have defined potential attack scenarios in which elementary tracking measures must meet their functional requirements, and we have assessed the knowledge, skills and means required in the attack concerned. The origin of these attacks may be inside or outside the company.

Tracking solutions

This study proposes adopting an approach to defining tracking solutions that provide security for high-risk radioactive sources by combining elementary tracking measures that meet the functional requirements and are the most resistant to malicious acts. In defining a tracking solution, this approach also takes into account other considerations contributing to source security (training, employee screening, etc.). It also identifies additional organisational or technical measures that could be implemented in order to reinforce the proposed solution ("two-person" rules, etc.). The study has revealed that most commercial off-the-shelf technologies are vulnerable to attacks that are easy to carry out.

The need for continuous tracking when several carriers are involved in the multi-modal transport of a high-risk source means that the tracking information must be centralised. This exists for the tracking of nuclear materials in transport, and an operational centre for this tracking is generally the State's responsibility.

Conclusions and prospects

The study presented in this report shows that a single elementary measure alone is not able to ensure the tracking of a high-risk radioactive source. As a general rule, several mutually-complementary elementary measures must be combined in order to form an effective tracking solution. In addition, the setting-up of a tracking solution is only conceivable if it complements a physical protection system that is suited to the nature and the risks associated with the radioactive sources to be protected from malicious acts. This study also shows that various tracking solutions can be set up that are suitable for different configurations and for different types of radioactive sources, whether they are in use, in storage or in transport.

Lastly, this study has identified the following areas requiring further investigation:

- qualification of the elementary tracking measures for the sources' conditions of use: radiation, temperature, environment, etc.;
- securing of the means of data communication provided by the tracking systems in order to protect them from the risk of jamming or falsification;
- the advantages of setting up an operational centre in order to centralise and coordinate the tracking information on high-consequence radioactive sources.